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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
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Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
 - 1 presented to TSG for information;
 - 2 presented to TSG for approval;
 - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

- shall** indicates a mandatory requirement to do something
- shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

- should** indicates a recommendation to do something
- should not** indicates a recommendation not to do something
- may** indicates permission to do something
- need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

- can** indicates that something is possible
- cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

- will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document
- will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document
- might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

1 Scope

The present document specifies the protocols for Proximity-based Services (ProSe) in 5G system as specified in 3GPP TS 23.304 [2] for:

- a) 5G ProSe direct discovery;
- b) 5G ProSe communication over the PC5 interface;
- c) 5G ProSe-enabled UE-to-network relay; and
- d) 5G ProSe-enabled UE-to-UE relay.

The present document defines the associated procedures for 5G ProSe service authorization, 5G ProSe direct discovery (e.g. the procedures between 5G ProSe-enabled UE and 5G Direct Discovery Name Management Function (DDNMF) over the PC3a interface, the procedures over the PC5 interface), 5G ProSe UE-to-network relay discovery, 5G ProSe UE-to-UE relay discovery and 5G ProSe direct communication.

The present document also defines the message format, message contents, error handling and system parameters applied by the protocols for ProSe in 5GS.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document in the same Release as the present document.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 23.304: "Proximity based Services (ProSe) in the 5G System (5GS); Stage 2".
- [3] IETF RFC 9112: "HTTP/1.1".
- [4] IETF RFC 9110: "HTTP Semantics".
- [5] 3GPP TS 24.526: "UE policies for 5G System (5GS); Stage 3".
- [6] OMA-WAP-TS-PushOTA-V2_1-20110405-A: "Push Over the Air".
- [7] OMA-AD-Push-V2_2-20110809-A: "Push Architecture".
- [8] WAP-168-ServiceLoad-20010731-a: "Service Loading".
- [9] 3GPP TS 29.555: "5G System; 5G Direct Discovery Name Management Services; Stage 3".
- [10] 3GPP TS 29.503: "5G System; Unified Data Management Services; Stage 3".
- [11] 3GPP TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3".
- [12] 3GPP TS 23.003: "Numbering, addressing and identification".
- [13] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol Specification".
- [14] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station (MS) in idle mode".

- [15] 3GPP TS 38.304: "User Equipment (UE) procedures in Idle mode and RRC Inactive state".
- [16] 3GPP TS 38.323: "NR; Packet Data Convergence Protocol (PDCP) specification".
- [17] 3GPP TS 24.555: "Proximity-services (ProSe) in 5G System (5GS); User Equipment (UE) policies; Stage 3".
- [18] 3GPP TS 24.587: "Vehicle-to-Everything (V2X) services in 5G System (5GS); Protocol aspects; Stage 3".
- [19] 3GPP TS 29.557: "5G System; Application Function ProSe Service; Stage 3".
- [20] 3GPP TS 24.007: "Mobile radio interface signalling layer-3; General aspects".
- [21] 3GPP TS 38.300: "NR; NR and NG-RAN Overall Description; Stage 2".
- [22] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".
- [23] IETF RFC 2131: "Dynamic Host Configuration Protocol".
- [24] IETF RFC 4039: "Rapid Commit Option for the Dynamic Host Configuration Protocol version 4 (DHCPv4)".
- [25] IETF RFC 4862: "IPv6 Stateless Address Autoconfiguration".
- [26] 3GPP TS 24.502: "Access to the 5G System (5GS) via non-3GPP access networks; Stage 3".
- [27] ITU-T Recommendation E.212: "The international identification plan for mobile terminals and mobile users".
- [28] ISO/IEC 10118-3:2018: "IT Security techniques – Hash-functions – Part 3: Dedicated hash-functions".
- [29] W3C REC-xmlschema-2-20041028: "XML Schema Part 2: Datatypes".
- [30] IETF RFC 4122: "A Universally Unique IDentifier (UUID) URN Namespace".
- [31] 3GPP TS 24.008: "Mobile Radio Interface Layer 3 specification; Core Network Protocols; Stage 3".
- [32] IETF RFC 826: "An Ethernet Address Resolution Protocol".
- [33] 3GPP TS 23.503: "Policy and Charging Control Framework for the 5G System; Stage 2".
- [34] 3GPP TS 33.503: "Security Aspects of Proximity based Services (ProSe) in the 5G System (5GS)".
- [35] 3GPP TS 23.303: "Proximity-based services (ProSe); Stage 2".
- [36] 3GPP TS 33.303: "Proximity-based Services (ProSe); Security aspects".
- [37] 3GPP TS 33.536: "Security aspects of 3GPP support for advanced Vehicle-to-Everything (V2X) services".
- [38] IETF RFC 3927: "Dynamic Configuration of IPv4 Link-Local Addresses".
- [39] IETF RFC 3748: "Extensible Authentication Protocol (EAP)".
- [40] IETF RFC 20: "ASCII format for Network Interchange".
- [41] IETF RFC 4288: "Media Type Specifications and Registration Procedures".
- [42] IETF RFC 7303: "XML Media Types".
- [43] IETF RFC 7542: "The Network Access Identifier".
- [44] 3GPP TS 33.223: "Generic Authentication Architecture (GAA); Generic Bootstrapping Architecture (GBA) Push function".

- [45] 3GPP TS 32.277: "Proximity-based Services (ProSe) charging".
- [46] 3GPP TS 33.220: "Generic Authentication Architecture (GAA); Generic Bootstrapping Architecture (GBA)".
- [47] 3GPP TS 33.535: "Authentication and Key Management for Applications (AKMA) based on 3GPP credentials in the 5G System (5GS)".
- [48] IETF RFC 1166: "Internet Numbers".
- [49] IETF RFC 5952: "A Recommendation for IPv6 Address Text Representation".
- [50] 3GPP TS 33.501: "Security architecture and procedures for 5G system".
- [51] 3GPP TS 23.502: "Procedures for the 5G System (5GS); Stage 2".
- [52] IETF RFC 4555: "IKEv2 Mobility and Multihoming Protocol (MOBIKE)".
- [53] IETF RFC 1035: "DOMAIN NAMES - IMPLEMENTATION AND SPECIFICATION".
- [54] 3GPP TS 23.041: "Technical realization of Cell Broadcast Service (CBS)".
- [55] 3GPP TS 33.533: "Security aspects of ranging based services and sidelink positioning".
- [56] 3GPP TS 24.514: "Ranging based services and sidelink positioning in 5G system(5GS); Stage 3".
- [57] 3GPP TS 29.343: "Proximity-services (ProSe) function to ProSe application server aspects (PC2); Stage 3".
- [58] 3GPP TS 23.122: "Non-Access-Stratum functions related to Mobile Station (MS) in idle mode".
- [59] IETF RFC 5444: "Generalized Mobile Ad Hoc Network (MANET) Packet/Message Format".
- [60] IETF RFC 6130: "Mobile Ad Hoc Network (MANET) Neighborhood Discovery Protocol (NHDP)".
- [61] IETF RFC 7181: "The Optimized Link State Routing Protocol Version 2".
- [62] IETF RFC 8245: "Rules for Designing Protocols Using the Generalized Packet/Message Format from RFC 5444".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

5G DDNMF CTF (ADF): Accounting Data Forwarding (ADF) function block of the Charging Trigger Function (CTF) in the 5G DDNMF.

5G ProSe Direct Communication: A function that supports the communications between two or more UEs in proximity that are 5G ProSe-enabled, by means of user plane transmission using NR technology via a path not traversing any network node.

5G ProSe Direct Discovery: A function employed by a 5G ProSe-enabled UE to discover other 5G ProSe-enabled UEs in its vicinity based on direct radio transmissions between the two UEs with NR technology.

5G ProSe UE-to-network relay: A function employed by a 5G ProSe-enabled UE to support the communications between a 5G ProSe remote UE and DN.

5G ProSe multi-hop UE-to-network relay: A function employed by a 5G ProSe UE-to-network relay UE to support the multi-hop communications between a 5G ProSe remote UE and DN.

5G ProSe layer-2 UE-to-network relay: A function employed by a 5G ProSe-enabled UE to support the communications between a 5G ProSe layer-2 remote UE and DN.

5G ProSe multi-hop layer-2 UE-to-network relay: A function employed by a 5G ProSe layer-2 UE-to-network relay UE to support the multi-hop communications between a 5G ProSe layer-2 remote UE and DN.

5G ProSe layer-3 UE-to-network relay: A function employed by a 5G ProSe-enabled UE to support the communications between a 5G ProSe layer-3 remote UE and DN.

5G ProSe multi-hop layer-3 UE-to-network relay: A function employed by a 5G ProSe layer-3 UE-to-network relay UE to support the multi-hop communications between a 5G ProSe layer-3 remote UE and DN.

5G ProSe UE-to-UE relay: A function employed by a 5G ProSe-enabled UE to support the communications between two 5G ProSe end UEs.

5G ProSe layer-2 UE-to-UE relay: A function employed by a 5G ProSe-enabled UE to support the communications between two 5G ProSe layer-2 end UEs.

5G ProSe layer-3 UE-to-UE relay: A function employed by a 5G ProSe-enabled UE to support the communications between two 5G ProSe layer-3 end UEs.

5G ProSe multi-hop layer-3 UE-to-UE relay: A function employed by a 5G ProSe layer-3 UE-to-UE relay UE to support the multi-hop communications between two 5G ProSe layer-3 end UEs.

5G ProSe UE-to-network relay UE: A 5G ProSe-enabled UE that provides functionality to support connectivity to the network for 5G ProSe remote UE(s).

5G ProSe multi-hop UE-to-network relay UE: A 5G ProSe UE-to-network relay UE that supports 5G ProSe multi-hop UE-to-network relay.

5G ProSe intermediate UE-to-network relay UE: A 5G ProSe-enabled UE that provides functionality to support connectivity to the network for 5G ProSe multi-hop remote UE(s) by using the PC5 reference point with other 5G ProSe-enabled UEs. The 5G ProSe intermediate UE-to-network relay UE is located on the path between the 5G ProSe multi-hop remote UE and the 5G ProSe multi-hop UE-to-network relay UE.

5G ProSe layer-2 intermediate UE-to-network relay UE: A 5G ProSe-enabled UE that provides functionality to support connectivity to the network for 5G ProSe layer-2 remote UE(s) by using the PC5 reference point with other 5G ProSe-enabled UEs via layer-2 protocol.

5G ProSe layer-3 intermediate UE-to-network relay UE: A 5G ProSe-enabled UE that provides functionality to support connectivity to the network for 5G ProSe layer-3 remote UE(s) by using the PC5 reference point with other 5G ProSe-enabled UEs via layer-3 protocol.

5G ProSe layer-2 UE-to-network relay UE: A 5G ProSe-enabled UE that provides functionality to support connectivity to the network for 5G ProSe layer-2 remote UE(s) via layer-2 protocol.

5G ProSe multi-hop layer-2 UE-to-network relay UE: A 5G ProSe layer-2 UE-to-network relay UE that supports 5G ProSe multi-hop layer-2 UE-to-network relay.

5G ProSe layer-3 UE-to-network relay UE: A 5G ProSe-enabled UE that provides functionality to support connectivity to the network for 5G ProSe layer-3 remote UE(s) via layer-3 protocol.

5G ProSe multi-hop layer-3 UE-to-network relay UE: A 5G ProSe layer-3 UE-to-network relay UE that supports 5G ProSe multi-hop layer-3 UE-to-network relay.

5G ProSe UE-to-UE relay UE: A 5G ProSe-enabled UE that provides functionality to support connectivity between two 5G ProSe end UEs.

5G ProSe layer-2 UE-to-UE relay UE: A 5G ProSe-enabled UE that provides functionality to support connectivity between two 5G ProSe layer-2 end UEs via layer-2 protocol.

5G ProSe layer-3 UE-to-UE relay UE: A 5G ProSe-enabled UE that provides functionality to support connectivity between two 5G ProSe layer-2 end UEs via layer-3 protocol.

5G ProSe multi-hop parent UE-to-network relay UE: When one or more 5G ProSe intermediate UE-to-network relay UEs are used on the path between a 5G ProSe multi-hop remote UE and the DN, a 5G ProSe multi-hop parent UE-

to-network relay UE is a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE, which has one less hop to the NG-RAN compared to another 5G ProSe intermediate UE-to-network relay UE or to the 5G ProSe multi-hop remote UE on the path.

5G ProSe multi-hop child UE-to-network relay UE: When one or more 5G ProSe intermediate UE-to-network relay UEs are used on the path between a 5G ProSe multi-hop remote UE and the DN, a 5G ProSe multi-hop child UE-to-network relay UE is a 5G ProSe intermediate UE-to-network relay UE, which has one more hop to the NG-RAN compared to another 5G ProSe intermediate UE-to-network relay UE or 5G ProSe multi-hop UE-to-network relay UE on the path.

5G ProSe multi-hop layer-3 UE-to-UE relay UE: A 5G ProSe layer-3 UE-to-UE relay UE that supports 5G ProSe multi-hop layer-3 UE-to-UE relay.

5G ProSe layer-2 remote UE: A 5G ProSe-enabled UE that communicates with a DN via a 5G ProSe layer-2 UE-to-network relay UE.

5G ProSe multi-hop layer-2 remote UE: A 5G ProSe-enabled UE that communicates with a DN via zero or more 5G ProSe layer-2 intermediate UE-to-network relay UE and a 5G ProSe multi-hop layer-2 UE-to-network relay UE.

5G ProSe layer-3 remote UE: A 5G ProSe-enabled UE that communicates with a DN via a 5G ProSe layer-3 UE-to-network relay UE.

5G ProSe multi-hop layer-3 remote UE: A 5G ProSe-enabled UE that communicates with a DN via zero or more 5G ProSe layer-3 intermediate UE-to-network relay UE and a 5G ProSe multi-hop layer-3 UE-to-network relay UE.

5G ProSe layer-2 end UE: A 5G ProSe-enabled UE that communicates with another 5G ProSe-enabled UE via a 5G ProSe layer-2 UE-to-UE relay UE.

5G ProSe layer-3 end UE: A 5G ProSe-enabled UE that communicates with another 5G ProSe-enabled UE via a 5G ProSe layer-3 UE-to-UE relay UE.

5G ProSe multi-hop layer-3 end UE: A 5G ProSe-enabled UE that communicates with another 5G ProSe-enabled UE via one or more 5G ProSe layer-3 UE-to-UE relay UE.

Open 5G ProSe direct discovery: A 5G ProSe direct discovery that takes place without explicit permission from the 5G ProSe-enabled UE being discovered.

Restricted 5G ProSe direct discovery: A 5G ProSe direct discovery that only takes place with explicit permission from the 5G ProSe-enabled UE being discovered.

Usage information report: Usage information related to one collection period.

Usage information report list: One or more usage information report(s) associated with the UE identity of a 5G ProSe-enabled UE.

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.304 [2] apply:

5G ProSe-enabled UE
5G ProSe remote UE
Application layer ID
Application layer group ID
Destination layer-2 ID
Direct network communication
Discovery entry ID
Discovery filter
Discovery query filter
Discovery response filter
Geographical area
Indirect network communication
Local PLMN
Member ID
Metadata index
Metadata index mask
Model A
Model B

Mode of communication
ProSe application code
ProSe application mask
ProSe application ID
ProSe discovery UE ID
ProSe identifier
ProSe layer-2 group ID
ProSe query code
ProSe response code
ProSe restricted code
ProSe restricted code prefix
ProSe restricted code suffix
Relay service code
Restricted ProSe application user ID
Source layer-2 ID
NR Tx profile
User info ID

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.501 [22] apply:

Closed Access Group (CAG)
Network identifier (NID)
Stand-alone Non-Public Network (SNPN)

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.122 [14] apply:

Registered SNPN (RSNPN)
Subscribed SNPN

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

5G DDNMF	5G Direct Discovery Name Management Function
5G PKMF	5G ProSe Key Management Function
5G ProSe	5G Proximity-based Services
AA	Authentication and Authorization
AKMA	Authentication and Key Management for Applications
CP-PRUK	Control Plane ProSe Remote User Key
CTF (ADF)	Charging Trigger Function (Accounting Data Forwarding)
DN	Data Network
DNS	Domain Name System
DUCK	Discovery User Confidentiality Key
DUIK	Discovery User Integrity Key
DUSK	Discovery User Scrambling Key
FQDN	Fully Qualified Domain Name
GBA	Generic Bootstrapping Architecture
GFBR	Guaranteed Flow Bit Rate
GPI	GBA Push Information
LSB	Least Significant 8 Bits
MSB	Most Significant 8 Bits
MFBR	Maximum Flow Bit Rate
MIC	Message Integrity Check
MOBIKE	IKv2 Mobility and Multihoming Protocol
NAI	Network Access Identifier
NCGI	NG-RAN Cell Global ID
NID	Network Identifier
NR	New Radio
PC3	Reference point between UE and the ProSe Function
PC3a	Reference point between the UE and the 5G DDNMF

PC3ach	PC3a for charging
PC5	Reference point between ProSe-enabled UEs used for control and user plane
PC5 LINK-AMBR	PC5 Link Aggregated Bit Rate
PDUID	ProSe Discovery UE ID
PNI-NPN	Public Network Integrated Non-Public Network
PQI	PC5 5QI
ProSeP	5G ProSe Policy
PSDK	Public Safety Discovery Key
RPAUID	Restricted ProSe Application User ID
RQI	Reflective QoS Indication
RSC	Relay Service Code
SNPN	Stand-alone Non-Public Network
TTL	Time-To-Live
UP-PRUK	User Plane ProSe Remote User Key
URSP	UE Route Selection Policy

4 General

4.1 Overview

5G Proximity-based Services (ProSe) are services that can be provided by the 3GPP system based on UEs being in proximity to each other. In this release of the document, the 3GPP system enablers for 5G ProSe include the following functions:

- a) 5G ProSe direct discovery;
- b) 5G ProSe direct communication;
- c) 5G ProSe UE-to-network relay; and
- d) 5G ProSe UE-to-UE relay.

The above functions are applicable for both public safety UE and commercial UEs.

The above functions are applicable in PLMN and SNPN, with considering the adaptations for SNPN specified in this specification.

The security aspects for 5G ProSe features are specified in 3GPP TS 33.503 [34].

5 Provisioning of configuration information for 5G ProSe

5.1 Overview

5G ProSe configuration parameters are configured by the related procedures which allow configuration of necessary 5G ProSe configuration parameters to UE.

5.2 Configuration and precedence of 5G ProSe configuration information

5.2.1 General

UE's usage of 5G ProSe service is controlled by 5G ProSe configuration information.

The 5G ProSe configuration information consist of the configuration parameters for 5G ProSe direct discovery, 5G ProSe direct communication, 5G ProSe UE-to-network relay, 5G ProSe UE-to-UE relay, 5G ProSe multi-hop UE-to-network relay, 5G ProSe multi-hop layer-3 UE-to-UE relay and 5G ProSe usage reporting.

5.2.2 Precedence of 5G ProSe configuration information

The 5G ProSe configuration information for 5G ProSe direct discovery, 5G ProSe direct communication, 5G ProSe UE-to-network relay, 5G ProSe UE-to-UE relay, 5G ProSe multi-hop UE-to-network relay, 5G ProSe multi-hop layer-3 UE-to-UE relay and 5G ProSe usage reporting can be:

- a) pre-configured in the ME;
- b) configured in the UICC;
- c) provided as a ProSeP by PCF using the UE policy delivery service as specified in 3GPP TS 24.501 [11] annex D;
- d) provided by a ProSe application server via PC1 reference point except:
 - 1) the authorization policy for 5G ProSe direct discovery and restricted ProSe discovery UE ID for restricted direct discovery in parameters for 5G ProSe direct discovery;
 - 2) the authorization policy in parameters for 5G ProSe direct communication;
 - 3) the following parameters for the role of a 5G ProSe UE-to-network relay UE:
 - i) authorization policy for acting as a 5G ProSe layer-3 UE-to-network relay UE, 5G ProSe layer-2 UE-to-network relay UE or both, when "served by NG-RAN";
 - ii) QoS mapping rules for 5G ProSe layer-3 UE-to-network relay; and
 - iii) a mapping of ProSe identifier(s) to ProSe application server address information for 5G ProSe layer-3 UE-to-network relay UE to relay Ethernet or Unstructured traffic from remote UE by using IP type PDU session;
 - 4) the following parameters for the role of a 5G ProSe remote UE:
 - i) authorization policy for using a 5G ProSe layer-3 UE-to-network relay UE, 5G ProSe layer-2 UE-to-network relay UE or both;
 - 5) the following parameters for the role of a 5G ProSe UE-to-network relay UE as well as for the role of a 5G ProSe remote UE:
 - i) radio parameters for 5G ProSe relay discovery when the UE is not "served by NG-RAN";
 - ii) radio parameters for 5G ProSe relay communication when the UE is not "served by NG-RAN"; and
 - iii) security related content for 5G ProSe UE-to-network relay;
 - 6) the following parameters for the role of a 5G ProSe UE-to-UE relay UE:
 - i) authorization policy for acting as a 5G ProSe layer-3 UE-to-UE relay UE, or 5G ProSe layer-2 UE-to-UE relay UE or both;
 - 7) the following parameters for the role of a 5G ProSe end UE:
 - i) authorization policy for using a 5G ProSe layer-3 UE-to-UE relay UE, or 5G ProSe layer-2 UE-to-UE relay UE or both;
 - 8) the following parameters for the role of a 5G ProSe multi-hop UE-to-network relay UE:
 - i) authorization policy for acting as a 5G ProSe multi-hop layer-3 UE-to-network relay UE, 5G ProSe multi-hop layer-2 UE-to-network relay UE or both, when "served by NG-RAN";
 - ii) QoS mapping rules for 5G ProSe multi-hop layer-3 UE-to-network relay; and

- iii) a mapping of ProSe identifier(s) to ProSe application server address information for 5G ProSe multi-hop layer-3 UE-to-network relay UE to relay Ethernet or Unstructured traffic from 5G ProSe multi-hop layer-3 remote UE by using IP type PDU session;
- 9) the following parameters for the role of a 5G ProSe intermediate UE-to-network relay UE:
 - i) authorization policy for acting as a 5G ProSe layer-3 intermediate UE-to-network relay UE, 5G ProSe layer-2 intermediate UE-to-network relay UE or both;
- 10) the following parameters for the role of a 5G ProSe multi-hop remote UE:
 - i) authorization policy for using:
 - A) a 5G ProSe layer-3 UE-to-network relay UE and 5G ProSe layer-3 intermediate UE-to-network relay UE;
 - B) a 5G ProSe layer-2 UE-to-network relay UE and 5G ProSe layer-2 intermediate UE-to-network relay UE; or
 - C) both;
- 11) the following parameters for the role of a 5G ProSe multi-hop UE-to-network relay UE, a 5G ProSe multi-hop remote UE and a 5G ProSe intermediate UE-to-network relay UE:
 - i) radio parameters for 5G ProSe multi-hop relay discovery when the UE is not "served by NG-RAN"; and
 - ii) radio parameters for 5G ProSe multi-hop relay communication when the UE is not "served by NG-RAN";
- 12) the following parameters for the role of a 5G ProSe multi-hop layer-3 UE-to-UE relay UE:
 - i) authorization policy for acting as a 5G ProSe multi-hop layer-3 UE-to-UE relay UE; and
- 13) the following parameters for the role of a 5G ProSe multi-hop layer-3 end UE:
 - i) authorization policy for using a 5G ProSe multi-hop layer-3 UE-to-UE relay UE; or
 - e) a combination of case a), b), c) or d) above.

The UE shall use the 5G ProSe configuration information in the following order of decreasing precedence:

- a) the 5G ProSe configuration information provided as a ProSeP by PCF;
- b) the 5G ProSe configuration information provided by a ProSe application server via PC1 reference point;
- c) the 5G ProSe configuration information configured in the UICC; and
- d) the 5G ProSe configuration information pre-configured in the ME.

NOTE: The UE can request or receive any 5G ProSe configuration information from the PCF over the indirect network communication path, when the UE is working as a 5G ProSe remote UE using a 5G ProSe layer-3 UE-to-network relay with N3IWF.

5.2.3 Configuration parameters for 5G ProSe direct discovery

The configuration parameters for 5G ProSe direct discovery over PC5 reference point consist of:

- a) a validity timer for the validity of the configuration parameter for 5G ProSe direct discovery over PC5 interface;
- b) a list of PLMNs in which the UE is authorised to perform open 5G ProSe direct discovery Model A monitoring when the UE is served by NG-RAN or an indication of whether the UE is authorized to perform open 5G ProSe direct discovery Model A monitoring when the UE is served by NG-RAN in the subscribed SNPN;
- c) a list of PLMNs in which the UE is authorized to perform open 5G ProSe direct discovery Model A announcing when the UE is served by NG-RAN or an indication of whether the UE is authorized to perform open 5G ProSe direct discovery Model A announcing when the UE is served by NG-RAN in the subscribed SNPN;

- d) a list of PLMNs in which the UE is authorised to perform restricted 5G ProSe direct discovery Model A monitoring when the UE is served by NG-RAN or an indication of whether the UE is authorized to perform restricted 5G ProSe direct discovery Model A monitoring when the UE is served by NG-RAN in the subscribed SNPN;
- e) a list of PLMNs in which the UE is authorized to perform restricted 5G ProSe direct discovery Model A announcing when the UE is served by NG-RAN or an indication of whether the UE is authorized to perform restricted 5G ProSe direct discovery Model A announcing when the UE is served by NG-RAN in the subscribed SNPN;
- f) a list of PLMNs in which the UE is authorized to perform restricted Model B discoverer operation when the UE is served by NG-RAN or an indication of whether the UE is authorized to perform restricted Model B discoverer operation when the UE is served by NG-RAN in the subscribed SNPN;
- g) a list of PLMNs in which the UE is authorized to perform restricted Model B discoveree operation when the UE is served by NG-RAN or an indication of whether the UE is authorized to perform restricted Model B discoveree operation when the UE is served by NG-RAN in the subscribed SNPN;
- h) an indication of whether the UE is authorized to perform 5G ProSe direct discovery for Model A or Model B when "not served by NG-RAN";
- i) radio parameters for ProSe direct discover per NR PC5 applicable per geographical area(s) with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when "not served by NG-RAN";

NOTE 1: Whether a frequency band is "operator managed" or "non-operator managed" in a given geographical area is defined by local regulations.

- j) a 5G PDUID for restricted direct discovery;
- k) a list of group member discovery parameters that enable the group member discovery. For each group the list consists of, one application layer group ID, layer-2 group ID and user info ID;

NOTE 2: User info ID is expected to be assigned uniquely to a user within the discovery group.

- l) a list of ProSe identifiers to be used for direct discovery over PC5 interface;
- m) a list of ProSe identifiers to default destination layer-2 ID for initial discovery signalling mapping rule. Each mapping rule contains one or more ProSe identifiers and the default destination layer-2 ID for the initial signalling of direct discovery;

NOTE 3: The ProSe identifiers to default destination layer-2 ID for initial discovery signalling mapping rule can include a default configuration entry with the lowest priority for the ProSe services that do not have corresponding configurations in the mapping rule (see 3GPP TS 24.555 [17]).

- n) default PC5 DRX configuration as specified in TS 38.331 [13] when the UE is not served by NG-RAN; and
- o) optionally, the 5G DDNMF address information in the HPLMN or subscribed SNPN.

NOTE 4: The security parameters for 5G ProSe direct discovery are provisioned by 5G DDNMF as defined in clause 6.2.

5.2.4 Configuration parameters for 5G ProSe direct communication over PC5 interface

The configuration parameters for 5G ProSe direct communication over PC5 interface consist of:

- a) a validity timer for the validity of the configuration parameters for 5G ProSe direct communication over PC5 interface;
- b) a list of PLMNs in which the UE is authorized to use 5G ProSe direct communication over PC5 interface when the UE is served by NG-RAN where each entry of the list contains a PLMN ID in which the UE is authorized to use 5G ProSe direct communication over PC5 interface or an indication of whether the UE is authorized to use 5G ProSe direct communication over PC5 interface when the UE is served by NG-RAN in the subscribed SNPN;

- c) an indication of whether the UE is authorized to use 5G ProSe direct communication over PC5 interface when the UE is not served by NG-RAN;
- d) the radio parameters of the 5G ProSe direct communication over PC5 interface applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- e) configuration parameters for groupcast mode 5G ProSe direct communication for each application layer group, consisting of:
 - 1) application layer group ID;
 - 2) ProSe layer-2 group identifier;
 - 3) ProSe group IP multicast address;
 - 4) an indication of whether the UE is authorized to use IPv4 or IPv6; and
 - 5) optionally, an IPv4 address to be used by the UE as a source address for a specific group if the UE is authorized to use IPv4;
- f) configuration parameters for privacy support, consisting of:
 - 1) a list of ProSe applications requiring privacy. Each entry of the list contains one or more ProSe identifiers and one or more geographical areas where the privacy is required; and
 - 2) a privacy timer value as specified in 3GPP TS 24.555 [17];
- g) optionally, a list of ProSe identifier to ProSe NR frequency mapping rules. Each mapping rule contains one or more ProSe identifiers and the ProSe NR frequencies with associated geographical areas;
- h) a list of ProSe identifier to destination layer-2 ID for broadcast mapping rules. Each mapping rule contains one or more ProSe identifiers and the destination layer-2 ID for broadcast;
- i) a list of ProSe identifier to destination layer-2 ID for groupcast mapping rules. Each mapping rule contains one or more ProSe identifiers and the destination layer-2 ID for groupcast;
- j) a list of ProSe identifier to default destination layer-2 ID for unicast initial signalling mapping rules. Each mapping rule contains one or more ProSe identifiers and the default destination layer-2 ID for initial signalling to establish unicast connection;
- k) a list of ProSe identifier to PC5 QoS parameters mapping rules. The PC5 QoS parameters are specified in clause 5.7 of 3GPP TS 23.304 [2];
- l) an AS configuration, including a list of SLRB mapping rules applicable when the UE is not served by NG-RAN. Each SLRB mapping rule contains a PC5 QoS profile and an SLRB. The PC5 QoS profile contains the following parameters:
 - 1) the PC5 QoS profile containing a PQI;
 - 2) if the PQI of the PC5 QoS profile identifies a GBR QoS, the PC5 QoS profile containing a PC5 flow bit rates consisting of a guaranteed flow bit rate (GFBR) and a maximum flow bit rate (MFBR);
 - 3) if the PQI of the PC5 QoS profile identifies a non-GBR QoS, the PC5 QoS profile containing the PC5 link aggregated bit rate consisting of a per link aggregate maximum bit rate (PC5 LINK-AMBR);

NOTE 1: PC5 link aggregated bit rate is only used for unicast mode communications over PC5 interface.

- 4) the PC5 QoS profile containing a range, which is only used for groupcast mode communications over PC5 interface; and
 - 5) the PC5 QoS profile optionally containing the priority level, the averaging window and the maximum data burst volume. If one or more of the priority levels, the averaging window or the maximum data burst volume are not contained in the PC5 QoS profile, their default values apply;
- m) a list of 5G ProSe direct link security policies. Each entry in the list contains a 5G ProSe direct link security policy composed of:

- 1) one or more ProSe identifiers;
 - 2) the signalling integrity protection policy for the ProSe identifier(s);
 - 3) the signalling ciphering policy for the ProSe identifier(s);
 - 4) the user plane integrity protection policy for the ProSe identifier(s);
 - 5) the user plane ciphering policy for the ProSe identifier(s); and
 - 6) one or more geographical areas where the 5G ProSe direct link security policy applies;
- n) a list of ProSe identifiers to default mode of communication mapping rules. Each mapping rule contains one or more ProSe identifiers and the default mode of communication (one of unicast, groupcast or broadcast);
 - o) a list of ProSe application to path preference mapping rules (i.e., PC5 preferred, Uu preferred, or no preference) as defined in clause 5.4 in 3GPP TS 24.555 [17]. The list of ProSe application to path preference mapping rules are in prioritized order according to the local configuration of the network;
 - p) a list of ProSe identifiers to NR Tx profiles for broadcast and groupcast mapping rules. Each mapping rule contains one or more ProSe identifiers and the NR Tx profile for broadcast and groupcast as specified in 3GPP TS 38.300 [21] and 3GPP TS 38.331 [13]; and
 - q) the PC5 DRX configuration for broadcast, groupcast and initial signalling of 5G ProSe direct link establishment, as specified in 3GPP TS 38.331 [13], including the mapping of PC5 QoS profile(s) to PC5 DRX cycle(s) and the default PC5 DRX configuration when the UE is not served by NG-RAN.

NOTE 2: In this release of specification, the application ID defined in 3GPP TS 23.303 [35] can be used as the ProSe identifier in 5G ProSe direct discovery and in a consequent 5G ProSe direct communication.

NOTE 3: Each mapping rule above can include a default configuration entry with the lowest priority for the ProSe services that do not have corresponding configurations in the mapping rules (see 3GPP TS 24.555 [17]).

5.2.5 Configuration parameters for 5G ProSe UE-to-network relay

The configuration parameters for the role of a ProSe UE-to-network relay UE over PC5 reference point consist of:

- a) a validity timer for the validity of the configuration parameter for 5G ProSe UE-to-network relay over PC5 interface;
- b) a list of PLMNs in which the UE is authorised to relay traffic for 5G ProSe layer-3 remote UEs when the UE is served by NG-RAN or an indication of whether the UE is authorised to relay traffic for 5G ProSe layer-3 remote UEs when the UE is served by NG-RAN in the subscribed SNPN and in each PLMN or the SNPN, where that authorization also authorizes the use of both 5G ProSe UE-to-network relay discovery Model A and 5G ProSe UE-to-network relay discovery Model B;
- c) a list of PLMNs in which the UE is authorised to relay traffic for 5G ProSe layer-2 remote UEs when the UE is served by NG-RAN or an indication of whether the UE is authorised to relay traffic for 5G ProSe layer-2 remote UEs when the UE is served by NG-RAN in the subscribed SNPN and in each PLMN or the SNPN, where that authorization also authorizes the use of both 5G ProSe UE-to-network relay discovery Model A and 5G ProSe UE-to-network relay discovery Model B;
- d) the default destination layer-2 ID(s) for sending the discovery signalling for announcement and additional information and for receiving the discovery signalling for solicitation;

NOTE 1: Which default destination layer-2 ID is selected is up to UE implementation when there are more than one default destination layer-2 ID.

- e) a User info ID for the UE-to-network relay discovery;
- f) one or more relay service code(s) for the UE-to-network relay discovery for normal services, one or more relay service code(s) for the UE-to-network relay discovery for emergency services or both, and for each relay service code:

- 1) security related content for 5G ProSe relay discovery that is used when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, including a validity timer for that security related content;
- 2) an indication of whether the relay service code is offering 5G ProSe layer-2 or layer-3 UE-to-network relay service;
- 3) for 5G ProSe layer-3 UE-to-network relay UE, a set of PDU session parameters:
 - i) PDU session type;
 - ii) DNN, if the 5G ProSe UE-to-network relay communication is not for emergency services;
 - iii) optionally, SSC mode;
 - iv) optionally, S-NSSAI; and
 - v) optionally, access type preference;
- 4) for 5G ProSe layer-2 UE-to-network relay UE and 5G ProSe layer-3 UE-to-network relay UE, security policies for 5G ProSe UE-to-network relay direct communication:
 - i) the signalling integrity protection policy;
 - ii) the signalling ciphering policy;
 - iii) the user plane integrity protection policy; and
 - iv) the user plane ciphering policy; and
- 5) for 5G ProSe layer-2 UE-to-network relay UE and 5G ProSe layer-3 UE-to-network relay UE, a control plane security indication to indicate whether to use the security procedure over control plane as specified in 3GPP TS 33.503 [34]. If the control plane security indication indicates not to use the security procedure over control plane, the 5G ProSe UE-to-network relay UE uses the security procedure over user plane as specified in 3GPP TS 33.503 [34];

NOTE 2: If the control plane security indication indicates to use the security procedure over control plane and the 5G ProSe UE-to-network relay UE doesn't support the security procedure over control plane, the 5G ProSe UE-to-network relay UE doesn't use that relay service code.

- g) for 5G ProSe layer-3 UE-to-network relay UE, QoS mapping rules including:
 - 1) a mapping between a 5QI value and a 5G ProSe PQI value over PC5 for traffic relayed over the PC5 interface;
 - 2) a PDB adjustment factor of the standardized PDB identified by the PQI; and
 - 3) optionally, the relay service code(s) associated with the QoS mapping rule;
- h) the radio parameters of the 5G ProSe UE-to-network relay discovery applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- i) for 5G ProSe layer-3 UE-to-network relay UE, for Ethernet and Unstructured traffic using IP type PDU session, a list of ProSe identifier(s) to ProSe application server address mapping rule. Each mapping rule contains one or more ProSe identifier(s) and IP address/FQDN and transport layer port number;
- j) the radio parameters of the 5G ProSe direct communication applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- k) optionally, the 5G PKMF address information;
- l) for 5G ProSe UE-to-network relay UE, the default PC5 DRX configuration for discovery as specified in 3GPP TS 38.331 [13] when the UE is not served by NG-RAN;
- m) the privacy timer value for changing the source layer-2 ID assigned by the 5G ProSe UE-to-network relay UE for direct communication, as specified in 3GPP TS 24.555 [17].

- n) the default destination layer-2 ID for broadcasting warning messages;
- o) the PC5 QoS parameters for broadcasting warning messages. The PC5 QoS parameters are specified in clause 5.6.1 of 3GPP TS 23.304 [2]; and
- p) the NR Tx profile for broadcasting warning messages. The NR Tx profile is specified in 3GPP TS 38.300 [21] and 3GPP TS 38.331 [13].

The configuration parameters for the role of a 5G ProSe remote UE consist of:

- a) a validity timer for the validity of the configuration parameters for 5G ProSe remote UE;
- b) an indication whether the UE is authorized to use a 5G ProSe layer-3 UE-to-network relay UE, where that authorization also authorizes the use of both 5G ProSe UE-to-network relay discovery Model A and 5G ProSe UE-to-network relay discovery Model B;
- c) a list of PLMNs in which the UE is authorized to use a 5G ProSe layer-2 UE-to-network relay UE or the indication of whether the UE is authorized to use a 5G ProSe layer-2 UE-to-network relay UE in the subscribed SNPN and in each PLMN or the SNPN, where that authorization also authorizes the use of both 5G ProSe UE-to-network relay discovery Model A and 5G ProSe UE-to-network relay discovery Model B;
- d) default destination layer-2 ID(s) for sending the discovery signalling for solicitation and for receiving the discovery signalling for announcement and additional information;

NOTE 3: Which default destination layer-2 ID is selected is up to UE implementation when there are more than one default destination layer-2 ID.

- e) a user info ID for the UE-to-network relay discovery;
- f) one or more relay service code(s) for the UE-to-network relay discovery for normal services, one or more relay service code(s) for the UE-to-network relay discovery for emergency services or both, and for each relay service code:
 - 1) security related content for 5G ProSe UE-to-network relay discovery that is used when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, including a validity timer for that security related content;
 - 2) an indication of whether the relay service code is offering 5G ProSe layer-2 or layer-3 UE-to-network relay service;
 - 3) for 5G ProSe remote UE using 5G ProSe layer-3 UE-to-network relay, one of the following:
 - i) a set of PDU session parameters for the relayed traffic without using N3IWF access:
 - A) PDU session type;
 - B) DNN, if the 5G ProSe UE-to-network relay communication is not for emergency services;
 - C) optionally, SSC mode;
 - D) optionally, S-NSSAI; and
 - E) optionally, access type preference; or
 - ii) an indication of using N3IWF access for the relayed traffic;
 - 4) for 5G ProSe remote UE using 5G ProSe layer-2 UE-to-network relays or 5G ProSe layer-3 UE-to-network relay, security policies for 5G ProSe UE-to-network relay direct communication:
 - i) the signalling integrity protection policy;
 - ii) the signalling ciphering policy;
 - iii) the user plane integrity protection policy; and
 - iv) the user plane ciphering policy;

- 5) optionally, for 5G ProSe remote UE using 5G ProSe layer-3 UE-to-network relay, the ProSe application traffic descriptor(s) (as defined in 3GPP TS 24.526 [5]) to be used for the relayed traffic; and
- 6) for 5G ProSe remote UE using 5G ProSe layer-2 UE-to-network relay or 5G ProSe layer-3 UE-to-network relay, a control plane security indication to indicate whether to use the security procedure over control plane as specified in 3GPP TS 33.503 [34]. If the control plane security indication indicates not to use the security procedure over control plane, the 5G ProSe remote UE uses the security procedure over user plane as specified in 3GPP TS 33.503 [34];

NOTE 4: If the control plane security indication indicates to use the security procedure over control plane and the 5G ProSe remote UE doesn't support the security procedure over control plane, the 5G remote UE doesn't use the corresponding relay service code.

- g) the radio parameters of the 5G ProSe UE-to-network relay discovery applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- h) the radio parameters of the 5G ProSe direct communication applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;

NOTE 5: Whether a frequency band is "operator managed" or "non-operator managed" in a given Geographical Area is defined by local regulations.

- i) if at least one relay service code is configured with the indication of using N3IWF access for the relayed traffic, the N3IWF selection information for 5G ProSe layer-3 remote UE:
 - 1) N3IWF identifier configuration (either FQDN or IP address); and
 - 2) 5G ProSe layer-3 UE-to-network relays, access node selection information, which consists of a prioritized list of PLMNs for N3IWF selection and an indication that the selection of an N3IWF in a PLMN should be based on Tracking Area Identity FQDN or on Operator Identifier FQDN;
- j) optionally, the 5G PKMF address information;
- k) for 5G ProSe remote UE, the default PC5 DRX configuration for discovery as specified in 3GPP TS 38.331 [13] when the UE is not served by NG-RAN;
- l) the privacy timer value for changing the source layer-2 ID assigned by the 5G ProSe remote UE for direct communication, as specified in 3GPP TS 24.555 [17].
- n) the default destination layer-2 ID for receiving warning messages;
- o) the PC5 QoS parameters for receiving warning messages. The PC5 QoS parameters are specified in clause 5.6.1 of 3GPP TS 23.304 [2]; and
- p) the NR Tx profile for broadcasting warning messages. The NR Tx profile is specified in 3GPP TS 38.300 [21] and 3GPP TS 38.331 [13].

5.2.6 Configuration parameters for 5G ProSe usage information reporting

The configuration parameters for 5G ProSe usage information reporting consist of:

- a) a validity timer for the validity of the configuration parameters for 5G ProSe usage information reporting;
- b) the 5G DDNMF CTF (ADF) address information to which the UE uploads the usage information reports;
- c) the collection period;
- d) the reporting window;
- e) for broadcast and groupcast mode 5G ProSe direct communication, whether or not the UE reports the group parameters in the usage information;

- f) whether or not the UE reports the time stamps of the first transmission/reception during the collection period in the usage information;
- g) whether or not the UE reports the amount of data transmitted during the collection period in the usage information, and whether with location information;
- h) whether or not the UE reports the amount of data received during the collection period in the usage information, and whether with location information;
- i) whether or not the UE reports the time stamps when it went in and out of NG-RAN coverage during the collection period in the usage information;
- j) whether or not the UE reports the list of locations of the UE when in NG-RAN coverage during the reporting period in the usage information;
- k) whether or not the UE reports the radio parameters used for 5G ProSe direct communication (i.e. indicator of which radio resources used and radio frequency used) during the reporting period in the usage information; and
- l) whether or not the UE reports the QoS flow information (i.e. PC5 QoS flow identifier, PC5 QoS flow descriptions) during the reporting period in the usage information.

5.2.7 Configuration parameters for 5G ProSe UE-to-UE relay

The configuration parameters for the role of a 5G ProSe UE-to-UE relay UE over PC5 reference point consist of:

- a) a validity timer for the validity of the configuration parameter for 5G ProSe UE-to-UE relay over PC5 interface;
- b) a list of PLMNs in which the UE is authorised to relay traffic for 5G ProSe layer-3 end UEs when the UE is served by NG-RAN or an indication of whether the UE is authorised to relay traffic for 5G ProSe layer-3 end UEs when the UE is served by NG-RAN in the subscribed SNPN and in each PLMN or the SNPN, where that authorization also authorizes the use of both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B;
- ba) an indication whether the UE is authorized to relay traffic for 5G ProSe layer-3 end UEs when the UE is not served by NG-RAN, where that authorization also authorizes the use of both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B;
- c) a list of PLMNs in which the UE is authorised to relay traffic for 5G ProSe layer-2 end UEs when the UE is served by NG-RAN or an indication of whether the UE is authorised to relay traffic for 5G ProSe layer-2 end UEs when the UE is served by NG-RAN in the subscribed SNPN and in each PLMN or the SNPN, where that authorization also authorizes the use of both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B;
- ca) an indication whether the UE is authorized to relay traffic for 5G ProSe layer-2 end UEs when the UE is not served by NG-RAN, where that authorization also authorizes the use of both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B;
- d) the default destination layer-2 ID(s) for sending the discovery signalling for announcement, for receiving the discovery signalling for solicitation and for sending discovery signalling for solicitation;
- da) the default destination layer-2 ID(s) for sending or receiving the direct communication signalling to establish unicast connection for 5G ProSe UE-to-UE relay communication with integrated discovery;

NOTE 1: Which default destination layer-2 ID is selected is up to UE implementation when there are more than one default destination layer-2 ID.

- e) a User info ID for 5G ProSe UE-to-UE relay discovery;
- f) one or more relay service code(s) for 5G ProSe UE-to-UE relay discovery and for each relay service code:
 - 1) optionally, security related content for 5G ProSe UE-to-UE relay discovery. The security related content for 5G ProSe UE-to-UE relay discovery applies only when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, including a validity timer for that security related content;

- 2) an indication of whether the relay service code is offering 5G ProSe layer-2 or layer-3 UE-to-UE relay service;
- 3) for 5G ProSe layer-3 UE-to-UE relay, the traffic type of the relayed service (i.e. IP, Ethernet or Unstructured);
- 4) security policies for 5G ProSe UE-to-UE relay direct communication:
 - i) the signalling integrity protection policy;
 - ii) the signalling ciphering policy;
 - iii) the user plane integrity protection policy; and
 - iv) the user plane ciphering policy;
- 5) a network assistance security indication to indicate whether to use the security procedure with network assistance or the security procedure without network assistance as specified in clause 6.6.3.3 of 3GPP TS 33.503 [34]; and
- 6) a control plane security indication to indicate whether to use the security procedure over control plane as specified in 3GPP TS 33.503 [34], if the security procedure with network assistance is to be used. If the control plane security indication indicates not to use the security procedure over control plane, the 5G ProSe UE-to-UE relay UE uses the security procedure over user plane as specified in 3GPP TS 33.503 [34];

NOTE 2: If the control plane security indication indicates to use the security procedure over control plane and the 5G ProSe UE-to-UE relay UE doesn't support the security procedure over control plane, the 5G ProSe UE-to-UE relay UE doesn't use that relay service code.

- g) the radio parameters of 5G ProSe UE-to-UE relay discovery applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;

NOTE 3: The radio parameters of 5G ProSe UE-to-UE relay discovery when the UE is not served by NG-RAN and the radio parameters of 5G ProSe direct discovery when the UE is not served by NG-RAN as defined in clause 5.2.3 are expected to be the same.

- h) the radio parameters of 5G ProSe UE-to-UE relay communication applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;

NOTE 4: The radio parameters of 5G ProSe UE-to-UE relay communication when the UE is not served by NG-RAN and the radio parameters of 5G ProSe direct communication when the UE is not served by NG-RAN as defined in clause 5.2.4 are expected to be the same.

- i) the default PC5 DRX configuration for discovery as specified in 3GPP TS 38.331 [13] when the UE is not served by NG-RAN; and
- j) optionally, the 5G PKMF address information.

The configuration parameters for the role of a 5G ProSe end UE consist of:

- a) a validity timer for the validity of the configuration parameters for 5G ProSe end UE;
- b) an indication whether the UE is authorized to use a 5G ProSe layer-3 UE-to-UE relay UE when the UE is not served by NG-RAN, where that authorization also authorizes the use of both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B;
- ba) a list of PLMNs in which the UE is authorised to use a 5G ProSe layer-3 UE-to-UE relay UE when the UE is served by NG-RAN or an indication of whether the UE is authorised to relay traffic for 5G ProSe layer-3 UE-to-UE relay UE when the UE is served by NG-RAN in the subscribed SNPN and in each PLMN or the SNPN, where that authorization also authorizes the use of both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B;

- c) an indication whether the UE is authorized to use a 5G ProSe layer-2 UE-to-UE relay UE when the UE is not served by NG-RAN and the authorization also authorizes the use of both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B;
- ca) a list of PLMNs in which the UE is authorised to use a 5G ProSe layer-2 UE-to-UE relay UE when the UE is served by NG-RAN or an indication of whether the UE is authorised to relay traffic for 5G ProSe layer-2 UE-to-UE relay UE when the UE is served by NG-RAN in the subscribed SNPN and in each PLMN or the SNPN, where that authorization also authorizes the use of both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B;
- d) the default destination layer-2 ID(s) for sending the discovery signalling for solicitation and for receiving the discovery signalling for announcement and for receiving the discovery signalling for solicitation;
- da) the default destination layer-2 ID(s) for sending or receiving the direct communication signalling to establish unicast connection for 5G ProSe UE-to-UE relay communication with integrated discovery;

NOTE 5: Which default destination layer-2 ID is selected is up to UE implementation when there are more than one default destination layer-2 ID.

- e) void;
- f) one or more relay service code(s) for 5G ProSe UE-to-UE relay discovery and for each relay service code:
 - 1) optionally, security related content for 5G ProSe UE-to-UE relay discovery. The security related content for 5G ProSe UE-to-UE relay discovery applies only when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, including a validity timer for that security related content;
 - 2) an indication of whether the relay service code is offering 5G ProSe layer-2 or layer-3 UE-to-UE relay service;
 - 3) for 5G ProSe layer-3 UE-to-UE relay, the traffic type of the relayed service (i.e. IP, Ethernet or Unstructured);
 - 4) security policies for 5G ProSe UE-to-UE relay direct communication:
 - i) the signalling integrity protection policy;
 - ii) the signalling ciphering policy;
 - iii) the user plane integrity protection policy; and
 - iv) the user plane ciphering policy;
 - 5) a network assistance security indication to indicate whether to use the security procedure with network assistance or the security procedure without network assistance as specified in clause 6.6.3.3 of 3GPP TS 33.503 [34]; and
 - 6) a control plane security indication to indicate whether to use the security procedure over control plane as specified in 3GPP TS 33.503 [34], if the security procedure with network assistance is to be used. If the control plane security indication indicates not to use the security procedure over control plane, the 5G ProSe end UE uses the security procedure over user plane as specified in 3GPP TS 33.503 [34];

NOTE 6: If the control plane security indication indicates to use the security procedure over control plane and the 5G ProSe end UE doesn't support the security procedure over control plane, the 5G end UE doesn't use the corresponding relay service code.

- g) the radio parameters of 5G ProSe UE-to-UE relay discovery applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;

NOTE 7: The radio parameters of 5G ProSe UE-to-UE relay discovery when the UE is not served by NG-RAN and the radio parameters of 5G ProSe direct discovery when the UE is not served by NG-RAN as defined in clause 5.2.3 are expected to be the same.

- h) the radio parameters of 5G ProSe UE-to-UE relay communication applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;

NOTE 8: The radio parameters of 5G ProSe UE-to-UE relay communication when the UE is not served by NG-RAN and the radio parameters of 5G ProSe direct communication when the UE is not served by NG-RAN as defined in clause 5.2.4 are expected to be the same.

- i) the default PC5 DRX configuration for discovery as specified in 3GPP TS 38.331 [13] when the UE is not served by NG-RAN; and
- j) optionally, the 5G PKMF address information.

5.2.8 Configuration parameters for 5G ProSe multi-hop UE-to-network relay

The configuration parameters for the role of a 5G ProSe multi-hop UE-to-network relay UE over PC5 reference point consist of:

- a) a validity timer for the validity of the configuration parameter for 5G ProSe multi-hop UE-to-network relay UE over PC5 interface;
- b) a list of PLMNs in which the UE is authorised to relay traffic for 5G ProSe multi-hop layer-3 remote UEs when the UE is served by NG-RAN and in each PLMN, or an indication of whether the UE is authorised to relay traffic for 5G ProSe multi-hop layer-3 remote UEs when the UE is served by NG-RAN in the subscribed SNPN, where that authorization also authorizes the use of both 5G ProSe multi-hop UE-to-network relay discovery Model A and 5G ProSe multi-hop UE-to-network relay discovery Model B;
- b1) a list of PLMNs in which the UE is authorised to relay traffic for 5G ProSe multi-hop layer-2 remote UEs when the UE is served by NG-RAN and in each PLMN, or an indication of whether the UE is authorised to relay traffic for 5G ProSe multi-hop layer-2 remote UEs when the UE is served by NG-RAN in the subscribed SNPN, where that authorization also authorizes the use of both 5G ProSe multi-hop UE-to-network relay discovery Model A and 5G ProSe multi-hop UE-to-network relay discovery Model B;
- c) the default destination layer-2 ID(s) for sending the discovery signalling for announcement and additional information and for receiving the discovery signalling for solicitation;

NOTE 1: Which default destination layer-2 ID is selected is up to UE implementation when there are more than one default destination layer-2 ID.

- d) a User info ID for the multi-hop UE-to-network relay discovery;
- e) one or more relay service code(s) for the multi-hop UE-to-network relay discovery for normal services, one or more relay service code(s) for the multi-hop UE-to-network relay discovery for emergency services or both, and for each relay service code:
 - 1) an indication of whether the relay service code is offering 5G ProSe multi-hop layer-2 or layer-3 UE-to-network relay service;
 - 2) a multi-hop indicator to indicate whether the associated relay service code can be supported for 5G ProSe multi-hop UE-to-network relay operation;
 - 3) maximum number of hops to indicate the maximum number of hops can be supported for the associated relay service code, if the multi-hop indicator is configured;
 - 4) for 5G ProSe multi-hop layer-3 UE-to-network relay UE, a set of PDU session parameters:
 - i) PDU session type;
 - ii) DNN, if the 5G ProSe multi-hop UE-to-network relay unicast direct communication is not for emergency services;
 - iii) optionally, SSC mode;
 - iv) optionally, S-NSSAI; and

- v) optionally, access type preference;
- 5) security related content for 5G ProSe multi-hop relay discovery that is used when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, including a validity timer for that security related content;
- 6) security policies for 5G multi-hop ProSe UE-to-network relay direct communication:
 - i) the signalling integrity protection policy;
 - ii) the signalling ciphering policy;
 - iii) the user plane integrity protection policy; and
 - iv) the user plane ciphering policy; and
- 7) a control plane security indication to indicate whether to use the security procedure over control plane as specified in 3GPP TS 33.503 [34]. If the control plane security indication indicates not to use the security procedure over control plane, the 5G ProSe multi-hop layer-3 UE-to-network relay UE uses the security procedure over user plane as specified in 3GPP TS 33.503 [34];

NOTE 2: If the control plane security indication indicates to use the security procedure over control plane and the 5G ProSe multi-hop layer-3 UE-to-network relay UE doesn't support the security procedure over control plane, the 5G ProSe multi-hop layer-3 UE-to-network relay UE doesn't use that relay service code.

- f) the radio parameters of the 5G ProSe multi-hop UE-to-network relay discovery applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- g) for 5G ProSe multi-hop layer-3 UE-to-network relay UE, for Ethernet and Unstructured traffic using IP type PDU session, a list of ProSe identifier(s) to ProSe application server address mapping rule. Each mapping rule contains one or more ProSe identifier(s) and IP address/FQDN and transport layer port number;
- h) the radio parameters of the 5G ProSe multi-hop UE-to-network relay unicast direct communication applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- i) the default PC5 DRX configuration for discovery as specified in 3GPP TS 38.331 [13] when the UE is not served by NG-RAN;
- j) the privacy timer value for changing the source layer-2 ID assigned by the 5G ProSe multi-hop UE-to-network relay UE for 5G ProSe multi-hop UE-to-network relay unicast direct communication, as specified in 3GPP TS 24.555 [17];
- k) QoS mapping rules including:
 - 1) a mapping between a 5QI value and a 5G ProSe PQI value over PC5 for traffic relayed over the PC5 interface;
 - 2) a PDB adjustment factor of the standardized PDB identified by the PQI; and
 - 3) optionally, the relay service code(s) associated with the QoS mapping rule; and
- l) optionally, the 5G PKMF address information.
- m) the default destination layer-2 ID for 5G ProSe broadcasting message for public warning notification;
- n) the PC5 QoS parameters for 5G ProSe broadcasting message for public warning notification. The PC5 QoS parameters are specified in clause 5.6.1 of 3GPP TS 23.304 [2]; and
- o) the NR Tx profile for 5G ProSe broadcasting message for public warning notification. The NR Tx profile is specified in 3GPP TS 38.300 [21] and 3GPP TS 38.331 [13].

The configuration parameters for the role of a 5G ProSe intermediate UE-to-network relay UE over PC5 reference point consist of:

- a) a validity timer for the validity of the configuration parameter for 5G ProSe multi-hop UE-to-network relay UE over PC5 interface;
- b) an indication whether the UE is authorized to relay traffic for 5G ProSe multi-hop layer-3 remote UEs, where that authorization also authorizes the use of both 5G ProSe multi-hop UE-to-network relay discovery Model A and 5G ProSe UE-to-network relay discovery Model B;
- b1) a list of PLMNs in which the UE is authorized to relay traffic for 5G ProSe multi-hop layer-2 remote UEs, or an indication of whether the UE is authorised to relay traffic for 5G ProSe multi-hop layer-2 remote UEs in the subscribed SNPN, where that authorization also authorizes the use of both 5G ProSe UE-to-network relay discovery Model A and 5G ProSe UE-to-network relay discovery Model B;
- c) the default destination layer-2 ID(s) for sending the discovery signalling for announcement, additional information and solicitation, and also for receiving the discovery signalling for announcement, additional information and solicitation;

NOTE 3: Which default destination layer-2 ID is selected is up to UE implementation when there are more than one default destination layer-2 ID.

- d) a User info ID for the multi-hop UE-to-network relay discovery;
- e) one or more relay service code(s) for the multi-hop UE-to-network relay discovery for normal services, one or more relay service code(s) for the multi-hop UE-to-network relay discovery for emergency services or both, and for each relay service code:
 - 1) an indication of whether the relay service code is offering 5G ProSe multi-hop layer-2 or layer-3 UE-to-network relay service;
 - 2) a multi-hop indicator to indicate whether the associated relay service code can be supported for 5G ProSe multi-hop UE-to-network relay operation;
 - 3) maximum number of hops to indicate the maximum number of hops can be supported for the associated relay service code, if the multi-hop indicator is configured;
 - 4) for 5G ProSe layer-3 intermediate UE-to-network relay UE, the traffic type (IP, Ethernet, Unstructured) to be used for the relayed traffic;
 - 5) security related content for 5G ProSe multi-hop relay discovery that is used when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, including a validity timer for that security related content;
 - 6) security policies for 5G ProSe multi-hop UE-to-network relay direct communication:
 - i) the signalling integrity protection policy;
 - ii) the signalling ciphering policy;
 - iii) the user plane integrity protection policy; and
 - iv) the user plane ciphering policy; and
 - 7) a control plane security indication to indicate whether to use the security procedure over control plane as specified in 3GPP TS 33.503 [34]. If the control plane security indication indicates not to use the security procedure over control plane, 5G ProSe layer-3 intermediate UE-to-network relay UE uses the security procedure over user plane as specified in 3GPP TS 33.503 [34];

NOTE 4: If the control plane security indication indicates to use the security procedure over control plane and the 5G ProSe layer-3 intermediate UE-to-network relay UE doesn't support the security procedure over control plane, 5G ProSe layer-3 intermediate UE-to-network relay UE doesn't use that relay service code.

- f) the radio parameters of the 5G ProSe multi-hop UE-to-network relay discovery applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;

- g) the radio parameters of the 5G ProSe multi-hop UE-to-network relay unicast direct communication applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- h) the default PC5 DRX configuration for discovery as specified in 3GPP TS 38.331 [13] when the UE is not served by NG-RAN;
- i) the privacy timer value for changing the source layer-2 ID assigned by the 5G ProSe intermediate UE-to-network relay UE for 5G ProSe multi-hop UE-to-network relay unicast direct communication, as specified in 3GPP TS 24.555 [17].
- j) optionally, the 5G PKMF address information.
- k) the default destination layer-2 ID for 5G ProSe broadcasting message for public warning notification;
- l) the PC5 QoS parameters for 5G ProSe broadcasting message for public warning notification. The PC5 QoS parameters are specified in clause 5.6.1 of 3GPP TS 23.304 [2]; and
- m) the NR Tx profile for 5G ProSe broadcasting message for public warning notification. The NR Tx profile is specified in 3GPP TS 38.300 [21] and 3GPP TS 38.331 [13].

The configuration parameters for the role of a 5G ProSe multi-hop remote UE consist of:

- a) a validity timer for the validity of the configuration parameters for 5G ProSe multi-hop remote UE;
- b) an indication whether the UE is authorized to use a 5G ProSe multi-hop layer-3 UE-to-network relay UE, where that authorization also authorizes the use of both 5G ProSe multi-hop UE-to-network relay discovery Model A and 5G ProSe multi-hop UE-to-network relay discovery Model B;
- b1) a list of PLMNs in which the UE is authorized to use a 5G ProSe multi-hop layer-2 UE-to-network relay UE, or an indication of whether the UE is authorized to use a 5G ProSe multi-hop layer-2 UE-to-network relay UE in the subscribed SNPN, where that authorization also authorizes the use of both 5G ProSe UE-to-network relay discovery Model A and 5G ProSe UE-to-network relay discovery Model B
- c) default destination layer-2 ID(s) for sending the discovery signalling for solicitation and for receiving the discovery signalling for announcement and additional information;

NOTE 5: Which default destination layer-2 ID is selected is up to UE implementation when there are more than one default destination layer-2 ID.

- d) a user info ID for the multi-hop UE-to-network relay discovery;
- e) one or more relay service code(s) for the multi-hop UE-to-network relay discovery for normal services, one or more relay service code(s) for the multi-hop UE-to-network relay discovery for emergency services or both, and for each relay service code:
 - 1) an indication of whether the relay service code is offering 5G ProSe multi-hop layer-2 or layer-3 UE-to-network relay service;
 - 2) a multi-hop indicator to indicate whether the associated relay service code can be supported for 5G ProSe multi-hop UE-to-network relay operation;
 - 3) maximum number of hops to indicate the maximum number of hops can be supported for the associated relay service code, if the multi-hop indicator is configured; and
 - 4) for 5G ProSe multi-hop layer-3 remote UE using 5G ProSe multi-hop layer-3 UE-to-network relay, one of the following:
 - i) a set of PDU session parameters for the relayed traffic without using N3IWF access:
 - A) PDU session type;
 - B) DNN, if the 5G ProSe multi-hop UE-to-network relay unicast direct communication is not for emergency services;
 - C) optionally, SSC mode;

- D) optionally, S-NSSAI; and
- E) optionally, access type preference; or
- ii) an indication of using N3IWF access for the relayed traffic;
- 5) optionally, for 5G ProSe multi-hop layer-3 remote UE using 5G ProSe multi-hop layer-3 UE-to-network relay, the ProSe application traffic descriptor(s) (as defined in 3GPP TS 24.526 [5]) to be used for the relayed traffic;
- 6) security related content for 5G ProSe multi-hop relay discovery that is used when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, including a validity timer for that security related content;
- 7) security policies for 5G ProSe multi-hop UE-to-network relay direct communication:
 - i) the signalling integrity protection policy;
 - ii) the signalling ciphering policy;
 - iii) the user plane integrity protection policy; and
 - iv) the user plane ciphering policy; and
- 8) a control plane security indication to indicate whether to use the security procedure over control plane as specified in 3GPP TS 33.503 [34]. If the control plane security indication indicates not to use the security procedure over control plane, 5G ProSe multi-hop layer-3 remote UE uses the security procedure over user plane as specified in 3GPP TS 33.503 [34];

NOTE 6: If the control plane security indication indicates to use the security procedure over control plane and the 5G ProSe multi-hop layer-3 remote UE doesn't support the security procedure over control plane, 5G ProSe multi-hop layer-3 remote UE doesn't use that relay service code.

- f) the radio parameters of the 5G ProSe multi-hop UE-to-network relay discovery applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- g) the radio parameters of the 5G ProSe multi-hop direct unicast direct communication applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;

NOTE 7: Whether a frequency band is "operator managed" or "non-operator managed" in a given Geographical Area is defined by local regulations.

- h) if at least one relay service code is configured with the indication of using N3IWF access for the relayed traffic, the N3IWF selection information for 5G ProSe multi-hop layer-3 remote UE:
 - 1) N3IWF identifier configuration (either FQDN or IP address); and
 - 2) 5G ProSe multi-hop layer-3 UE-to-network relays, access node selection information, which consists of a prioritized list of PLMNs for N3IWF selection and an indication that the selection of an N3IWF in a PLMN should be based on Tracking Area Identity FQDN or on Operator Identifier FQDN;
- i) the default PC5 DRX configuration for discovery as specified in 3GPP TS 38.331 [13] when the UE is not served by NG-RAN;
- j) the privacy timer value for changing the source layer-2 ID assigned by the 5G ProSe multi-hop remote UE for 5G ProSe multi-hop unicast direct communication, as specified in 3GPP TS 24.555 [17];
- k) the default destination layer-2 ID for 5G ProSe broadcasting message for public warning notification;
- l) the PC5 QoS parameters for 5G ProSe broadcasting message for public warning notification. The PC5 QoS parameters are specified in clause 5.6.1 of 3GPP TS 23.304 [2]
- m) the NR Tx profile for 5G ProSe broadcasting message for public warning notification. The NR Tx profile is specified in 3GPP TS 38.300 [21] and 3GPP TS 38.331 [13]; and

- n) optionally, the 5G PKMF address information.

5.2.9 Configuration parameters for 5G ProSe multi-hop layer-3 UE-to-UE relay

The configuration parameters for the role of a 5G ProSe multi-hop layer-3 UE-to-UE relay UE over PC5 reference point consist of:

- a) a validity timer for the validity of the configuration parameter for 5G ProSe multi-hop layer-3 UE-to-UE relay over PC5 interface;
- b) a list of PLMNs in which the UE is authorised to relay traffic for 5G ProSe multi-hop layer-3 end UEs when the UE is served by NG-RAN and in each PLMN, or an indication of whether the UE is authorised to relay traffic for 5G ProSe multi-hop layer-3 end UEs when the UE is served by NG-RAN in the subscribed SNPN, whether that authorization also authorizes the use of both 5G ProSe multi-hop layer-3 UE-to-UE relay discovery Model A and 5G ProSe multi-hop layer-3 UE-to-UE relay discovery Model B;
- c) an indication whether the UE is authorized to relay traffic for 5G ProSe multi-hop layer-3 end UEs when the UE is not served by NG-RAN, whether that authorization also authorizes the use of both 5G ProSe multi-hop layer-3 UE-to-UE relay discovery Model A and 5G ProSe multi-hop layer-3 UE-to-UE relay discovery Model B;
- d) the default destination layer-2 ID(s) for sending the discovery signalling for announcement, for receiving the discovery signalling for solicitation and for sending discovery signalling for solicitation;

NOTE 1: Which default destination layer-2 ID is selected is up to UE implementation when there are more than one default destination layer-2 ID.

- e) a User info ID for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery;
- f) one or more relay service code(s) for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery and for each relay service code:
 - 1) an indication of whether the relay service code is offering 5G ProSe multi-hop layer-3 UE-to-UE relay service;
 - 2) a multi-hop indicator to indicate whether the associated relay service code can be supported for 5G ProSe multi-hop layer-3 UE-to-UE relay operation;
 - 3) maximum number of hops to indicate the maximum number of hops can be supported for the associated relay service code, if the multi-hop indicator is configured;
 - 4) for 5G ProSe multi-hop layer-3 UE-to-UE relay, the traffic type of the relayed service (i.e. IP, Ethernet or Unstructured);
 - 5) optionally, security related content for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery. The security related content for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery applies only when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, including a validity timer for that security related content;
 - 6) security policies for 5G ProSe multi-hop layer-3 UE-to-UE relay direct communication for non-IP PDU type:
 - i) the signalling integrity protection policy;
 - ii) the signalling ciphering policy;
 - iii) the user plane integrity protection policy; and
 - iv) the user plane ciphering policy;
 - 7) a network assistance security indication to indicate whether to use the security procedure for non-IP PDU type with network assistance or the security procedure for non-IP PDU type without network assistance as specified in clause 6.6.3.3 of 3GPP TS 33.503 [34]; and
 - 8) a control plane security indication to indicate whether to use the security procedure over control plane as specified in 3GPP TS 33.503 [34], if the security procedure for non-IP PDU type with network assistance is

to be used. If the control plane security indication indicates not to use the security procedure over control plane, the 5G ProSe multi-hop layer-3 UE-to-UE relay UE uses the security procedure for non-IP PDU type over user plane as specified in 3GPP TS 33.503 [34];

NOTE 2: If the control plane security indication indicates to use the security procedure for non-IP PDU type over control plane and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE doesn't support the security procedure over control plane, the 5G ProSe UE-to-UE relay UE doesn't use that relay service code.

- g) the radio parameters of 5G ProSe multi-hop layer-3 UE-to-UE relay discovery applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- h) the radio parameters of 5G ProSe multi-hop layer-3 UE-to-UE relay unicast direct communication applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- i) the default PC5 DRX configuration for discovery as specified in 3GPP TS 38.331 [13] when the UE is not served by NG-RAN; and
- j) optionally, the 5G PKMF address information.

The configuration parameters for the role of a 5G ProSe multi-hop layer-3 end UE consist of:

- a) a validity timer for the validity of the configuration parameters for 5G ProSe multi-hop layer-3 end UE;
- b) an indication whether the UE is authorized to use a 5G ProSe multi-hop layer-3 UE-to-UE relay UE when the UE is not served by NG-RAN, whether that authorization also authorizes the use of both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B;
- c) a list of PLMNs in which the UE is authorised to use a 5G ProSe multi-hop layer-3 UE-to-UE relay UE when the UE is served by NG-RAN and in each PLMN, or an indication of whether the UE is authorised to relay traffic for 5G ProSe multi-hop layer-3 UE-to-UE relay UE when the UE is served by NG-RAN in the subscribed SNPN, whether that authorization also authorizes the use of both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B;
- d) the default destination layer-2 ID(s) for sending the discovery signalling for solicitation and for receiving the discovery signalling for announcement and for receiving the discovery signalling for solicitation;

NOTE 3: Which default destination layer-2 ID is selected is up to UE implementation when there are more than one default destination layer-2 ID.

- e) one or more relay service code(s) for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery and for each relay service code:
 - 1) an indication of whether the relay service code is offering 5G ProSe multi-hop layer-3 UE-to-UE relay service;
 - 2) a multi-hop indicator to indicate whether the associated relay service code can be supported for 5G ProSe multi-hop layer-3 UE-to-UE relay operation;
 - 3) maximum number of hops to indicate the maximum number of hops can be supported for the associated relay service code, if the multi-hop indicator is configured;
 - 4) for 5G ProSe multi-hop layer-3 UE-to-UE relay, the traffic type of the relayed service (i.e. IP, Ethernet or Unstructured);
 - 5) optionally, security related content for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery. The security related content for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery applies only when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, including a validity timer for that security related content;
 - 6) security policies for 5G ProSe multi-hop layer-3 UE-to-UE relay direct communication for non-IP PDU type:
 - i) the signalling integrity protection policy;
 - ii) the signalling ciphering policy;

- iii) the user plane integrity protection policy; and
- iv) the user plane ciphering policy;
- 7) a network assistance security indication to indicate whether to use the security procedure for non-IP PDU type with network assistance or the security procedure for non-IP PDU type without network assistance as specified in clause 6.6.3.3 of 3GPP TS 33.503 [34]; and
- 8) a control plane security indication to indicate whether to use the security procedure over control plane as specified in 3GPP TS 33.503 [34], if the security procedure for non-IP PDU type with network assistance is to be used. If the control plane security indication indicates not to use the security procedure over control plane, the 5G ProSe multi-hop layer-3 UE-to-UE end UE uses the security procedure for non-IP PDU type over user plane as specified in 3GPP TS 33.503 [34];

NOTE 4: If the control plane security indication indicates to use the security procedure for non-IP PDU type over control plane and the 5G ProSe multi-hop layer-3 UE-to-UE end UE doesn't support the security procedure over control plane, the 5G ProSe UE-to-UE end UE doesn't use that relay service code.

- f) the radio parameters of 5G ProSe multi-hop layer-3 UE-to-UE relay discovery applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- g) the radio parameters of 5G ProSe multi-hop layer-3 UE-to-UE relay communication applicable per geographical area with an indication of whether these radio parameters are "operator managed" or "non-operator managed" when the UE is not served by NG-RAN;
- h) the default PC5 DRX configuration for discovery as specified in 3GPP TS 38.331 [13] when the UE is not served by NG-RAN; and
- i) optionally, the 5G PKMF address information.

5.3 Procedures

5.3.1 General

The procedure for provisioning of parameters for 5G ProSe allows the UE to obtain 5G ProSe policy (ProSeP).

5.3.2 UE-requested ProSeP provisioning procedure

5.3.2.1 General

The UE-requested ProSeP policy provisioning procedure enables the UE to request ProSeP from the PCF in the following cases:

- a) if the T5051 for a UE policies for 5G ProSe direct discovery expires;
- b) if the T5052 for a UE policies for 5G ProSe direct communications expires;
- c) if the T5053 for a UE policies for 5G ProSe UE-to-network relay UE expires;
- d) if the T5054 for UE policies for 5G ProSe remote UE expires;
- e) if the T5057 for UE policies for 5G ProSe usage information reporting expires;
- f) if the T5058 for a UE policies for 5G ProSe UE-to-UE relay UE expires;
- g) if the T5059 for a UE policies for 5G ProSe end UE expires;
- h) if the T5120 for a UE policies for 5G ProSe multi-hop UE-to-network relay UE expires;
- i) if the T5121 for a UE policies for 5G ProSe multi-hop remote UE expires;
- j) if the T5122 for a UE policies for 5G ProSe intermediate UE-to-network relay UE expires;

- k) if the T5123 for a UE policies for 5G ProSe multi-hop UE-to-UE relay UE expires;
- l) if the T5124 for a UE policies for 5G ProSe multi-hop end UE expires; and
- m) if there are no valid configuration parameters, e.g., for the current area, or due to abnormal situation.

The UE shall follow the principles of PTI handling for UE policy delivery service procedures defined in 3GPP TS 24.501 [11] clause D.1.2.

5.3.2.2 UE-requested ProSeP policy provisioning procedure initiation

In order to initiate the UE-requested ProSeP policy provisioning procedure, the UE shall create a UE POLICY PROVISIONING REQUEST message (see example in figure 5.3.2.2.1). The UE:

- a) shall allocate a PTI value currently not used and set the PTI IE to the allocated PTI value;
- b) shall include the Requested UE policies IE indicating whether the UE policies for 5G ProSe direct discovery, the UE policies for 5G ProSe direct communications, the UE policies for 5G ProSe UE-to-network relay, the UE policies for 5G ProSe remote UE, the UE policies for 5G ProSe usage information reporting, the UE policies for 5G ProSe UE-to-UE relay, the UE policies for 5G ProSe end UE, the UE policies for 5G ProSe multi-hop UE-to-network relay UE, the UE policies for 5G ProSe multi-hop remote UE, the UE policies for 5G ProSe intermediate UE-to-network relay UE, the UE policies for 5G ProSe multi-hop UE-to-UE relay UE, the UE policies for 5G ProSe multi-hop end UE, or any combination of them are requested;
- c) shall transport the UE POLICY PROVISIONING REQUEST message using the NAS transport procedure as specified in 3GPP TS 24.501 [11] clause 5.4.5; and
- d) shall start timer T5040.

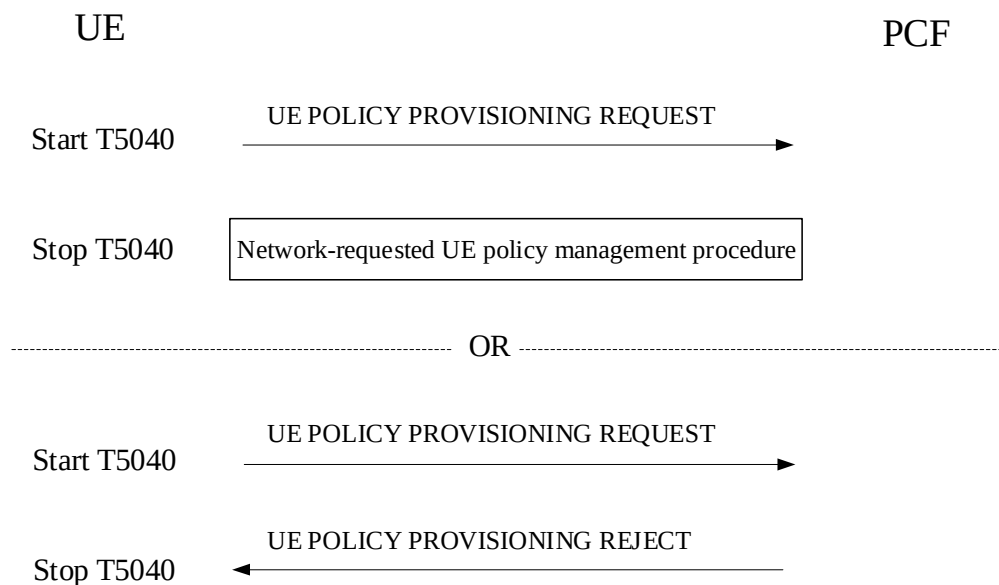


Figure 5.3.2.2.1: UE-requested ProSeP policy provisioning procedure

5.3.2.3 UE-requested ProSeP policy provisioning procedure accepted by the network

Handling in 3GPP TS 24.587 [18] clause 5.3.2.3 shall apply.

If new UE policies for 5G ProSe direct discovery are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5051 if it is running and start timer T5051 with the value included in the UE policies for 5G ProSe direct discovery and start using the new UE policies for 5G ProSe direct discovery included in the MANAGE UE POLICY COMMAND message.

If new UE policies for 5G ProSe direct communications are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5052 if it is running and start timer T5052 with the value included in the UE policies for 5G ProSe direct communications and start using the new UE policies for 5G ProSe direct communications included in the MANAGE UE POLICY COMMAND message.

If new UE policies for 5G ProSe UE-to-network relay UE are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5053 if it is running and start timer T5053 with the value included in the UE policies for 5G ProSe UE-to-network relay UE and start using the new UE policies for 5G ProSe UE-to-network relay UE included in the MANAGE UE POLICY COMMAND message. If the security related parameters for discovery are included in the new UE policies for 5G ProSe UE-to-network relay UE in the MANAGE UE POLICY COMMAND message and the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, the UE shall stop timer T5055 if it is running and start timer T5055 with the value included in the security related parameters for discovery, and start using the security related parameters for discovery included in the new UE policies for 5G ProSe UE-to-network relay UE.

If new UE policies for 5G ProSe remote UE are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5054 if it is running and start timer T5054 with the value included in the UE policies for 5G ProSe remote UE and start using the new UE policies for 5G ProSe remote UE included in the MANAGE UE POLICY COMMAND message. If the security related parameters for discovery are included in the new UE policies for 5G ProSe remote UE in the MANAGE UE POLICY COMMAND message and the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, the UE shall stop timer T5056 if it is running and start timer T5056 with the value included in the security related parameters for discovery, and start using the security related parameters for discovery included in the new UE policies for 5G ProSe remote UE.

If new UE policies for 5G ProSe usage information reporting are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5057 if it is running and start timer T5057 with the value included in the UE policies for 5G ProSe usage information reporting, and start using the UE policies for 5G ProSe usage information reporting included in the MANAGE UE POLICY COMMAND message.

If new UE policies for 5G ProSe UE-to-UE relay UE are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5058 if it is running and start timer T5058 with the value included in the UE policies for 5G ProSe UE-to-UE relay UE and start using the new UE policies for 5G ProSe UE-to-UE relay UE included in the MANAGE UE POLICY COMMAND message. If the security related parameters for discovery are included in the new UE policies for 5G ProSe UE-to-UE relay UE in the MANAGE UE POLICY COMMAND message and the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, the UE shall stop timer T5101 if it is running and start timer T5101 with the value included in the security related parameters for discovery, and start using the security related parameters for discovery included in the new UE policies for 5G ProSe UE-to-UE relay UE.

If new UE policies for 5G ProSe end UE are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5059 if it is running and start timer T5059 with the value included in the UE policies for 5G ProSe end UE and start using the new UE policies for 5G ProSe end UE included in the MANAGE UE POLICY COMMAND message. If the security related parameters for discovery are included in the new UE policies for 5G ProSe end UE in the MANAGE UE POLICY COMMAND message and the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, the UE shall stop timer T5102 if it is running and start timer T5102 with the value included in the security related parameters for discovery, and start using the security related parameters for discovery included in the new UE policies for 5G ProSe end UE.

If new UE policies for 5G ProSe multi-hop UE-to-network relay UE are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5120 if it is running and start timer T5120 with the value included in the UE policies for 5G ProSe multi-hop UE-to-network relay UE and start using the new UE policies for 5G ProSe multi-hop UE-to-network relay UE included in the MANAGE UE POLICY COMMAND message. If the security related parameters for discovery are included in the new UE policies for 5G ProSe multi-hop UE-to-network relay UE in the MANAGE UE POLICY COMMAND message and the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, the UE shall stop timer T5127 if it is running and start timer T5127 with the value included in the security related parameters for discovery, and start using the security related parameters for discovery included in the new UE policies for 5G ProSe multi-hop UE-to-network relay UE.

If new UE policies for 5G ProSe multi-hop remote UE are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5121 if it is running and start timer T5121 with the value included in the UE policies for 5G ProSe multi-hop remote UE and start using the new UE policies for 5G ProSe multi-hop remote UE included in the MANAGE UE POLICY COMMAND message. If the security related parameters for discovery are included in the new UE policies for 5G ProSe multi-hop remote UE in the MANAGE UE POLICY COMMAND message and the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, the UE shall stop timer T5128 if it is

running and start timer T5128 with the value included in the security related parameters for discovery, and start using the security related parameters for discovery included in the new UE policies for 5G ProSe multi-hop remote UE.

If new UE policies for 5G ProSe intermediate UE-to-network relay UE are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5122 if it is running and start timer T5122 with the value included in the UE policies for 5G ProSe intermediate UE-to-network relay UE and start using the new UE policies for 5G ProSe intermediate UE-to-network relay UE included in the MANAGE UE POLICY COMMAND message. If the security related parameters for discovery are included in the new UE policies for 5G ProSe intermediate UE-to-network relay UE in the MANAGE UE POLICY COMMAND message and the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, the UE shall stop timer T5129 if it is running and start timer T5129 with the value included in the security related parameters for discovery, and start using the security related parameters for discovery included in the new UE policies for 5G ProSe intermediate UE-to-network relay UE.

If new UE policies for 5G ProSe multi-hop UE-to-UE relay UE are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5123 if it is running and start timer T5123 with the value included in the UE policies for 5G ProSe multi-hop UE-to-UE relay UE and start using the new UE policies for 5G ProSe multi-hop UE-to-UE relay UE included in the MANAGE UE POLICY COMMAND message. If the security related parameters for discovery are included in the new UE policies for 5G ProSe multi-hop UE-to-UE relay UE in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5130 if it is running and start timer T5130 with the value included in the security related parameters for discovery, and start using the security related parameters for discovery included in the new UE policies for 5G ProSe multi-hop UE-to-UE relay UE.

If new UE policies for 5G ProSe multi-hop end UE are included in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5124 if it is running and start timer T5124 with the value included in the UE policies for 5G ProSe multi-hop end UE and start using the new UE policies for 5G ProSe multi-hop end UE included in the MANAGE UE POLICY COMMAND message. If the security related parameters for discovery are included in the new UE policies for 5G ProSe multi-hop end UE in the MANAGE UE POLICY COMMAND message, the UE shall stop timer T5131 if it is running and start timer T5131 with the value included in the security related parameters for discovery, and start using the security related parameters for discovery included in the new UE policies for 5G ProSe multi-hop end UE.

5.3.2.4 UE-requested ProSeP policy provisioning procedure not accepted by the network

Handling in 3GPP TS 24.587 [18] clause 5.3.2.4 shall apply.

5.3.2.5 Abnormal cases on the network side

Handling in 3GPP TS 24.587 [18] clause 5.3.2.5 shall apply.

5.3.2.6 Abnormal cases on the UE

Handling in 3GPP TS 24.587 [18] clause 5.3.2.6 shall apply.

6 5G ProSe direct discovery

6.1 Overview

6.1.1 Transport protocol for PC3a control protocol messages for 5G ProSe direct discovery

The UE and 5G DDNMF shall use HTTP/1.1 as specified in IETF RFC 9112 [3] and IETF RFC 9110 [4] as the transport protocol for 5G ProSe messages over the PC3a interface. The 5G ProSe messages described here shall be included in the body of either an HTTP request message or an HTTP response message.

6.1.2 Handling of UE-initiated procedures

6.1.2.1 General

The following rules apply for UE-initiated procedures:

- a) the UE initiates 5G ProSe transactions with an HTTP request message containing the PC3a request(s);
- b) the 5G DDNMF responds to the requests with an HTTP response message containing the PC3a response(s) for the PC3a request(s); and
- c) HTTP POST methods are used for PC3a direct discovery procedures.

The UE may use UE local configuration or URSP, as defined in 3GPP TS 24.526 [5], to establish a PDU session for reaching the HPLMN or subscribed SNPN 5G DDNMF:

- a) if a PDU session for reaching the HPLMN or subscribed SNPN 5G DDNMF is not established yet, the UE shall establish the PDU session for reaching the HPLMN or subscribed SNPN 5G DDNMF and shall send the HTTP request message via the PDU session for reaching the HPLMN or subscribed SNPN 5G DDNMF; and
- b) if a PDU session for reaching the HPLMN or subscribed SNPN 5G DDNMF is already established (e.g., either due to other 5G ProSe feature or due to other application), the UE shall send the HTTP request message via the PDU session for reaching the HPLMN or subscribed SNPN 5G DDNMF.

6.1.2.2 5G DDNMF discovery

The IP address or the FQDN of the 5G DDNMF in the HPLMN or subscribed SNPN may be pre-configured in the UE. The FQDN of the 5G DDNMF in the HPLMN or subscribed SNPN may also be self-constructed by the UE, i.e. derived from the PLMN ID of the HPLMN. The FQDN of the 5G DDNMF in the HPLMN or subscribed SNPN may also be provisioned by the PCF as described in clause 5.2.3. The UE may use the pre-configured IP address or the FQDN of the 5G DDNMF in the HPLMN or subscribed SNPN to discover the 5G DDNMF.

6.1.3 Handling of 5G DDNMF-initiated procedures

6.1.3.1 General

The 5G DDNMF address information (i.e. either IP address or FQDN) in the HPLMN or subscribed SNPN may be pre-configured in the UE. The 5G DDNMF address information (i.e. either IP address or FQDN) in the HPLMN or subscribed SNPN may also be provisioned by the PCF as described in clause 5.2.3. The UE may use the IP address or the FQDN of the 5G DDNMF in the HPLMN or subscribed SNPN to discover the 5G DDNMF.

If the UE has neither the pre-configured 5G DDNMF address information in the HPLMN or subscribed SNPN nor the 5G DDNMF address information in the HPLMN or subscribed SNPN provisioned by the PCF, the UE may self-construct the FQDN of the 5G DDNMF in the HPLMN or subscribed SNPN (e.g. deriving the FQDN from the PLMN ID of the HPLMN).

If the UE supports the HTTP long polling, the UE shall include a Network-Initiated Transaction Method set to "HTTP long polling" in the DISCOVERY_REQUEST message to the 5G DDNMF.

Upon receiving a DISCOVERY_REQUEST message containing a Network-Initiated Transaction Method set to "HTTP long polling", if the 5G DDNMF supports the HTTP long polling, the 5G DDNMF shall include a Network-Initiated Transaction Method set to "HTTP long polling" in the DISCOVERY_RESPONSE message.

If the UE receives a DISCOVERY_RESPONSE message including a Network-Initiated Transaction Method set to "HTTP long polling", the UE shall use the HTTP long polling for network initiated procedures. Otherwise, the UE shall assume that the 5G DDNMF uses OMA Push for network initiated procedures.

6.1.3.2 HTTP long polling

The HTTP long polling method is described by the following steps:

- a) the UE sends an empty HTTP request message as a polling request when it expects network initiated message(s) over the PC3a interface;
- b) the 5G DDNMF defers its response to the UE's request until;
 - 1) one or more network-initiated PC3a message(s) for the UE are available. The 5G DDNMF encloses the message(s) in an HTTP response message and send it to the UE; or
 - 2) a particular timeout for HTTP polling has occurred. The 5G DDNMF then sends an empty HTTP response message as the polling response to the UE; and
- c) after receiving the response from the 5G DDNMF, the UE may keep polling after some waiting period if:
 - 1) the UE receives an empty polling response; or
 - 2) the UE receives 5G DDNMF-initiated message(s) from the 5G DDNMF but still expects additional network-initiated message(s).

NOTE: The implementation of the HTTP polling process can be coordinated with the SUPL (Secure User Plane Location) procedures to synchronize the SUPL location report procedures and the HTTP polling procedure so as to reduce unnecessary wait time of polling.

If the UE is triggered to send a PC3a message to the 5G DDNMF while it has a pending HTTP polling request, the UE shall open another HTTP connection to the 5G DDNMF to send this new request. Alternately the UE may always use a separate dedicated HTTP connection for polling.

6.1.3.3 OMA Push

The OMA Push method is described by the following steps:

- a) if one or more network-initiated PC3a message(s) for the UE are available, the 5G DDNMF sends a push message containing a particular URL to the UE via the OMA-Push Architecture as defined in OMA-AD-Push-V2_2-20110809-A [6]. The URL is linked to the PC3a message(s) to be sent to the UE. The 5G DDNMF (performing OMA Push Proxy Gateway functionality) generates a Push Message as specified in OMA-WAP-TS-PushOTA-V2_1-20110405-A [7] with the PDU set according to WAP-168-ServiceLoad-20010731-a [8]. The URL information shall be included in the PDU payload;
- b) after receiving the push message, the UE retrieves the URL from the payload of the message and sends an HTTP GET request to the 5G DDNMF with this URL; and
- c) the 5G DDNMF sends an HTTP response message containing the PC3a message(s) to the UE.

6.2 Procedures

6.2.1 Types of 5G ProSe direct discovery procedures

The following PC3a control protocol procedures are defined:

- a) announce request;
- b) monitor request;
- c) discoveree request;
- d) discoverer request;
- e) match report;
- f) network initiated direct discovery update;
- g) announcing alert request; and
- h) 5G PKMF address request procedure.

The following PC5 protocol procedures are defined:

- a) 5G ProSe direct discovery procedure over PC5 interface; and
- b) Group member discovery over PC5 interface.

In the following descriptions of PC3a control protocol procedures, the terms "request" and "response" refer to the corresponding PC3a control protocol messages, not to the HTTP request or response. The following procedure descriptions use a single PC3a control protocol message for illustration purposes.

The PC3a control protocol procedures for 5G ProSe direct discovery shall be integrity protected and confidentiality protected using the security procedures defined in clause 5.2.3 in 3GPP TS 33.503 [34].

NOTE: A single HTTP request message can contain multiple PC3a control protocol requests and a single HTTP response message can contain multiple PC3a control protocol responses.

When the TLS tunnel between the UE and the 5G DDNMF for transport of PC3a messages is established by the UE according to 3GPP TS 33.503 [34], the 5G DDNMF shall obtain identity of the served UE using the procedures specified in 3GPP TS 33.220 [46] or 3GPP TS 33.535 [47].

6.2.2 Announce request procedure for open 5G ProSe direct discovery

6.2.2.1 General

The purpose of the announce request procedure for open 5G ProSe direct discovery is for the UE:

- a) to obtain one or more ProSe application code(s) to be announced over the PC5 interface, upon a request for announcing from upper layers as defined in 3GPP TS 23.304 [2];
- b) to inform the 5G DDNMF that the UE wants to stop announcing a ProSe application code as defined in 3GPP TS 23.304 [2]; or
- c) to upload metadata associated with a ProSe application ID to the 5G DDNMF as defined in 3GPP TS 23.304 [2].

The UE shall be authorized for open 5G ProSe direct discovery announcing in the registered PLMN or the local PLMN or the subscribed SNPN based on the service authorization procedure as specified in clause 5, before initiating the announce request procedure.

The UE includes one of the ProSe application code(s) obtained as a result of a successful announce request procedure per PROSE PC5 DISCOVERY message and passes the PROSE PC5 DISCOVERY messages to the lower layers for transmission over the PC5 interface.

6.2.2.2 Announce request procedure initiation

Before initiating the announce request procedure for open 5G ProSe direct discovery, the UE is configured with the data structure of the ProSe application IDs appropriate for its HPLMN or its subscribed SNPN. This step is performed using mechanisms out of scope of 3GPP.

If the UE is authorized to perform open 5G ProSe direct discovery announcing in the PLMN or SNPN operating the radio resources signalled from the serving PLMN or subscribed SNPN, it shall initiate an announce request procedure:

- a) when the UE is triggered by an upper layer application to announce a ProSe application ID and the UE has no valid corresponding ProSe application code for that upper layer application;
- b) when the validity timer T5060 assigned by the 5G DDNMF to a ProSe application code has expired and the request from upper layers to announce the ProSe application ID corresponding to that ProSe application code is still in place;
- c) when the UE selects a new PLMN while announcing a ProSe application code and intends to announce in the new PLMN and the UE is authorized for open 5G ProSe direct discovery announcing in the new PLMN;
- d) when, while announcing a ProSe application ID, the UE intends to switch the announcing PLMN to a different PLMN without performing PLMN selection and the UE does not have a valid allocated ProSe application code for this new PLMN yet;

- e) when the UE needs to inform the 5G DDNMF that the UE wants to stop announcing a ProSe application code; or
- f) when the UE needs to update metadata associated with a ProSe application ID to the 5G DDNMF.

When the UE selects a new PLMN while announcing a ProSe application code and the UE is not yet authorized for open 5G ProSe direct discovery announcing in the new PLMN, the UE shall initiate an announce request procedure only after the UE is authorized for open 5G ProSe direct discovery announcing in the new PLMN.

NOTE 1: To ensure service continuity if the UE needs to keep announcing a ProSe application code corresponding to the same ProSe application ID, the UE can initiate the announce request procedure before the validity timer T5060 assigned by the 5G DDNMF for a ProSe application code expires.

The UE shall initiate the announce request procedure for open 5G ProSe direct discovery by sending a DISCOVERY_REQUEST message with:

- a) a new transaction ID;
- b) the ProSe application ID set to the ProSe application ID received from upper layers;
- c) the command set to "metadata_update" if the UE has a valid ProSe application code corresponding to the ProSe application ID and intends to update metadata associated with the ProSe application ID to the 5G DDNMF, otherwise set to "announce";
- d) the application identity set to the ProSe identifier of the upper layer application that requested the announcing as specified in clause 5.2.3;
- e) the discovery entry ID set to 0 when this is a new request or set to the discovery entry ID received from the 5G DDNMF if the announce request is to update a previously sent announce request;
- f) the ACE enabled indicator set to "application-controlled extension enabled" if application-controlled extension is required by the upper layers or "normal" if application-controlled extension is not used;
- g) optionally the requested timer set to the length of validity timer associated with the ProSe application code that the UE expects to receive from the 5G DDNMF;
- h) optionally the Metadata set to the metadata received from upper layers associated with the ProSe application ID; and
- i) optionally the announcing PLMN ID set to the PLMN ID of the local PLMN operating the radio resources that the UE intends to use for announcing this ProSe application ID.

If open 5G ProSe direct discovery with application-controlled extension is requested by upper layers, the DISCOVERY_REQUEST message shall also include the application level container, which contains application-level data transparent to the 3GPP network, to be used by the ProSe application server e.g., to assign ProSe application code suffix(es).

When the UE initiates the announce request procedure to inform the 5G DDNMF that the UE wants to stop announcing a ProSe application code before the associated valid timer expires, the UE shall set the requested timer to 0.

NOTE 2: A UE can include one or multiple transactions in one DISCOVERY_REQUEST message for different ProSe application IDs and receive corresponding <response-announce> element or <response-reject> element in a DISCOVERY_RESPONSE message for each respective transaction. In the following description of the announce request procedure, only one transaction is included.

Figure 6.2.2.2.1 illustrates the interaction of the UE and the 5G DDNMF in the announce request procedure.

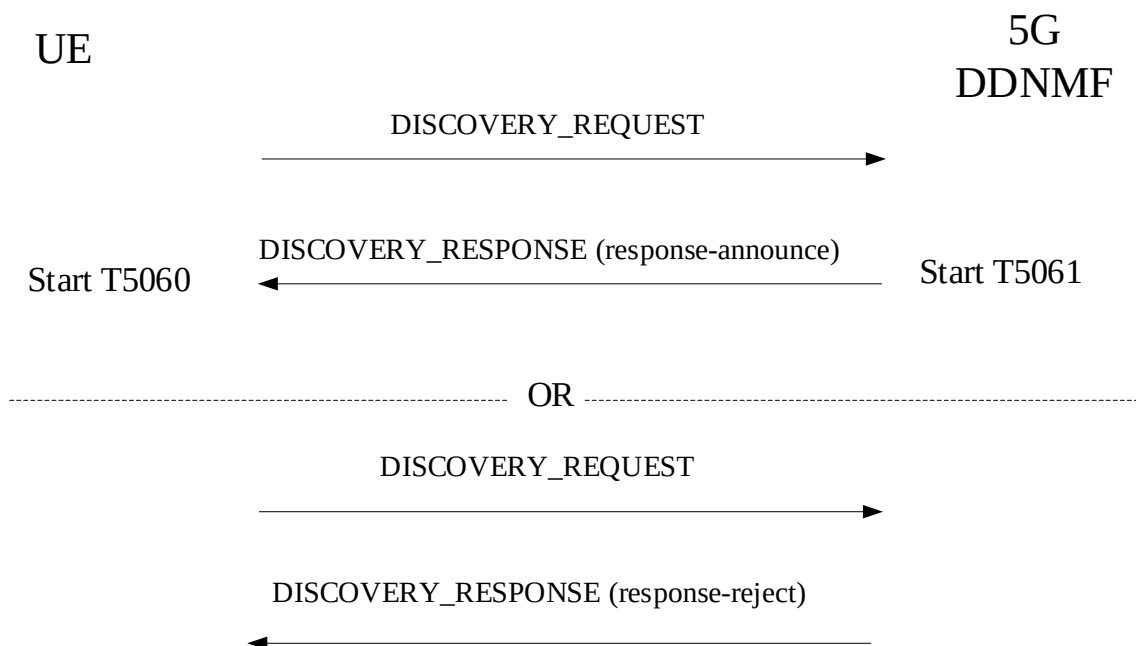


Figure 6.2.2.1: Announce request procedure

6.2.2.3 Announce request procedure accepted by the 5G DDNMF

Upon receiving a DISCOVERY_REQUEST message with the command set to "announce", if the requested timer is included in the DISCOVERY_REQUEST message and the requested timer is set to 0, the 5G DDNMF shall check whether there is an existing UE context containing the discovery entry identified by the discovery entry ID included in the DISCOVERY_REQUEST message. If the discovery entry exists in the UE context, the 5G DDNMF shall inform the 5G DDNMF in the announcing PLMN to remove the corresponding discovery entry as specified in 3GPP TS 29.555 [9] when the announcing PLMN is not the same as that of the PLMN to which the 5G DDNMF belongs and remove the discovery entry identified by the discovery entry ID from the UE's context. Then the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-announce> element with:

- a) the transaction ID set to the value of the transaction ID received in the DISCOVERY_REQUEST message; and
- b) the discovery entry ID set to the identifier associated with the corresponding discovery entry.

Upon receiving a DISCOVERY_REQUEST message with the command set to "announce", if the requested timer is not included in the DISCOVERY_REQUEST message or the requested timer included in the DISCOVERY_REQUEST message is not set to 0, the 5G DDNMF shall perform the following procedure.

The 5G DDNMF shall check that the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is authorized for open 5G ProSe direct discovery announcing. If the application is authorized for open 5G ProSe direct discovery announcing, the 5G DDNMF may also check whether the ProSe application ID contained in the DISCOVERY_REQUEST message is known. If the ProSe application ID is known or the 5G DDNMF skips the check of the ProSe application ID, the 5G DDNMF shall check whether there is an existing context for the UE associated with the requested ProSe application ID.

If there is no associated UE context, the 5G DDNMF checks with the UDM whether the UE is authorized for open 5G ProSe direct discovery announcing as described in 3GPP TS 29.503 [10]. If the check indicates that the UE is authorized then:

- a) the 5G DDNMF shall check whether the UE is authorized to announce the ProSe application ID contained in the DISCOVERY_REQUEST message;

- b) if the UE is authorized to announce the ProSe application ID, the ACE enabled indicator is included and set to "application-controlled extension enabled", the application level container is included in the DISCOVERY_REQUEST message and the requested application uses application-controlled extension, the 5G DDNMF shall check whether the UE is authorized to use ACE. If the UE is authorized for ACE, the 5G DDNMF shall invoke the procedure described in 3GPP TS 29.557 [19] to check whether the UE is authorized to announce the requested ProSe application ID with application-defined suffix(es) and obtain suffix-related information from the ProSe application server. The 5G DDNMF shall then allocate one ProSe application code prefix and a value for validity timer T5060 to be used with the ProSe application code suffix(es) obtained from the ProSe application server for the given ProSe application ID as specified in 3GPP TS 29.557 [19]. The 5G DDNMF may take into account the requested timer if contained in the DISCOVERY_REQUEST message;
- c) if the UE is authorized to announce the ProSe application ID, the ACE enabled indicator is included and set to "normal" in the DISCOVERY_REQUEST message and the requested application does not use application-controlled extension, the 5G DDNMF shall allocate the corresponding ProSe application code(s) and a value for validity timer T5060. The 5G DDNMF may take into account the requested timer if contained in the DISCOVERY_REQUEST message;
- d) if the UE is authorized to announce the ProSe application ID, the ACE enabled indicator is set included and to "normal" in the DISCOVERY_REQUEST message, the application level container is included in the DISCOVERY_REQUEST and the requested application only uses application-controlled extension, the 5G DDNMF shall check whether the UE is authorized to use ACE. If the UE is authorized for ACE, 5G DDNMF shall invoke the procedure described in 3GPP TS 29.557 [19] to check whether the UE is authorized to announce the requested ProSe application ID with application-defined suffix(es) and obtain suffix-related information from the ProSe application server. The 5G DDNMF shall then allocate one ProSe application code prefix and a value for validity timer T5060 to be used with the ProSe application code suffix(es) obtained from the ProSe application server for the given ProSe application ID as specified in 3GPP TS 29.557 [19]. The 5G DDNMF may take into account the requested timer if contained in the DISCOVERY_REQUEST message;
- e) if the UE is authorized to announce the ProSe application ID, the ACE enabled indicator is included and set to "application-controlled-extension enabled" and the application level container is included in the DISCOVERY_REQUEST message but the requested application does not use application-controlled extension, the 5G DDNMF shall allocate the corresponding ProSe application code(s) and a value for validity timer T5060. The 5G DDNMF may consider the requested timer if contained in the DISCOVERY_REQUEST message; and
- f) if the UE is authorized to announce the ProSe application ID and the ACE enabled indicator is not included in the DISCOVERY_REQUEST message, the 5G DDNMF shall allocate the corresponding ProSe application code(s) and a value for validity timer T5060. The 5G DDNMF may consider the requested timer if contained in the DISCOVERY_REQUEST message.

NOTE: The 5G DDNMF can allocate multiple ProSe application codes for a given ProSe application ID for instance in the case when one or more labels in the ProSe application ID name are wild carded as described in clause 24.2.2 of 3GPP TS 23.003 [12].

If the requested ProSe application ID is country-specific or global as described in clause 24.2 of 3GPP TS 23.003 [12], the 5G DDNMF shall allocate the corresponding ProSe application code(s) or ProSe application code prefix according to clause 24.3 of 3GPP TS 23.003 [12]. The temporary identity part of each ProSe application code or ProSe application code prefix is taken from the data structure corresponding to the country-specific or global ProSe application ID namespace according to clause 24.3 of 3GPP TS 23.003 [12]. The 5G DDNMF shall use the MCC and MNC of the PLMN ID of this 5G DDNMF for the PLMN ID part of the ProSe application code or ProSe application code prefix. To support 5G ProSe in SNPN, the value of PLMN ID within the ProSe application code shall be combined with a network identifier (NID) to identify a SNPN.

After the ProSe application code(s) or ProSe application code prefix allocation, the 5G DDNMF then associates the ProSe application code(s) or ProSe application code prefix with a new discovery entry identified by a non-zero value discovery entry ID in the new context for the UE that contains the UE's subscription parameters obtained from the UDM and starts timer T5061. The UDM also provides to the 5G DDNMF the PLMN ID of the PLMN or the PLMN ID with a NID of the SNPN in which the UE is currently registered. For a given set of ProSe application codes or the allocated ProSe application code prefix, timer T5061 shall be longer than timer T5060. By default, the value of timer T5061 is 4 minutes greater than the value of timer T5060.

If there is an existing context for the UE that contains the UE's subscription parameters obtained from the UDM, but no discovery entry identified by the discovery entry ID contained in the DISCOVERY_REQUEST message, the 5G

DDNMF shall behave as if the discovery entry ID included in the DISCOVERY_REQUEST message was set to 0 and the 5G DDNMF shall allocate a new non-zero discovery entry ID for this entry.

If the metadata is included in the DISCOVERY_REQUEST message, the 5G DDNMF shall allocate the ProSe application code or ProSe application code prefix including a metadata index to indicate the current version of the metadata and store the received metadata in the UE context.

Moreover, if the command is set to "metadata_update" in the DISCOVERY_REQUEST message and there is an existing UE context stored in the 5G DDNMF, the 5G DDNMF shall update the metadata in the UE context by using the received metadata in the DISCOVERY_REQUEST message and update the ProSe application code or ProSe application code prefix in the UE context by changing the metadata index portion and keeping the rest unchanged.

After the ProSe application code(s) allocation, the 5G DDNMF then associates the ProSe application code(s) with a new discovery entry identified by a non-zero value discovery entry ID in the UE context and starts timer T5061.

If there is an existing context for the UE and a discovery entry identified by the discovery entry ID contained in the DISCOVERY_REQUEST message associated with the requested ProSe application ID, the 5G DDNMF shall either update the discovery entry with a new validity timer T5060, or allocate new ProSe application code(s) or ProSe application code prefix for the requested ProSe application ID with a new validity timer T5060 and restart timer T5061. The 5G DDNMF may consider the requested timer if contained in the DISCOVERY_REQUEST message.

If a new discovery entry was created or an existing discovery entry was updated and the UE is currently roaming or the Announcing PLMN ID is included in the DISCOVERY_REQUEST message, the 5G DDNMF checks with the 5G DDNMF of the VPLMN or in case of open 5G ProSe direct discovery the local PLMN identified by the Announcing PLMN ID whether the UE is authorized for open 5G ProSe direct discovery announcing as described in 3GPP TS 29.555 [9].

If the check indicates that the UE is authorized, then the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-announce> element with:

- a) the transaction ID set to the value of the transaction ID received in the DISCOVERY_REQUEST message from the UE;
- b) either the ProSe application code(s) set to the ProSe application code(s) allocated by the 5G DDNMF, or the ProSe application code ACE parameter set to include the ProSe-application code- prefix allocated by the 5G DDNMF and one or more ProSe application code suffix Ranges which contain the suffix(es) for the ProSe application ID received in the DISCOVERY_REQUEST message from the UE;
- c) validity timer T5060 set to the T5060 timer value assigned by the 5G DDNMF to the ProSe application code(s);
- d) if the ACE enabled indicator was included by the UE in the DISCOVERY_REQUEST message, the ACE enabled indicator set to:
 - 1) "application-controlled extension enabled" if application-controlled extension is used; or
 - 2) "normal" if application-controlled extension is not used;
- e) the discovery entry ID set to the identifier associated with the corresponding discovery entry;
- f) the discovery key set to a value provided by the 5G DDNMF; and
- g) the current time set to the current UTC-based time at the 5G DDNMF and the max offset.

If timer T5061 expires, the 5G DDNMF shall remove the discovery entry identified by the discovery entry ID from the UE's context.

The 5G DDNMF uses the information (e.g. ProSe application ID, application identity) received from the UE in the DISCOVERY_REQUEST message, UE identity in GBA or AKMA information related to TLS tunnel transporting the DISCOVERY_REQUEST message, and other information for charging purposes as specified in 3GPP TS 32.277 [45].

6.2.2.4 Announce request procedure completion by the UE

Upon receipt of the DISCOVERY_RESPONSE message, if only the transaction ID and the discovery entry ID are contained in the <response-announce> element and the transaction ID and the discovery entry ID match the corresponding values sent by the UE in a DISCOVERY_REQUEST message, the UE shall:

- a) stop the validity timer T5060 corresponding to the ProSe application code(s) or ProSe application code prefix in the discovery entry identified by the discovery entry ID;
- b) remove the discovery entry identified by the discovery entry ID included; and
- c) instruct the lower layers to stop announcing.

Upon receipt of the DISCOVERY_RESPONSE message, if the transaction ID contained in the <response-announce> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "announce", the UE shall create a new discovery entry or update an existing discovery entry with the received ProSe application code(s) and the PLMN ID of the intended announcing PLMN or with the received ProSe application code(s) and the PLMN ID combined with a NID of the subscribed SNPN. For this discovery entry, the UE shall stop the validity timer T5060 if running and start the validity timer T5060 with the received value. Otherwise, the UE shall discard the DISCOVERY_RESPONSE message and shall not perform the procedures below. The UE shall set a ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter and store the received max offset parameter.

For any one of the received ProSe application codes or ProSe application code prefix in this discovery entry, the UE may perform open 5G ProSe direct discovery announcing as described in clause 6.2.14.2.1.1.

6.2.2.5 Announce request procedure not accepted by the 5G DDNMF

If the DISCOVERY_REQUEST message cannot be accepted by the 5G DDNMF, the 5G DDNMF sends a DISCOVERY_RESPONSE message containing a <response-reject> element to the UE including an appropriate PC3a control protocol cause value.

If the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is not authorized for open 5G ProSe direct discovery announcing, the 5G DDNMF shall send the DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #1 "Invalid application".

If the ProSe application ID contained in the DISCOVERY_REQUEST message is unknown to the 5G DDNMF, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #2 "Unknown ProSe application ID".

If the UE is not authorized for open 5G ProSe direct discovery announcing, the 5G DDNMF shall send the DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

If the UE is not authorized to use the ProSe application ID contained in the DISCOVERY_REQUEST message, the 5G DDNMF shall send the DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

If the UE requests a country-specific ProSe application ID for a country that does not correspond to the country of its HPLMN or its subscribed SNPN and the 5G DDNMF has not authorized the UE to announce in that country, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #8 "Scope violation in Prose application ID".

If the UE requests a country-specific ProSe application ID for a country that does not correspond to the country of its HPLMN or its subscribed SNPN and the 5G DDNMF has no agreement to access the country-wide ProSe application ID database of that country, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #8 "Scope violation in Prose application ID".

If the discovery entry ID contained in the DISCOVERY_REQUEST message is unknown to the 5G DDNMF and the requested timer is set to zero, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value # 10 "Unknown or invalid discovery entry ID".

If the UE is not authorized to use ACE, but the DISCOVERY_REQUEST message contains the ACE enabled indicator set to "application-controlled extension enabled", the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #12 "UE unauthorized for discovery with application-controlled extension".

If the DISCOVERY_REQUEST message contains the ACE enabled indicator set to "application-controlled extension enabled", but does not contain the application level container parameter, the 5G DDNMF shall send a

DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #14 "Missing application level container".

If the ProSe application server indicates to the 5G DDNMF that the application level container in the DISCOVERY_REQUEST message contains invalid information, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #15 "Invalid data in application level container".

If the DISCOVERY_REQUEST message does not contain the ACE enabled indicator and the requested application only uses application-controlled extension, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #1 "Invalid application".

6.2.2.6 Abnormal cases

6.2.2.6.1 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of DISCOVERY_REQUEST message (e.g., after TCP retransmission timeout)

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the announce request procedure.

NOTE 1: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

- b) No response from the 5G DDNMF after the DISCOVERY_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the DISCOVERY_REQUEST message)

The UE shall retransmit the DISCOVERY_REQUEST message.

NOTE 2: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

NOTE 3: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

- c) Indication from upper layers that the request to announce the ProSe application ID is no longer in place after sending the DISCOVERY_REQUEST message, but before the announce request procedure is completed

The UE shall acknowledge the DISCOVERY_RESPONSE message received from the 5G DDNMF but discard its contents and then abort the procedure.

- d) Change of PLMN

If a PLMN change occurs before the announce request procedure is completed, the procedure shall be aborted. If the UE is authorized to announce in the new PLMN, the procedure shall be restarted once the UE is registered on the new PLMN.

- e) Absence of discovery entry ID parameter in a DISCOVERY_RESPONSE message received in response to a DISCOVERY_REQUEST message which contained a discovery entry ID parameter

If the DISCOVERY_REQUEST message:

- 1) included a requested timer which is set to 0; or
- 2) included an Announcing PLMN ID;

the UE shall acknowledge the DISCOVERY_RESPONSE message received from the 5G DDNMF but discard its content and then abort the procedure.

6.2.2.6.2 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of DISCOVERY_RESPONSE message

After receiving an indication from lower layer that the DISCOVERY_RESPONSE message has not been successfully acknowledged (e.g., TCP ACK is not received), the 5G DDNMF shall abort the procedure and stop any associated timer(s) T5061, if running.

6.2.3 Announce request procedure for restricted 5G ProSe direct discovery model A

6.2.3.1 General

The purpose of the announce request procedure for restricted 5G ProSe direct discovery model A is for the UE:

- a) to obtain a ProSe restricted code corresponding to the RPAUID to be announced over the PC5 interface, upon a request for announcing from upper layers (e.g., application client) as defined in 3GPP TS 23.304 [2]; or
- b) to inform the 5G DDNMF that the UE wants to stop announcing a ProSe restricted code as defined in 3GPP TS 23.304 [2].

Before initiating the announce request procedure, the UE shall be authorized for restricted 5G ProSe direct discovery model A announcing in the registered PLMN or local PLMN or subscribed SNPN based on the service authorization procedure as specified in clause 5.

The UE includes the ProSe restricted code obtained from a successful announce request procedure in a PROSE PC5 DISCOVERY message and passes the PROSE PC5 DISCOVERY message to the lower layers for transmission over the PC5 interface.

6.2.3.2 Announce request procedure initiation

Before initiating the announce request procedure, the user sets the permissions for the restricted discovery using application layer mechanisms. The application client in the UE retrieves the PDUID provisioned to the UE as part of the service authorization procedure as specified in clause 5 and obtains an RPAUID associated with the UE's PDUID from the ProSe application server. The UE may provide metadata to be associated with the RPAUID and the ProSe application server stores the metadata. This step is performed using mechanisms that are out of scope of the present specification.

If the UE is authorized to perform restricted 5G ProSe direct discovery model A announcing in the PLMN operating the radio resources signalled from the serving PLMN or the subscribed SNPN, it shall initiate an announce request procedure:

- a) when the UE is triggered by an upper layer application to announce an RPAUID and the UE has no valid corresponding ProSe restricted code for that RPAUID of the upper layer application;
- b) when the validity timer T5062 assigned by the 5G DDNMF to a ProSe restricted code has expired and the request from upper layers to announce the RPAUID corresponding to that ProSe restricted code is still in place;
- c) when the UE selects a new PLMN while announcing a ProSe restricted code and intends to announce in the new PLMN and the UE is authorized for restricted 5G ProSe direct discovery model A announcing in the new PLMN;
- d) when, while announcing a RPAUID, the UE intends to switch the announcing PLMN to a different PLMN without performing PLMN selection and the UE does not have a valid allocated ProSe restricted code for this new PLMN yet; or
- e) when the UE needs to update a previously sent restricted 5G ProSe direct discovery model A announcing request.

When the UE selects a new PLMN while announcing a ProSe restricted code and the UE is not yet authorized for restricted 5G ProSe direct discovery model A announcing in the new PLMN, the UE shall initiate an announce request procedure only after the UE is authorized for restricted 5G ProSe direct discovery model A announcing in the new PLMN.

NOTE 1: To ensure service continuity if the UE needs to keep announcing a ProSe restricted code corresponding to the same RPAUID, the UE can initiate the announce request procedure before the validity timer T5062 assigned by the 5G DDNMF for a ProSe restricted code expires.

The UE shall initiate the announce request procedure by sending a DISCOVERY_REQUEST message with:

- a) a new transaction ID not used in any other direct discovery procedures in PC3a interface;
- b) the RPAUID set to the RPAUID received from upper layers;
- c) the command set to "announce";
- d) the application identity set to the ProSe identifier of the upper layer application that requested the announcing as specified in clause 5.2.3;
- e) the discovery type set to "Restricted discovery";
- r) the ACE enabled indicator set to "application-controlled extension enabled" if application-controlled extension is required by the upper layers or "normal" if application-controlled extension is not used;
- g) the announcing type set to "on demand" if on demand announcing is requested by upper layers and "normal" if on demand announcing is not requested by upper layers;
- h) optionally the requested timer set to the length of validity timer associated with the ProSe restricted code that the UE expects to receive from the 5G DDNMF;
- i) the discovery entry ID set to a 0 if the announcing request is a new request and set to the discovery entry ID received from the 5G DDNMF if the announcing request is to update a previously sent announcing request;
- j) optionally the announcing PLMN ID set to the PLMN ID of the local PLMN operating the radio resources that the UE intends to use for announcing the RPAUID; and
- k) the PC5 UE ciphering algorithm capability set to the UE supported ciphering algorithm(s) for ciphering the PROSE PC5 DISCOVERY message.

If restricted 5G ProSe direct discovery model A with application-controlled extension is requested by upper layers, the DISCOVERY_REQUEST message shall also include the application level container, which contains application-level data transparent to the 3GPP network, to be used by the ProSe application server e.g., to assign ProSe restricted code suffix(es).

When the UE initiates the announce request procedure to inform the 5G DDNMF that the UE wants to stop announcing a ProSe restricted code before the associated valid timer expires, the UE shall set the requested timer to 0.

NOTE 2: A UE can include one or multiple transactions in one DISCOVERY_REQUEST message for different RPAUIDs and receive corresponding <restricted-announce-response> element or <response-reject> element in a DISCOVERY_RESPONSE message for each respective transaction. In the following description of the announce request procedure, only one transaction is included.

Figure 6.2.3.2.1 illustrates the interaction of the UE and the 5G DDNMF in the announce request procedure.

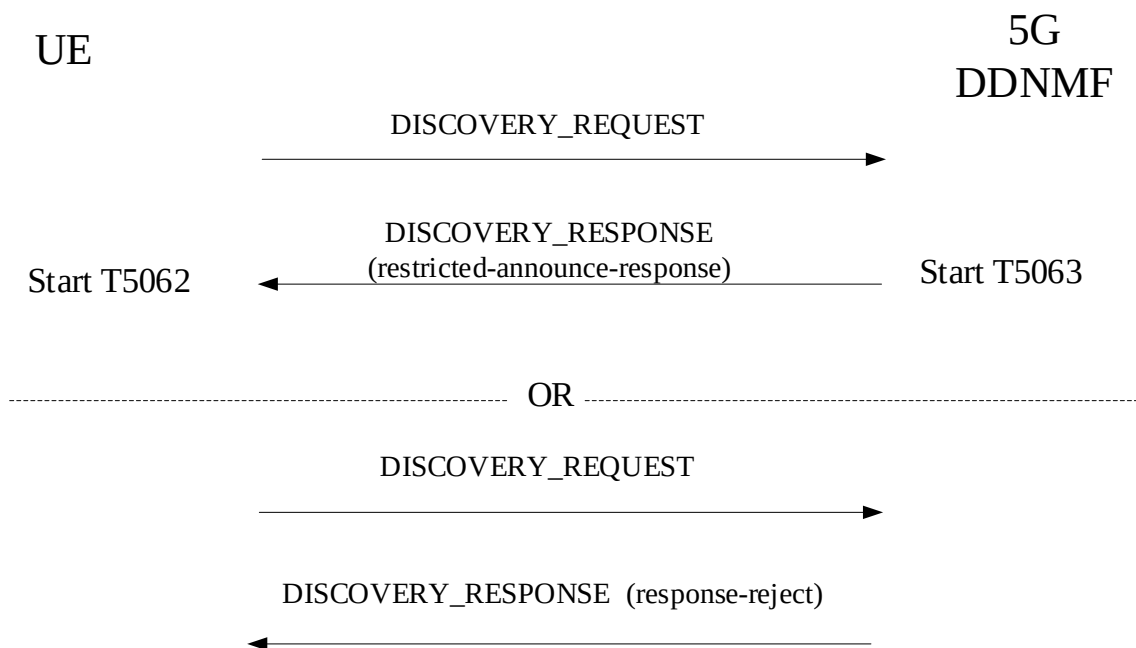


Figure 6.2.3.2.1: Announce request procedure for restricted 5G ProSe direct discovery model A

6.2.3.3 Announce request procedure accepted by the 5G DDNMF

Upon receiving a DISCOVERY_REQUEST message with the command set to "announce" and the discovery type set to "Restricted discovery", if the requested timer is included in the DISCOVERY_REQUEST message and the requested timer is set to 0, the 5G DDNMF shall check whether there is an existing UE context containing the discovery entry identified by the discovery entry ID included in the DISCOVERY_REQUEST message. If the discovery entry exists in the UE context, the 5G DDNMF shall inform the 5G DDNMF in the announcing PLMN to remove the corresponding discovery entry as specified in 3GPP TS 29.555 [9] when the announcing PLMN is not the same as that of the PLMN to which the 5G DDNMF belongs and remove the discovery entry identified by the discovery entry ID from the UE's context.

Upon receiving a DISCOVERY_REQUEST message with the command set to "announce" and the discovery type set to "Restricted discovery", if the requested timer is not included in the DISCOVERY_REQUEST message or the requested timer included in the DISCOVERY_REQUEST message is not set to 0, the 5G DDNMF shall perform the following procedure.

The 5G DDNMF shall check that the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is authorized for restricted 5G ProSe direct discovery model A announcing. If the application is authorized for restricted 5G ProSe direct discovery model A announcing, the 5G DDNMF shall check whether there is an existing context for the UE.

If there is no associated UE context, the 5G DDNMF checks with the UDM whether the UE is authorized for restricted 5G ProSe direct discovery model A announcing as described in 3GPP TS 29.503 [10]. If the check indicates that the UE is authorized, the 5G DDNMF creates a UE context that contains the UE's subscription parameters obtained from the UDM. The UDM also provides to the 5G DDNMF the PLMN ID of the PLMN or the PLMN ID combined with a NID of the SNPN in which the UE is currently registered. If the UE context exists, the 5G DDNMF shall then check whether the UE is authorized for restricted 5G ProSe direct discovery model A announcing in the currently registered PLMN or the subscribed SNPN or in the local PLMN identified by the Announcing PLMN ID included in the DISCOVERY_REQUEST message.

If the UE is authorized and the discovery entry ID included in the DISCOVERY_REQUEST message is set to 0 then:

- a) the 5G DDNMF shall check whether the UE is authorized to announce the RPAUID contained in the DISCOVERY_REQUEST message. Optionally this can include checking with the ProSe application server as described in 3GPP TS 29.557 [19] to obtain the binding between the RPAUID and PDUID and then verifying that the PDUID belongs to the requesting UE;
- b) if the UE is authorized to announce the RPAUID, the ACE enabled indicator is set to "application-controlled extension enabled", the application level container is included in the DISCOVERY_REQUEST message and the requested application uses application-controlled extension, the 5G DDNMF shall check whether the UE is authorized to use ACE. If the UE is authorized for ACE, the 5G DDNMF shall invoke the procedure described in 3GPP TS 29.557 [19] to check whether the UE is authorized to announce the requested RPAUID with application-defined suffix(es) and obtain suffix-related information from the ProSe application server. The 5G DDNMF shall then allocate a ProSe restricted code prefix and a value for validity timer T5062 to be used with the ProSe restricted code suffix(es) obtained from the ProSe application server for the given RPAUID as specified in 3GPP TS 29.557 [19]. The 5G DDNMF may take into account the requested timer if contained in the DISCOVERY_REQUEST message when allocating validity timer T5062;
- c) if the UE is authorized to announce the RPAUID, the ACE enabled indicator is set to "normal" in the DISCOVERY_REQUEST message and the requested application does not use application-controlled extension, the 5G DDNMF shall allocate the corresponding ProSe restricted code and a value for validity timer T5062. The 5G DDNMF may take into account the requested timer if contained in the DISCOVERY_REQUEST message when allocating validity timer T5062;
- d) if the UE is authorized to announce the RPAUID, the ACE enabled indicator is set to "normal" in the DISCOVERY_REQUEST message, the application level container is included in the DISCOVERY_REQUEST and the requested application only uses application-controlled extension, the 5G DDNMF shall check whether the UE is authorized to use ACE. If the UE is authorized for ACE, the 5G DDNMF shall invoke the procedure described in 3GPP TS 29.557 [19] to check whether the UE is authorized to announce the requested RPAUID with application-defined suffix(es) and obtain suffix-related information from the ProSe application server. The 5G DDNMF shall then allocate a ProSe restricted code prefix and a value for validity timer T5062 to be used with the ProSe restricted code suffix(es) obtained from the ProSe application server for the given RPAUID as specified in 3GPP TS 29.557 [19]. The 5G DDNMF may consider the requested timer if contained in the DISCOVERY_REQUEST message when allocating validity timer T5062;
- e) if the UE is authorized to announce the RPAUID, the ACE enabled indicator is set to "application-controlled-extension enabled" and the application level container is included in the DISCOVERY_REQUEST message but the requested application does not use application-controlled extension, the 5G DDNMF shall allocate the corresponding ProSe restricted code and a value for validity timer T5062. The 5G DDNMF may consider the requested timer if contained in the DISCOVERY_REQUEST message when allocating validity timer T5062; and
- f) the 5G DDNMF associates the allocated ProSe restricted code or ProSe restricted code prefix with a new discovery entry in the UE's context and starts timer T5063. The UDM also provides to the 5G DDNMF the PLMN ID of the PLMN or the PLMN ID combined with a NID in which the UE is currently registered. For a given ProSe restricted code, timer T5063 shall be longer than timer T5062. By default, the value of timer T5063 is 4 minutes greater than the value of timer T5062.

If the discovery entry ID included in the DISCOVERY_REQUEST message is not set to 0 and if there is an existing discovery entry for this discovery entry ID value in the UE's context, the 5G DDNMF shall either update the discovery entry with a new validity timer T5062, or allocate a new ProSe restricted code or ProSe restricted code prefix for the requested RPAUID with a new validity timer T5062, restart timer T5063 and clear any existing on demand announcing enabled indicator. The 5G DDNMF may consider the requested timer if contained in the DISCOVERY_REQUEST message when allocating validity timer T5062.

If the discovery entry ID contained in the DISCOVERY_REQUEST message is not found in the UE context or there is no UE context in the 5G DDNMF, the 5G DDNMF shall behave as if the discovery entry ID included in the DISCOVERY_REQUEST message was set to 0 and the 5G DDNMF shall allocate a new non-zero discovery entry ID for this entry.

If the announcing type is set to "on demand" in the DISCOVERY_REQUEST message, the 5G DDNMF shall check if "on demand" announcing is authorized and enabled based on the ProSe identifier and the operator's policy. If "on demand" announcing is authorized and enabled and there is no ongoing monitoring request for this RPAUID, then the 5G DDNMF shall set the on demand announcing enabled indicator to 1 for the corresponding discovery entry in the UE's context.

If a new UE context was created or an existing UE context was updated and the UE is currently roaming or the announcing PLMN ID is included in the DISCOVERY_REQUEST message and the on demand announcing enabled indicator is not set to 1 for this discovery entry in the UE's context, the 5G DDNMF checks with the 5G DDNMF of the VPLMN or the local PLMN represented by the Announcing PLMN ID whether the UE is authorized for restricted 5G ProSe direct discovery model A announcing as described in 3GPP TS 29.555 [9].

The 5G DDNMF shall then send a DISCOVERY_RESPONSE message containing a <restricted-announce-response> element with:

- a) the transaction ID set to the value of the transaction ID received in the DISCOVERY_REQUEST message from the UE;
- b) if the on demand announcing enabled indicator is not set to 1 in the UE's context for this discovery entry, either the ProSe restricted code set to the ProSe restricted code or the ProSe restricted code prefix allocated by the 5G DDNMF. If restricted Direct Discovery with application-controlled extension was requested by the announcing UE, the DISCOVERY_RESPONSE message also contains one or more ProSe restricted code suffix Ranges which contain the suffix(es) for the RPAUID received in the DISCOVERY_REQUEST message;
- c) a validity timer T5062 set to the T5062 timer value assigned by the 5G DDNMF to the ProSe restricted code;
- d) the ACE enabled indicator set to "application-controlled extension enabled" if application-controlled extension is used, or "normal" if application-controlled extension is not used;
- e) the code-sending security parameter containing the security-related information for the UE to protect the transmission of the ProSe restricted code;
- f) the on demand announcing enabled indicator indicating whether the on demand announcing is enabled or not for this discovery entry if the announcing type is set to "on demand" in the DISCOVERY_REQUEST message;
- g) the discovery entry ID set to the ID of the discovery entry associated with this announce request in the UE's context;
- h) the current time set to the current UTC-based time at the 5G DDNMF and the max offset;
- i) optionally, the PC5 security policies that are associated with the ProSe restricted code and used for 5G ProSe direct link establishment procedure instead of any PC5 security policies configured in the UE as specified in clause 5; and
- j) the selected PC5 ciphering algorithm set to the PC5 ciphering algorithm selected by the 5G DDNMF based on the received PC5 UE ciphering algorithm capability and the ProSe restricted code.

If timer T5063 expires, the 5G DDNMF shall remove the discovery entry associated with the corresponding RPAUID from the UE's context.

The 5G DDNMF may associate the ProSe restricted code with the PC5 security policies.

The 5G DDNMF uses the information (e.g. application identity) received from the UE in the DISCOVERY_REQUEST message, UE identity in GBA or AKMA information related to TLS tunnel transporting the DISCOVERY_REQUEST message, and other information for charging purposes as specified in 3GPP TS 32.277 [45].

6.2.3.4 Announce request procedure completion by the UE

Upon receipt of the DISCOVERY_RESPONSE message, if only the transaction ID and the discovery entry ID are contained in the <restricted-announce-response> element and the transaction ID and the discovery entry ID match the corresponding values sent by the UE in a DISCOVERY_REQUEST message, the UE shall:

- a) stop the validity timer T5062 for the discovery entry corresponding to the discovery entry ID received in the DISCOVERY_RESPONSE message;
- b) remove the discovery entry identified by the discovery entry ID included; and
- c) instruct the lower layers to stop announcing.

Upon receipt of the DISCOVERY_RESPONSE message, if the transaction ID contained in the <restricted-announce-response> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to

"announce", the UE shall create a new discovery entry or update an existing discovery entry with the received ProSe restricted code or ProSe restricted code prefix and the PLMN ID of the intended announcing PLMN, or the UE shall create a new discovery entry or update an existing discovery entry with the received ProSe restricted code or ProSe restricted code prefix and the PLMN ID combined with a NID of the subscribed SNPN. For this discovery entry, the UE shall stop the validity timer T5062, if running, for the discovery entry corresponding to the discovery entry ID received in the DISCOVERY_RESPONSE message and start the validity timer T5062 for this discovery entry with the received value in the DISCOVERY_RESPONSE message. Otherwise, the UE shall discard the DISCOVERY_RESPONSE message and shall not perform the procedures below. The UE shall set a ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter and store the received max offset parameter.

If the DISCOVERY_RESPONSE message includes new ProSe restricted code or ProSe restricted code prefix to replace the existing ProSe restricted code being announced, the UE shall notify lower layer to stop announcing the old ProSe restricted code in PC5 interface.

The UE shall store the selected PC5 ciphering algorithm received in the DISCOVERY_RESPONSE message for the received ProSe restricted code and use it for protection of the restricted 5G ProSe direct discovery messages over the PC5 interface as specified in clause 6.1.3.2.3 of 3GPP TS 33.503 [34].

If the DISCOVERY_RESPONSE message contains an on demand announcing enabled indicator set to 1, the UE shall wait for an announcing alert Request message from the 5G DDNMF of the HPLMN before starting to perform restricted 5G ProSe direct discovery model A announcing. Otherwise, the UE may perform restricted 5G ProSe direct discovery model A announcing as described in clause 6.2.14.2.1.

6.2.3.5 Announce request procedure not accepted by the 5G DDNMF

If the DISCOVERY_REQUEST message cannot be accepted by the 5G DDNMF, the 5G DDNMF sends a DISCOVERY_RESPONSE message containing a <response-reject> element to the UE including an appropriate PC3a control protocol cause value.

If the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is not authorized for ProSe direct discovery announcing, the 5G DDNMF shall send the DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #1 "Invalid application".

If the RPAUID contained in the DISCOVERY_REQUEST message is unknown to the 5G DDNMF or ProSe application server, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #9 "Unknown RPAUID".

If the RPAUID contained in the DISCOVERY_REQUEST message does not match the stored RPAUID for the requested discovery entry ID, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #10 "Unknown or invalid discovery entry ID".

If the UE is not authorized for restricted 5G ProSe direct discovery model A announcing, the 5G DDNMF shall send the DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

If the UE is not authorized for restricted "on demand" restricted 5G ProSe direct discovery model A announcing, the 5G DDNMF shall send the DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #13 "UE unauthorized for on-demand announcing".

If the RPAUID contained in the DISCOVERY_REQUEST message is not associated with the PDUID belonging to the requesting UE, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization Failure".

If the UE is not authorized to use ACE, but the DISCOVERY_REQUEST message contains the ACE enabled indicator set to "application-controlled extension enabled", the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #12 "UE unauthorized for discovery with application-controlled extension".

If the DISCOVERY_REQUEST message contains the ACE enabled indicator set to "application-controlled extension enabled", but does not contain the application level container parameter, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #14 "Missing application level container".

If the ProSe application server indicates to the 5G DDNMF that the application level container in the DISCOVERY_REQUEST message contains invalid information, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #15 "Invalid data in application level container".

If the discovery entry ID contained in the DISCOVERY_REQUEST message is unknown to the 5G DDNMF and the requested timer is set to zero, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value # 10 "Unknown or invalid discovery entry ID".

If the PC5 UE ciphering algorithm capability contained in the DISCOVERY_REQUEST message is not compatible with the selected PC5 ciphering algorithm for the target ProSe restricted code, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #19 "Not compatible PC5 UE ciphering algorithm capability".

6.2.3.6 Abnormal cases

6.2.3.6.1 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of DISCOVERY_REQUEST message (e.g., after TCP retransmission timeout)

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the announce request procedure.

NOTE 1: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

- b) No response from the 5G DDNMF after the DISCOVERY_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the DISCOVERY_REQUEST message)

The UE shall retransmit the DISCOVERY_REQUEST message.

NOTE 2: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

NOTE 3: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

- c) Indication from upper layers that the request to announce the RPAUID is no longer in place after sending the DISCOVERY_REQUEST message, but before the announce request procedure is completed

The UE shall acknowledge the DISCOVERY_RESPONSE message received from the 5G DDNMF but discard its contents and then abort the procedure.

- d) Change of PLMN

If a PLMN change occurs before the announce request procedure is completed, the procedure shall be aborted. If the UE is authorized to announce in the new PLMN, the procedure shall be restarted once the UE is registered on the new PLMN.

6.2.3.6.2 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of DISCOVERY_RESPONSE message

After receiving an indication from lower layer that the DISCOVERY_RESPONSE message has not been successfully acknowledged (e.g. TCP ACK is not received), the 5G DDNMF shall abort the procedure and stop any associated timer(s) T5063, if running.

6.2.4 Monitor request procedure for open 5G ProSe direct discovery

6.2.4.1 General

The purpose of the monitor request procedure for open 5G ProSe direct discovery is to allow a UE:

- a) to receive and process PROSE PC5 DISCOVERY messages upon a request for monitoring from upper layers as defined in 3GPP TS 23.304 [2]; or
- b) to inform the 5G DDNMF that the UE wants to stop using discovery filters for direct discovery monitoring as defined in 3GPP TS 23.304 [2].

The UE shall only initiate the monitor request procedure if it has been authorized for open 5G ProSe direct discovery monitoring at least in one PLMN or the subscribed SNPN based on the service authorization procedure.

As a result of the monitor request procedure completing successfully, the UE obtains one or more discovery filters, along with a TTL (Time-To-Live) timer T5064 for each discovery filter indicating the time during which the filter is valid.

6.2.4.2 Monitor request procedure Initiation

Before initiating the monitor request procedure, the UE is configured with the data structure of the ProSe application IDs it wants to monitor. This step is performed using mechanisms that are out of scope of 3GPP.

If the UE is authorized to perform open 5G ProSe direct discovery monitoring in at least one PLMN or the subscribed SNPN, it shall initiate a monitor request procedure:

- a) when the UE is triggered by an upper layer application to perform open 5G ProSe direct discovery monitoring corresponding to a ProSe application ID and the UE has no valid discovery filters corresponding to the requested ProSe application ID for that upper layer application;
- b) when the TTL timer T5064 assigned by the 5G DDNMF to a discovery filter has expired and the request from upper layers to monitor that ProSe application ID is still in place; or
- c) when the UE needs to inform the 5G DDNMF that the UE wants to stop using discovery filters for direct discovery monitoring.

NOTE 1: To ensure service continuity if the UE needs to keep monitoring the same discovery filter, the UE can initiate the monitor request procedure before the TTL timer T5064 assigned by the 5G DDNMF for a discovery filter expires.

The UE shall initiate the monitor request procedure for open 5G ProSe direct discovery by sending a DISCOVERY_REQUEST message with:

- a) a new transaction ID;
- b) the ProSe application ID set to the ProSe application ID received from upper layers;
- c) the command set to "monitor";
- d) the application identity set to the ProSe identifier of the upper layer application that requested the monitoring as specified in clause 5.2.3;
- e) the ACE enabled indicator set to "application-controlled extension enabled" if application-controlled extension is required by the upper layers, or "normal" if application-controlled extension is not used;
- f) the discovery entry ID set to 0 if this is a new request or set to the discovery entry ID received from the 5G DDNMF if the monitor request is to update a previously sent monitor request; and
- g) optionally, the requested timer set to 0 only when the UE wants to stop using discovery filters for direct discovery monitoring.

If open 5G ProSe direct discovery with application-controlled extension is requested by upper layers, the DISCOVERY_REQUEST message shall also include the application level container, which contains information corresponding to the ProSe application code suffix, e.g., group or user-specific information.

NOTE 2: A UE can include one or multiple transactions in one DISCOVERY_REQUEST message for one or more ProSe application IDs and receive corresponding <response-monitor> element or <response-reject> element in the DISCOVERY_RESPONSE message for each respective transaction. In the following description of the monitor request procedure, only one transaction is included.

Figure 6.2.4.2.1 illustrates the interaction between the UE and the 5G DDNMF in the monitor request procedure.

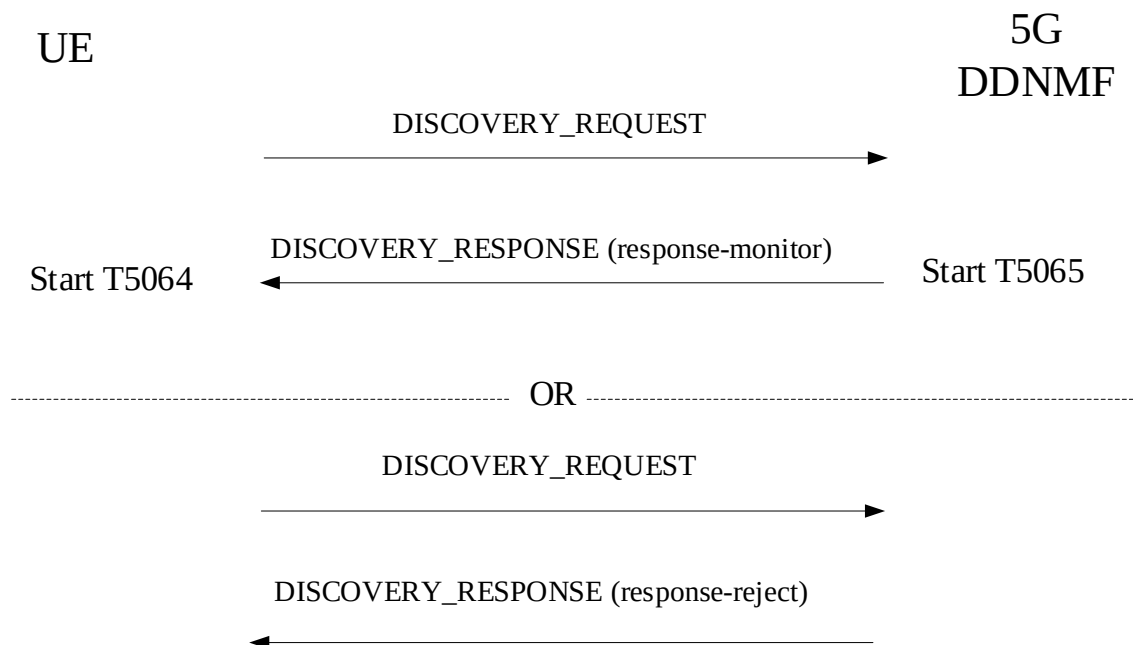


Figure 6.2.4.2.1: Monitor request procedure

6.2.4.3 Monitor request procedure accepted by the 5G DDNMF

Upon receiving a DISCOVERY_REQUEST message with the command set to "monitor", if the requested timer is included in the DISCOVERY_REQUEST message and the requested timer is set to 0, the 5G DDNMF shall check whether there is an existing UE context containing the discovery entry identified by the discovery entry ID included in the DISCOVERY_REQUEST message. If the discovery entry exists in the UE context, the 5G DDNMF shall remove the discovery entry identified by the discovery entry ID from the UE's context. When the associated ProSe application ID is PLMN-specific and that PLMN ID indicated by the ProSe application ID is not the same as that of the PLMN to which the 5G DDNMF belongs, the 5G DDNMF shall inform the 5G DDNMF in the PLMN indicated by the ProSe application ID to remove the corresponding discovery entry as specified in 3GPP TS 29.555 [9]. Then the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-monitor> element with:

- the transaction ID set to the value of the transaction ID received in the DISCOVERY_REQUEST message; and
- the discovery entry ID set to the value of the discovery entry ID received in the DISCOVERY_REQUEST message.

Upon receiving a DISCOVERY_REQUEST message with the command set to "monitor", if the requested timer is not included in the DISCOVERY_REQUEST message, the 5G DDNMF shall perform the following procedure.

The 5G DDNMF shall check that the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is authorized for open 5G ProSe direct discovery monitoring. If the application is authorized for open 5G ProSe direct discovery monitoring, the 5G DDNMF checks whether there is an existing context for the UE associated with the requested ProSe application ID.

If there is no associated UE context, the 5G DDNMF checks with the UDM whether the UE is authorized for open 5G ProSe direct discovery monitoring as described in 3GPP TS 29.503 [10]. The UDM provides to the 5G DDNMF the PLMN ID of the PLMN or PLMN ID combined with a NID of the SNPN in which the UE is currently registered. If the subscription check indicates that the UE is authorized, the 5G DDNMF creates a new context for the UE and a new discovery entry identified by a non-zero value discovery entry ID which is associated with the requested ProSe application ID.

If the ACE enabled indicator in the DISCOVERY_REQUEST message is included and set to "application-controlled extension enabled" and the requested application uses application-controlled extension, the 5G DDNMF shall check whether the UE is authorized to use ACE. If the UE is authorized for ACE, the 5G DDNMF shall also use the procedure described in 3GPP TS 29.557 [19] to obtain the mask(s) for monitoring the ProSe application code suffix (es) corresponding to the requested ProSe application ID.

If the PLMN ID indicated in the ProSe application ID is PLMN-Specific and that PLMN ID is not the same as that of the PLMN to which the 5G DDNMF belongs, then the 5G DDNMF executes the procedures defined in 3GPP TS 29.555 [9] to obtain the discovery filter(s) for the ProSe application ID. Otherwise, the 5G DDNMF shall allocate one or more discovery filters for the requested ProSe application ID if it is known to the 5G DDNMF and at least one corresponding valid ProSe application code or ProSe application code prefix is available in the 5G DDNMF. Each discovery filter consists of a ProSe application code, one or more ProSe application masks and a TTL timer T5064. If application-controlled extension is used, the allocated Discovery Filter shall be applicable to match both prefix and suffix portions of the ProSe application code.

If the requested ProSe application ID is country-specific or global or PLMN-specific as defined respectively in clause 24.2 of 3GPP TS 23.003 [12], the 5G DDNMF shall allocate the discovery filter which contains ProSe application code and ProSe application mask(s) in the corresponding scope. If the ProSe application ID is country-specific or global, the ProSe application mask(s) enclosed in the discovery filter hides the PLMN ID part or the PLMN ID combined with a NID part correspondingly and the temporary identity part is taken from the data structure corresponding to the global or country-wide ProSe application ID namespace, as specified in clause 24.3 of 3GPP TS 23.003 [12]. If the requested ProSe application ID is PLMN-specific, the 5G DDNMF shall allocate one or more PLMN-specific discovery filters. Each of these discovery filters shall contain a PLMN-specific ProSe application code and the ProSe application mask(s) whose PLMN ID portion shall be set such that when the mask is applied to the ProSe application code, the outcome matches the full PLMN ID of that specific PLMN.

After the discovery filter(s) are allocated, the 5G DDNMF then associates the discovery filters with the new discovery entry in the UE context and starts timer T5065 assigned for each discovery filter. For a given discovery filter timer T5065 shall be longer than timer T5064. By default, the value of timer T5065 is 4 minutes greater than the value of timer T5064.

If there is an existing context for the UE that contains the UE's subscription parameters obtained from the UDM, but no discovery entry identified by the discovery entry ID contained in the DISCOVERY_REQUEST message, the 5G DDNMF shall check whether the UE is authorized for ProSe direct discovery monitoring. If the UE is authorized, the 5G DDNMF shall allocate the discovery filter as specified above.

After the discovery filter is allocated, the 5G DDNMF then associates the discovery filter with a new discovery entry identified by a non-zero value discovery entry ID in the UE context and starts timer T5065 assigned for each discovery filter.

Similarly, if there is an existing context and a discovery entry identified by the discovery entry ID contained in the DISCOVERY_REQUEST message for the UE associated with the requested ProSe application ID, the 5G DDNMF updates the content of discovery filter(s), associate the discovery entry with the updated discovery filter(s) and restart timer T5065 for each filter. The update of a discovery filter content includes setting new TTL timer(s) and if necessary, assigning new ProSe application code or ProSe application code prefix and ProSe application mask(s).

Then the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-monitor> element with:

- a) the transaction ID set to the value of the transaction ID received in the DISCOVERY_REQUEST message from the UE;
- b) the discovery entry ID set to the identifier associated with the discovery entry;
- c) if the ACE enabled indicator was included by the UE in the DISCOVERY_REQUEST message, the ACE enabled indicator set to:
 - 1) "application-controlled extension enabled" if application-controlled extension is used; or

- 2) "normal" if application-controlled extension is not used;
- d) one or more discovery filters allocated by the 5G DDNMF(s) for the ProSe application ID received in the DISCOVERY_REQUEST message from the UE; and
- e) the current time set to the current UTC-based time at the 5G DDNMF and the max offset.

If timer T5065 expires, the 5G DDNMF shall remove the UE's association with the corresponding discovery filter. Furthermore, the 5G DDNMF shall remove the discovery entry from the UE's context if there is no discovery filter corresponding to the ProSe application ID.

The 5G DDNMF uses the information (e.g. application identity) received from the UE in the DISCOVERY_REQUEST message, UE identity in GBA or AKMA information related to TLS tunnel transporting the DISCOVERY_REQUEST message, and other information for charging purposes as specified in 3GPP TS 32.277 [45].

6.2.4.4 Monitor request procedure completion by the UE

Upon receipt of the DISCOVERY_RESPONSE message, if only the transaction ID and the discovery entry ID are contained in the <response-monitor> element and the transaction ID and the discovery entry ID match the corresponding values sent by the UE in a DISCOVERY_REQUEST message, the UE shall:

- a) stop TTL timer T5064 for each discovery filter in the discovery entry identified by the discovery entry ID;
- b) remove the discovery entry identified by the discovery entry ID; and
- c) instruct the lower layers to stop monitoring.

Upon receipt of the DISCOVERY_RESPONSE message, if the transaction ID contained in the <response-monitor> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "monitor", the UE shall, for each discovery filter assigned by the 5G DDNMF, stop TTL timer T5064 if running and start TTL timer T5064 with the received value. Otherwise, the UE shall discard the DISCOVERY_RESPONSE message and shall not perform the procedures below. The UE shall set a ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter and store the received max offset parameter.

The UE may perform open 5G ProSe direct discovery monitoring for discovery messages received over the PC5 interface as described in clause 6.2.14.2.1.4.

6.2.4.5 Monitor request procedure not accepted by the 5G DDNMF

If the DISCOVERY_REQUEST message is not accepted by the 5G DDNMF, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element to the UE including an appropriate PC3a control protocol cause value.

If the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is not authorized for open 5G ProSe direct discovery monitoring, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #1 "Invalid application".

If the ProSe application ID contained in the DISCOVERY_REQUEST message is unknown to the 5G DDNMF, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #2 "Unknown ProSe application ID".

If the UE is not authorized for open 5G ProSe direct discovery monitoring, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

If the UE requests a country-specific ProSe application ID for a country that does not correspond to the country of its HPLMN or its subscribed SNPN and the 5G DDNMF has not authorized the UE to monitor in that country, it shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #8 "Scope violation in Prose application ID".

If the UE requests a country-specific ProSe application ID for a country that does not correspond to the country of its HPLMN or its subscribed SNPN and the 5G DDNMF has no agreement to access the country-specific ProSe application ID database of that country, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #8 "Scope violation in Prose application ID".

If the discovery entry ID contained in the DISCOVERY_REQUEST message is unknown to the 5G DDNMF and the requested timer is set to 0, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #10 "Unknown or invalid discovery entry ID".

If the 5G DDNMF cannot retrieve a valid ProSe application code corresponding to the ProSe application ID contained in the DISCOVERY_REQUEST message, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #17 "No valid ProSe application code".

If the UE is not authorized to use ACE, but the DISCOVERY_REQUEST message contains the ACE enabled indicator set to "application-controlled extension enabled", the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #12 "UE unauthorized for discovery with application-controlled extension".

If the DISCOVERY_REQUEST message does not contain the ACE enabled indicator and the requested application only uses application-controlled extension, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #1 "Invalid application".

6.2.4.6 Abnormal cases

6.2.4.6.1 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of DISCOVERY_REQUEST message (e.g., after TCP retransmission timeout)

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the monitor request procedure.

NOTE 1: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

- b) No response from the 5G DDNMF after the DISCOVERY_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the DISCOVERY_REQUEST message)

The UE shall retransmit the DISCOVERY_REQUEST message.

NOTE 2: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

NOTE 3: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

- c) Indication from upper layers that the request to monitor the ProSe application ID is no longer in place after sending the DISCOVERY_REQUEST message, but before the monitor request procedure is completed

The UE shall acknowledge the DISCOVERY_RESPONSE message received from the 5G DDNMF but discard its contents and then abort the procedure.

- d) Change of PLMN

If a PLMN change occurs before the monitor request procedure is completed, the procedure shall be aborted. If the UE is authorized to monitor in the new PLMN, the procedures shall be restarted once the UE is registered on the new PLMN.

6.2.4.6.2 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of DISCOVERY_RESPONSE message

After receiving an indication from lower layer that the DISCOVERY_RESPONSE message has not been successfully acknowledged, the 5G DDNMF shall abort the procedure and stop any associated timer(s) T5065, if running.

6.2.5 Monitor request procedure for restricted 5G ProSe direct discovery model A

6.2.5.1 General

The purpose of the monitor request procedure for restricted 5G ProSe direct discovery model A is:

- a) to allow a UE participating in restricted 5G ProSe direct discovery model A to receive and process PROSE PC5 DISCOVERY messages upon a request for monitoring from upper layers as defined in 3GPP TS 23.304 [2]; or
- b) to inform the 5G DDNMF that the UE wants to stop using restricted discovery filter(s) for direct discovery monitoring as defined in 3GPP TS 23.304 [2].

The UE shall only initiate the restricted 5G ProSe direct discovery model A monitor request procedure if it has been authorized for restricted 5G ProSe direct discovery model A monitoring in at least in one PLMN or the subscribed SNPN based on the service authorization procedure.

As a result of the monitor request procedure completing successfully, the UE obtains one or more restricted discovery filters, along with a TTL (Time-To-Live) timer T5066 for each restricted discovery filter indicating the time during which the filter is valid.

6.2.5.2 Monitor request procedure Initiation

Before initiating the monitor request procedure, the user sets the permissions for the restricted discovery using application layer mechanisms. The application client in the UE retrieves the PDUID provisioned to the UE as part of the service authorization procedure as specified in clause 5 and obtains an RPAUID associated with the UE's PDUID and the target RPAUID(s) to be monitored from the ProSe application server. This step is performed using mechanisms that are out of scope of the present specification.

If the UE is authorized to perform ProSe direct discovery model A monitoring in at least one PLMN or the subscribed SNPN, it shall initiate a monitor request procedure:

- a) when the UE is triggered by an upper layer application to perform restricted 5G ProSe direct discovery model A monitoring corresponding to at least one RPAUID and the UE has no valid restricted discovery filters corresponding to the requested RPAUID for that upper layer application;
- b) when the TTL timer T5066 assigned by the 5G DDNMF to a Restricted discovery filter has expired and the request from upper layers to monitor that RPAUID is still in place; or

NOTE 1: To ensure service continuity if the UE needs to keep monitoring the same restricted discovery filter, the UE can initiate the monitor request procedure before the TTL timer T5066 assigned by the 5G DDNMF for a Restricted discovery filter expires.

- c) when the UE needs to update a previously sent restricted 5G ProSe direct discovery model A monitoring request.

The UE shall initiate the monitor request procedure by sending a DISCOVERY_REQUEST message with:

- a) a new transaction ID;
- b) the RPAUID set to the RPAUID received from upper layers;
- c) the command set to "monitor";
- d) the discovery type set to "Restricted discovery";
- e) the application identity set to the ProSe identifier of the upper layer application that requested the monitoring as specified in clause 5.2.3;
- f) the ACE enabled indicator set to "application-controlled extension enabled" if application-controlled extension is required by the upper layers, or "normal" if application-controlled extension is not used;
- g) the application level container set to the target RPAUIDs to monitor;

- h) the discovery entry ID set to 0 if the monitoring request is a new request and set to the discovery entry ID received from the 5G DDNMF if the monitoring request is to update a previously sent monitoring request;
- i) optionally, the requested timer set to 0 only when the UE wants to stop using restricted discovery filter(s) for direct discovery monitoring; and
- j) the PC5 UE ciphering algorithm capability set to the UE supported ciphering algorithm(s) for ciphering the PROSE PC5 DISCOVERY message.

If restricted direct discovery model A with application-controlled extension is requested by upper layers, the application level container included in the DISCOVERY_REQUEST also contains information corresponding to the ProSe restricted code suffix, e.g., group or user-specific information.

NOTE 2: A UE can include one or multiple transactions in one DISCOVERY_REQUEST message for one or more different monitoring targets and receive corresponding <response-monitor> element or <response-reject> element in the DISCOVERY_RESPONSE message for each respective transaction. In the following description of the monitor request procedure, only one transaction is included.

Figure 6.2.5.2.1 illustrates the interaction between the UE and the 5G DDNMF in the monitor request procedure.

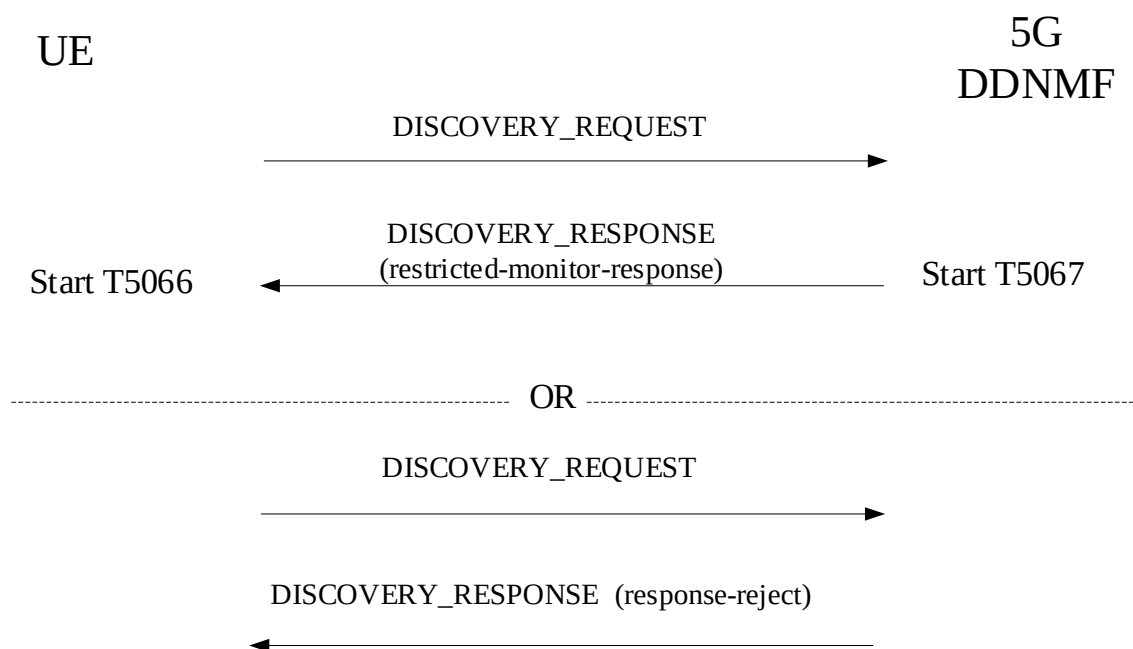


Figure 6.2.5.2.1: Monitor request procedure for restricted 5G ProSe direct discovery model A

6.2.5.3 Monitor request procedure accepted by the 5G DDNMF

Upon receiving a DISCOVERY_REQUEST message with the command set to "monitor" and the discovery type set to "Restricted discovery", if the requested timer is included in the DISCOVERY_REQUEST message and the requested timer is set to 0, the 5G DDNMF shall check whether there is an existing UE context containing the discovery entry identified by the discovery entry ID included in the DISCOVERY_REQUEST message. If the discovery entry exists in the UE context, the 5G DDNMF shall remove the discovery entry identified by the discovery entry ID from the UE's context. For each of the PDUIDs corresponding to the target RPAUIDs contained the restricted discovery filters in the discovery entry, if the PDUID is PLMN-specific and that PLMN ID indicated by the PDUID is not the same as that of the PLMN to which the 5G DDNMF belongs, the 5G DDNMF shall inform the 5G DDNMF in the PLMN indicated by the PDUID to remove the corresponding discovery entry as specified in 3GPP TS 29.555 [9].

Upon receiving a DISCOVERY_REQUEST message with the command set to "monitor" and the discovery type set to "Restricted discovery", if the requested timer is not included in the DISCOVERY_REQUEST message, the 5G DDNMF shall perform the following procedure.

The 5G DDNMF shall check that the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is authorized for ProSe direct discovery model A monitoring. If the application is authorized for restricted 5G ProSe direct discovery model A monitoring, the 5G DDNMF shall check whether there is an existing UE context.

If there is no associated UE context, the 5G DDNMF checks with the UDM whether the UE is authorized for restricted 5G ProSe direct discovery model A monitoring as described in 3GPP TS 29.503 [10]. The UDM provides to the 5G DDNMF the PLMN ID of the PLMN or PLMN ID combined with a NID of the SNPN in which the UE is currently registered. If the subscription check indicates that the UE is authorized, the 5G DDNMF creates a new UE context containing the UE's subscription parameters obtained from the UDM.

If the discovery entry ID included in the DISCOVERY_REQUEST is set to 0 then:

- a) the 5G DDNMF shall use the procedure described in 3GPP TS 29.557 [19] to pass the application level container included in the DISCOVERY_REQUEST message to the ProSe application server and obtain a list of PDUID(s), an application level container and optionally Metadata Indicator(s) corresponding to the authorized target RPAUID(s) from the ProSe application server;
- b) if the ACE enabled indicator in the DISCOVERY_REQUEST message is set to "application-controlled extension enabled" and the requested application uses application-controlled extension, the 5G DDNMF shall check whether the UE is authorized to use ACE. If the UE is authorized for ACE, the 5G DDNMF shall also use the procedure described in 3GPP TS 29.557 [19] to obtain the mask(s) for monitoring a ProSe restricted suffix pool corresponding to each of the Target RPAUIDs.

NOTE 1: The ProSe application server can reject the request for some of the target RPAUIDs included in the application level container in the DISCOVERY_REQUEST message because they are ineligible to be monitored by the requesting UE. Depending on the operator policy and application layer permissions, it is possible that only a subset of valid RPAUIDs is authorized by the ProSe application server.

- c) for each of the PDUIDs corresponding to an authorized target RPAUID, if the PLMN ID of the PDUID is not the same as that of the PLMN to which the 5G DDNMF belongs, then the 5G DDNMF executes the procedures defined in 3GPP TS 29.555 [9] to obtain the ProSe restricted code or ProSe restricted code prefix for the target RPAUID and creates restricted discovery filter(s). Otherwise, for each target RPAUID, the 5G DDNMF shall allocate one or more restricted discovery filter(s). If the ACE enabled indicator in the DISCOVERY_REQUEST message does not match the ACE configuration in the 5G DDNMF or ProSe application server for this application, the ACE configuration in the 5G DDNMF or ProSe application server shall be used to create Restricted discovery filter(s). Each Restricted discovery filter consists of a ProSe restricted code, one or more masks, a TTL timer T5066, optionally the target RPAUID, optionally a metadata indicator and optionally metadata associated with this RPAUID;
- d) the 5G DDNMF associates the restricted discovery filters with a new discovery entry in the UE's context; and
- e) the 5G DDNMF starts timer T5067 assigned for each Restricted discovery filter. For a given restricted discovery filter, timer T5067 shall be longer than timer T5066. By default, the value of timer T5067 is 4 minutes greater than the value of timer T5066.

NOTE 2: For each target RPAUID, the 5G DDNMF either allocates one restricted discovery filter for full-matching the ProSe restricted code assigned to this RPAUID, or allocates one or more restricted discovery filter(s) for matching the ProSe restricted code prefix and suffix pool assigned to this RPAUID.

If the discovery entry ID included in the DISCOVERY_REQUEST message is not set to 0 and if there is an existing discovery entry for this discovery entry ID in the UE's context, the 5G DDNMF shall check whether the UE is authorized for restricted 5G ProSe direct discovery model A monitoring. If the UE is authorized, the 5G DDNMF shall process the request as above-mentioned and update this discovery entry with the contents of the restricted discovery filter(s) associated with this discovery entry and restart timer T5067(s) for each filter. The update of a restricted discovery filter content includes setting new TTL timer(s) and if necessary, obtaining new ProSe restricted code and ProSe restricted mask(s) via the procedure defined in 3GPP TS 29.555 [9].

If the discovery entry ID contained in the DISCOVERY_REQUEST message is not found in the UE context or there is no UE context in the 5G DDNMF, the 5G DDNMF shall behave as if the discovery entry ID included in the

DISCOVERY_REQUEST message was set to 0 and the 5G DDNMF shall allocate a new non-zero discovery entry ID for this entry.

Then the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <restricted-monitor-response> element with:

- a) the transaction ID set to the value of the transaction ID received in the DISCOVERY_REQUEST message from the UE;
- b) one or more restricted discovery filter(s) allocated by the 5G DDNMF(s) for the authorized target RPAUID(s);
- c) the ACE enabled indicator set to "application-controlled extension enabled" if application-controlled extension is used, or "normal" if application-controlled extension is not used;
- d) the discovery entry ID set to the ID of the discovery entry associated with this monitor request;
- e) the application level container set to the application-level data received from the ProSe application server;
- f) the coding-receiving security parameter containing the security-related information needed by the UE to undo the protection applied by the announcing UE;
- g) the current time set to the current UTC-based time at the 5G DDNMF and the max offset;
- h) optionally, the PC5 security policies that are associated with the ProSe restricted code and used for 5G ProSe direct link establishment procedure instead of any PC5 security policies configured in the UE as specified in clause 5; and
- i) the selected PC5 ciphering algorithm set to the PC5 ciphering algorithm selected by the 5G DDNMF if the received PC5 UE ciphering algorithm capability includes the selected PC5 ciphering algorithm associated with the ProSe restricted code corresponding to the restricted discovery filter(s).

If T5067 expires, the 5G DDNMF shall remove the corresponding restricted discovery filter from the discovery entry in the UE's context. Furthermore, if there are no valid restricted discovery filters associated with the discovery entry (e.g., all restricted discovery filters have expired), the 5G DDNMF shall delete the discovery entry from the UE's context.

The 5G DDNMF uses the information (e.g. application identity) received from the UE in the DISCOVERY_REQUEST message, UE identity in GBA or AKMA information related to TLS tunnel transporting the DISCOVERY_REQUEST message, and other information for charging purposes as specified in 3GPP TS 32.277 [45].

6.2.5.4 Monitor request procedure completion by the UE

Upon receipt of the DISCOVERY_RESPONSE message, if only the transaction ID and the discovery entry ID are contained in <restricted-monitor-response> element and the transaction ID and the discovery entry ID match the corresponding values sent by the UE in a DISCOVERY_REQUEST message with the command set to "monitor", the UE shall:

- a) stop TTL timer T5066 for each Restricted discovery filter in the discovery entry identified by the discovery entry ID;
- b) remove the discovery entry identified by the discovery entry ID; and
- c) instruct the lower layers to stop monitoring.

Upon receipt of the DISCOVERY_RESPONSE message, if the transaction ID contained in the <restricted-monitor-response> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "monitor" and, the UE shall process as follow:

- a) if the DISCOVERY_RESPONSE creates a new discovery entry, start the TTL timer T5066 with the received value for each restricted discovery filter information element received in the DISCOVERY_RESPONSE message; or
- b) if the DISCOVERY_RESPONSE updates an existing discovery entry, the UE shall

- 1) stop the T5066 timer(s) of any restricted discovery filter in this discovery entry which are no longer authorized by the 5G DDNMF, ask lower layers to stop using those filters in monitoring operation and remove the corresponding restricted discovery filter from the discovery entry;
- 2) restart the T5066 timer(s) for those remain eligible; and
- 3) start the T5066 timer(s) for any new restricted discovery filter(s) included in the DISCOVERY_RESPONSE message.

Otherwise, the UE shall discard the DISCOVERY_RESPONSE message and shall not perform the procedures below. The UE shall set a ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter and store the received max offset parameter.

The UE shall store the selected PC5 ciphering algorithm received in the DISCOVERY_RESPONSE message for the received ProSe restricted code and use it for decryption of the restricted 5G ProSe direct discovery messages over the PC5 interface as specified in clause 6.1.3.2.3 of 3GPP TS 33.503 [34].

The UE may perform monitoring for discovery messages received over the PC5 interface as described in clause 6.2.14.2.1.4.

6.2.5.5 Monitor request procedure not accepted by the 5G DDNMF

If the DISCOVERY_REQUEST message is not accepted by the 5G DDNMF, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element to the UE including an appropriate PC3a control protocol cause value.

If the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is not authorized for ProSe direct discovery monitoring, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #1 "Invalid application".

If the RPAUID contained in the DISCOVERY_REQUEST message is unknown to the ProSe application server, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #9 "Unknown RPAUID".

If none of the RPAUID(s) contained in the application level container in the DISCOVERY_REQUEST message is eligible to be discovered by the requesting RPAUID, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #11 "Invalid discovery target".

If the RPAUID contained in the DISCOVERY_REQUEST message does not match the stored RPAUID for the requested discovery entry ID, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #10 "Unknown or invalid discovery entry ID".

If the UE is not authorized for restricted 5G ProSe direct discovery monitoring, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

If the RPAUID contained in the DISCOVERY_REQUEST message is not associated with a PDUID belonging to the requesting UE, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

If the UE is not authorized to use ACE, but the DISCOVERY_REQUEST message contains the ACE enabled indicator set to "application-controlled extension enabled", the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #12 "UE unauthorized for discovery with application-controlled extension".

If the discovery entry ID contained in the DISCOVERY_REQUEST message is unknown to the 5G DDNMF and the requested timer is set to 0, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #10 "Unknown or invalid discovery entry ID".

If the PC5 UE ciphering algorithm capability contained in the DISCOVERY_REQUEST message is not compatible with the selected PC5 ciphering algorithm for the target ProSe restricted code, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #19 "Not compatible PC5 UE ciphering algorithm capability".

6.2.5.6 Abnormal cases

6.2.5.6.1 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of DISCOVERY_REQUEST message (e.g., after TCP retransmission timeout)

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the monitor request procedure.

NOTE 1: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

- b) No response from the 5G DDNMF after the DISCOVERY_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the DISCOVERY_REQUEST message)

The UE shall retransmit the DISCOVERY_REQUEST message.

NOTE 2: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

NOTE 3: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

- c) Indication from upper layers that the request to monitor the targets contained in application level container is no longer in place after sending the DISCOVERY_REQUEST message, but before the monitor request procedure is completed

The UE shall acknowledge the DISCOVERY_RESPONSE message received from the 5G DDNMF but discard its contents and then abort the procedure.

- d) Change of PLMN

If a PLMN change occurs before the monitor request procedure is completed, the procedure shall be aborted. If the UE is authorized to monitor in the new PLMN, the procedures shall be restarted once the UE is registered on the new PLMN.

6.2.5.6.2 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of DISCOVERY_RESPONSE message

After receiving an indication from lower layer that the DISCOVERY_RESPONSE message has not been successfully acknowledged, the 5G DDNMF shall abort the procedure and stop any associated timer(s) T5067, if running.

6.2.6 Discoveree request procedure for restricted 5G ProSe direct discovery model B

6.2.6.1 General

The purpose of the discoveree request procedure for restricted 5G ProSe direct discovery model B is for the UE to obtain discovery query filter(s) to be used for monitoring a model B query for a RPAUID over the PC5 interface and a ProSe response code to be announced over the PC5 interface as a response to a model B query, as defined in 3GPP TS 23.304 [2].

Before initiating the discoveree request procedure, the UE shall be authorised for restricted 5G ProSe direct discovery model B discoveree operation in the registered PLMN, the registered SNPN or the local PLMN based on the service authorization procedure as specified in clause 5.

As the result of successful completion of this procedure, the UE obtains one or more discovery query filters and applies them to the monitoring operation in PC5 interface. The UE shall also include the ProSe response code in a PROSE PC5 DISCOVERY message and passes the message to the lower layers for transmission over the PC5 interface when there is a match of the discovery query filter(s).

6.2.6.2 Discoveree request procedure initiation

Before initiating the discoveree request procedure, the user sets the permissions for the restricted discovery using application layer mechanisms. The application client in the UE retrieves the PDUID provisioned to the UE as part of the service authorization procedure as specified in clause 5 and obtains a RPAUID associated with the UE's PDUID from the ProSe application server. The UE can provide metadata to be associated with the RPAUID and the ProSe application server stores the metadata. This step is performed using mechanisms that are out of scope of the present specification.

If the UE is authorised to perform restricted 5G ProSe direct discovery model B discoveree operation in the PLMN or the SNPN operating the radio resources signalled from the serving PLMN or the subscribed SNPN, it shall initiate a discoveree request procedure:

- a) when the UE is triggered by an upper layer application to announce a RPAUID in Model B and the UE has no valid corresponding ProSe response code and discovery query filter(s) for that RPAUID of the upper layer application;
- b) when the validity timer T5068 assigned by the 5G DDNMF to a ProSe response code and the corresponding discovery query filter(s) has expired and the request from upper layers to announce the RPAUID corresponding to that ProSe response code is still in place;
- c) when the UE selects a new PLMN while announcing or waiting for announcing a ProSe response code and intends to announce in the new PLMN and the UE is authorised for restricted 5G ProSe direct discovery model B discoveree operation in the new PLMN, and the UE does not have a valid allocated ProSe response code for this new PLMN yet; or
- d) when the UE needs to update a previously sent restricted 5G ProSe direct discovery model B discoveree request.

When the UE selects a new PLMN while announcing or waiting for announcing a ProSe response code and the UE is not yet authorised for restricted 5G ProSe direct discovery model B discoveree operation in the new PLMN, the UE shall initiate a discoveree request procedure only after the UE is authorised for restricted 5G ProSe direct discovery model B discoveree operation in the new PLMN.

NOTE 1: To ensure service continuity if the UE needs to keep announcing in Model B a ProSe response code corresponding to the same RPAUID, the UE can initiate the discoveree request procedure before the validity timer T5068 assigned by the 5G DDNMF for a ProSe response code expires.

The UE shall initiate the discoveree request procedure by sending a DISCOVERY_REQUEST message with:

- a) a new transaction ID not used in any other direct discovery procedures in PC3a interface;
- b) the RPAUID set to the RPAUID received from upper layers;
- c) the command set to "response";
- d) the application identity set to the ProSe identifier of the upper layer application that requested the announcing as specified in clause 5.2.3;
- e) the discovery type set to "Restricted discovery";
- f) the discovery model set to "Model B";
- g) the discovery entry ID set to a 0 if the discoveree request is a new request and set to the discovery entry ID received from the 5G DDNMF if the discoveree request is to update a previously sent discoveree request;
- h) optionally the announcing PLMN ID set to the PLMN ID of the local PLMN operating the radio resources that the UE intends to use for announcing the RPAUID; and
- i) the PC5 UE ciphering algorithm capability set to the UE supported ciphering algorithm(s) for ciphering the PROSE PC5 DISCOVERY message.

NOTE 2: A UE can include one or multiple transactions in one DISCOVERY_REQUEST message for different RPAUIDs (e.g., for different applications) and receive corresponding <restricted-discoveree-response> element or <response-reject> element in a DISCOVERY_RESPONSE message for each respective transaction. In the following description of the discoveree request procedure, only one transaction is included.

Figure 6.2.6.2.1 illustrates the interaction of the UE and the 5G DDNMF in the discoveree request procedure.

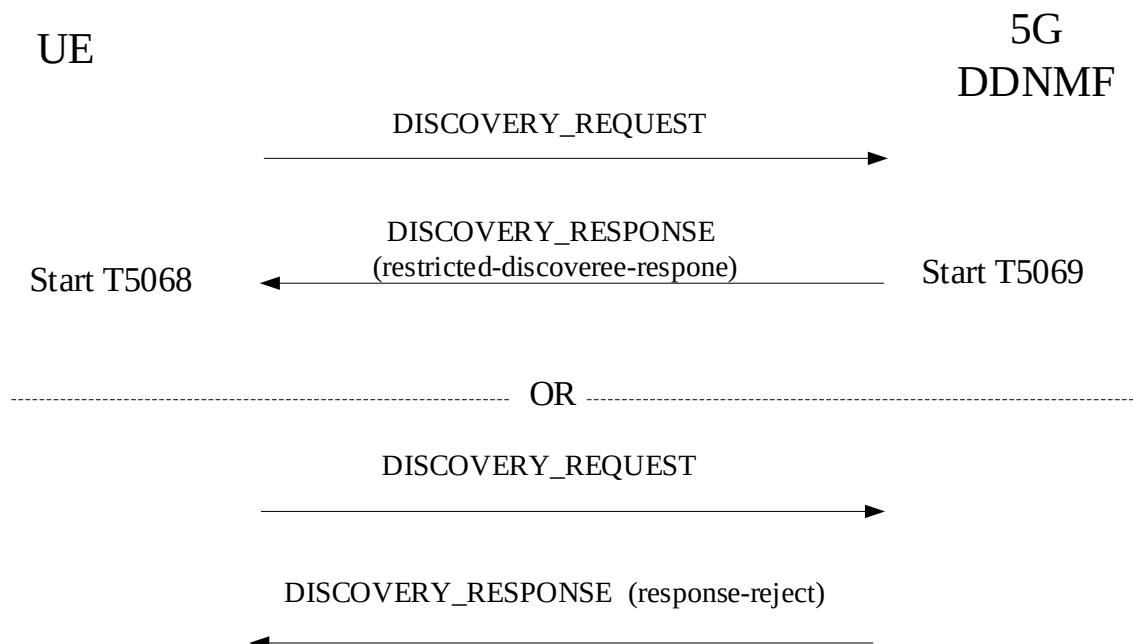


Figure 6.2.6.2.1: Discoveree request procedure for restricted 5G ProSe direct discovery model B

6.2.6.3 Discoveree request procedure accepted by the 5G DDNMF

Upon receiving a DISCOVERY_REQUEST message, the 5G DDNMF shall check that the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is authorised for restricted 5G ProSe direct discovery model B discoveree operation. If the application is authorised for restricted 5G ProSe direct discovery model B discoveree operation, the 5G DDNMF shall check whether there is an existing context for the UE.

If there is no associated UE context, the 5G DDNMF checks with the UDM whether the UE is authorised for restricted 5G ProSe direct discovery model B discoveree operation as described in 3GPP TS 29.503 [10]. If the check indicates that the UE is authorised, the 5G DDNMF creates a UE context that contains the UE's subscription parameters obtained from the UDM. The UDM also provides to the 5G DDNMF the PLMN ID of the PLMN or the PLMN ID combined with a NID of the SNPN in which the UE is currently registered.

If the UE context exists, the 5G DDNMF shall check whether the UE is authorized for restricted 5G ProSe direct discovery model B discoveree operation in the currently registered PLMN or the local PLMN identified by the Announcing PLMN ID included in the DISCOVERY_REQUEST message, or the 5G DDNMF shall check whether the UE is authorized for restricted 5G ProSe direct discovery model B discoveree operation in the subscribed SNPN.

If the UE is authorized and the discovery entry ID included in the DISCOVERY_REQUEST message is set to 0 then:

- a) the 5G DDNMF shall check whether the UE is authorised to announce the RPAUID contained in the DISCOVERY_REQUEST message. Optionally this can include checking with the ProSe application server as described in 3GPP TS 29.557 [19] to obtain the binding between the RPAUID and PDUID and then verifying that the PDUID belongs to the requesting UE;

- b) if the UE is authorised to announce the RPAUID, the 5G DDNMF shall allocate the corresponding ProSe response code and ProSe query code for the RPAUID. It shall also allocate discovery query filter(s) based on the allocated ProSe query code. Then it shall assign a value for validity timer T5068, which is associated with the ProSe response code, ProSe query code and discovery query filter(s); and
- c) the 5G DDNMF associates the allocated ProSe response code, ProSe query code and discovery query filter with a new discovery entry ID in the UE context and starts timer T5069. For a given ProSe response code, timer T5069 shall be longer than timer T5068. By default, the value of timer T5069 is 4 minutes greater than the value of timer T5068.

If the discovery entry ID included in the DISCOVERY_REQUEST message is not set to 0 and if there is an existing discovery entry for this discovery entry ID value in the UE context, the 5G DDNMF shall either update the discovery entry with a new validity timer T5068, or allocate a new ProSe response code, ProSe query code and the discovery query filter(s) for the requested RPAUID with a new validity timer T5068, restart timer T5069.

If the discovery entry ID contained in the DISCOVERY_REQUEST message is not found in the UE context or there is no UE context in the 5G DDNMF, the 5G DDNMF shall behave as if the discovery entry ID included in the DISCOVERY_REQUEST message was set to 0 and the 5G DDNMF shall allocate a new non-zero discovery entry ID for this entry.

If a new UE context was created or an existing UE context was updated and the UE is currently roaming or the Announcing PLMN ID is included in the DISCOVERY_REQUEST message, the 5G DDNMF checks with the 5G DDNMF of the VPLMN or the local PLMN identified by the Announcing PLMN ID whether the UE is authorised for restricted 5G ProSe direct discovery model B discoveree operation as described in 3GPP TS 29.555 [9].

The 5G DDNMF shall then send a DISCOVERY_RESPONSE message containing a <restricted-discoveree-response> element with:

- a) the transaction ID set to the value of the transaction ID received in the DISCOVERY_REQUEST message from the UE;
- b) the ProSe response code set to the ProSe response code allocated for the RPAUID received in the DISCOVERY_REQUEST message;
- c) one or more discovery query filters set to the ProSe query filter(s) used to match a query for the RPAUID received in the DISCOVERY_REQUEST message;
- d) a validity timer T5068 set to the T5068 timer value assigned by the 5G DDNMF to the ProSe response code and the discovery query filter(s);
- e) the code-sending security parameter containing the security-related information for the discoveree UE to protect the transmission of the ProSe response code;
- f) the code-receiving security parameter containing the security-related information needed by the discoveree UE to undo the protection applied by the discoverer UE;
- g) the discovery entry ID set to the ID of the discovery entry associated with this discoveree request in the UE context;
- h) the current time set to the current UTC-based time at the 5G DDNMF and the max offset;
- i) optionally, the PC5 security policies that are associated with the ProSe response code and used for 5G ProSe direct link establishment procedure instead of any PC5 security policies configured in the UE as specified in clause 5; and
- j) the selected PC5 ciphering algorithm set to the PC5 ciphering algorithm selected by the 5G DDNMF if the received PC5 UE ciphering algorithm capability includes the selected PC5 ciphering algorithm associated with the ProSe response code corresponding to the discovery query filters.

If timer T5069 expires, the 5G DDNMF shall remove the discovery entry associated with the corresponding RPAUID from the UE's context.

The 5G DDNMF may associate the ProSe response code with the PC5 security policies.

The 5G DDNMF uses the information (e.g. application identity) received from the UE in the DISCOVERY_REQUEST message, UE identity in GBA or AKMA information related to TLS tunnel transporting the DISCOVERY_REQUEST message, and other information for charging purposes as specified in 3GPP TS 32.277 [45].

6.2.6.4 Discoveree request procedure completion by the UE

Upon receipt of the DISCOVERY_RESPONSE message, if the transaction ID contained in the <restricted-discoveree-response> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "response", the UE shall create a new discovery entry or update an existing discovery entry with the ProSe response code and discovery query filter(s) received in the DISCOVERY_RESPONSE message and the PLMN ID of the intended announcing PLMN. For this discovery entry, the UE shall stop the validity timer T5068 if running and start the validity timer T5068 with the received value. The UE shall also use the received ProSe response code and discovery query filter(s) to replace the old counterparts if they are currently used. This may involve notifying the lower layers to stop announcing the old ProSe response code or to stop monitoring with the old discovery query filter(s). Otherwise, the UE shall discard the DISCOVERY_RESPONSE message and shall not perform the procedures described in clause 6.2.14.2.2.3. The UE shall set a ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter and store the received max offset parameter.

The UE shall store the selected PC5 ciphering algorithm received in the DISCOVERY_RESPONSE message for the ProSe response code and the ProSe query code and the UE shall use it for protection of the restricted 5G ProSe direct discovery messages over the PC5 interface as specified in clause 6.1.3.2.3 of 3GPP TS 33.503 [34].

6.2.6.5 Discoveree request procedure not accepted by the 5G DDNMF

If the DISCOVERY_REQUEST message cannot be accepted by the 5G DDNMF, the 5G DDNMF sends a DISCOVERY_RESPONSE message containing a <response-reject> element to the UE including an appropriate PC3a control protocol cause value.

If the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is not authorised for ProSe direct discovery Model B discoveree operation, the 5G DDNMF shall send the DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #1 "Invalid application".

If the RPAUID contained in the DISCOVERY_REQUEST message is unknown to the 5G DDNMF or ProSe application server, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #9 "Unknown RPAUID".

If the RPAUID contained in the DISCOVERY_REQUEST message does not match the stored RPAUID for the requested discovery entry ID, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #10 "Unknown or invalid discovery entry ID".

If the UE is not authorised for restricted 5G ProSe direct discovery model B discoveree operation, the 5G DDNMF shall send the DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

If the RPAUID contained in the DISCOVERY_REQUEST message is not associated with a PDUID belonging to the requesting UE, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

If the PC5 UE ciphering algorithm capability contained in the DISCOVERY_REQUEST message is not compatible with the selected PC5 ciphering algorithm for the ProSe response code and the ProSe query code, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #19 "Not compatible PC5 UE ciphering algorithm capability".

6.2.6.6 Abnormal cases

6.2.6.6.1 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of DISCOVERY_REQUEST message (e.g., after TCP retransmission timeout)

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the discoveree request procedure.

NOTE 1: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

- b) No response from the 5G DDNMF after the DISCOVERY_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the DISCOVERY_REQUEST message)

The UE shall retransmit the DISCOVERY_REQUEST message.

NOTE 2: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

NOTE 3: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

- c) Indication from upper layers that the request to announce the RPAUID in model B is no longer in place after sending the DISCOVERY_REQUEST message, but before the discoveree request procedure is completed

The UE shall acknowledge the DISCOVERY_RESPONSE message received from the 5G DDNMF but discard its contents and then abort the procedure.

- d) Change of PLMN

If a PLMN change occurs before the discoveree request procedure is completed, the procedure shall be aborted. If the UE is authorized to perform restricted 5G ProSe direct discovery model B discoveree operation in the new PLMN, the procedure shall be restarted once the UE is registered on the new PLMN.

6.2.6.6.2 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of DISCOVERY_RESPONSE message

After receiving an indication from lower layer that the DISCOVERY_RESPONSE message has not been successfully acknowledged (e.g. TCP ACK is not received), the 5G DDNMF shall abort the procedure and stop any associated timer(s) T5069, if running.

6.2.7 Discoverer request procedure for restricted 5G ProSe direct discovery model B

6.2.7.1 General

The purpose of the discoverer request procedure for restricted 5G ProSe direct discovery model B is for the UE to obtain ProSe query code(s) and discovery response filter(s) to be used for sending query and monitoring responses over the PC5 interface based on the information provided by the upper layer application, as defined in 3GPP TS 23.304 [2].

Before initiating the discoverer request procedure, the UE shall be authorised for restricted 5G ProSe direct discovery model B discoverer operation in the registered PLMN, the subscribed SNPN or the local PLMN based on the service authorization procedure as specified in clause 5.

As the result of successful completion of this procedure, the UE obtains one or more ProSe query code(s) which can be included in a PROSE PC5 DISCOVERY message and passes the PROSE PC5 DISCOVERY message to the lower layers for transmission over the PC5 interface. The UE also obtains discovery response filter(s) and apply it to the monitoring operation in PC5 interface to match potential responses for the sent query request for the target RPAUID.

6.2.7.2 Discoverer request procedure initiation

Before initiating the discoverer request procedure, the user sets the permissions for the restricted discovery using application layer mechanisms. The application client in the UE retrieves the PDUID provisioned to the UE as part of the service authorization procedure as specified in clause 5 and obtains a RPAUID associated with the UE's PDUID from

the ProSe application server. The UE can also obtain the target RPAUID(s) from the ProSe application server. This step is performed using mechanisms that are out of scope of the present specification.

If the UE is authorised to perform restricted 5G ProSe direct discovery model B discoverer operation in the PLMN or the SNPN operating the radio resources signalled from the serving PLMN or the subscribed SNPN, it shall initiate a discoverer request procedure:

- a) when the UE is triggered by an upper layer application to perform the query for one or more target RPAUIDs in Model B and the UE has no valid corresponding ProSe query code and discovery response filter for those target RPAUIDs of the upper layer application;
- b) when the validity timer T5070 assigned by the 5G DDNMF to a ProSe query codes and the corresponding discovery response filter has expired and the request from upper layers to announce the RPAUID corresponding to that ProSe query code is still in place;
- c) when the UE selects a new PLMN while announcing a ProSe query code or waiting for a ProSe response code and intends to announce the ProSe query code in the new PLMN and the UE is authorised for restricted 5G ProSe direct discovery model B discoverer operation in the new PLMN, and the UE does not have a valid ProSe query code and discovery response filter for the target RPAUIDs for this new PLMN yet; or
- d) when the UE needs to update a previously sent restricted 5G ProSe direct discovery model B discoverer request.

When the UE selects a new PLMN while announcing a ProSe query code or waiting for a ProSe response code and the UE is not yet authorised for restricted 5G ProSe direct discovery model B discoverer operation in the new PLMN, the UE shall initiate a discoverer request procedure only after the UE is authorised for restricted 5G ProSe direct discovery model B discoverer operation in the new PLMN.

NOTE 1: To ensure service continuity if the UE needs to keep announcing in Model B a ProSe query code corresponding to the same RPAUID, the UE can initiate the discoverer request procedure before the validity timer T5070 assigned by the 5G DDNMF for a ProSe query code expires.

The UE shall initiate the discoverer request procedure by sending a DISCOVERY_REQUEST message with:

- a) a new transaction ID not used in any other direct discovery procedures in PC3a interface;
- b) the RPAUID set to the RPAUID received from upper layers;
- c) the application level container set to contain the application-layer information, e.g., target RPAUID(s) to discover;
- d) the command set to "query";
- e) the application identity set to the ProSe identifier of the upper layer application that requested the announcing as specified in clause 5.2.3;
- f) the discovery type set to "Restricted discovery";
- g) the discovery model set to "Model B";
- h) the discovery entry ID set to a 0 if the discoverer request is a new request and set to the discovery entry ID received from the 5G DDNMF if the discoverer request is to update a previously sent discoverer request;
- i) optionally the Announcing PLMN ID set to the PLMN ID of the local PLMN operating the radio resources that the UE intends to use for transmitting the query for the target RPAUID(s); and
- j) the PC5 UE ciphering algorithm capability set to the UE supported ciphering algorithm(s) for ciphering the PROSE PC5 DISCOVERY message.

NOTE 2: A UE can include one or multiple transactions in one DISCOVERY_REQUEST message for different discovering requests (e.g., for different applications) and receive corresponding <restricted-discoverer-response> element or <response-reject> element in a DISCOVERY_RESPONSE message for each respective transaction. In the following description of the discoverer request procedure, only one transaction is included.

Figure 6.2.7.2.1 illustrates the interaction of the UE and the 5G DDNMF in the discoverer request procedure.

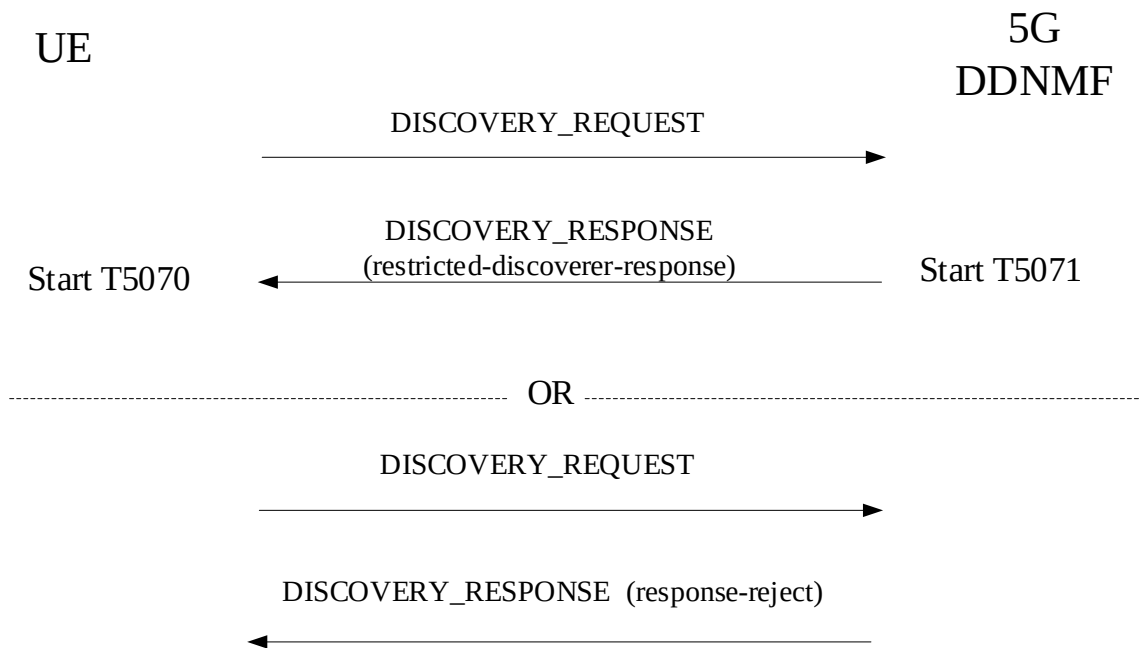


Figure 6.2.7.2.1: Discoverer request procedure for restricted 5G ProSe direct discovery model B

6.2.7.3 Discoverer request procedure accepted by the 5G DDNMF

Upon receiving a DISCOVERY_REQUEST message, the 5G DDNMF shall check that the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is authorised for restricted 5G ProSe direct discovery model B discoverer operation. If the application is authorised for restricted 5G ProSe direct discovery model B discoverer operation, the 5G DDNMF shall check whether there is an existing context for the UE.

If there is no associated UE context, the 5G DDNMF checks with the UDM whether the UE is authorised for restricted 5G ProSe direct discovery model B discoverer operation as described in 3GPP TS 29.503 [10]. If the check indicates that the UE is authorised, the 5G DDNMF creates a UE context that contains the UE's subscription parameters obtained from the UDM. The UDM also provides to the 5G DDNMF the PLMN ID of the PLMN or the PLMN ID combined with a NID of the SNPN in which the UE is currently registered.

If the UE context exists, the 5G DDNMF shall check whether the UE is authorized for restricted 5G ProSe direct discovery model B discoverer operation in the currently registered PLMN or the local PLMN identified by the Announcing PLMN ID included in the DISCOVERY_REQUEST message, or the 5G DDNMF shall check whether the UE is authorized for restricted 5G ProSe direct discovery model B discoverer operation in the subscribed SNPN.

If the UE is authorized and the discovery entry ID included in the DISCOVERY_REQUEST message is set to 0 then:

- a) the 5G DDNMF uses the procedure described in 3GPP TS 29.557 [19] to pass the application level container included in the DISCOVERY_REQUEST message to the ProSe application server and obtain a list of PDUID(s) corresponding to the authorised target RPAUID(s) from the ProSe application server;
- b) for each of the PDUIDs corresponding to an authorised target RPAUID:
 - 1) if the PLMN ID of the PDUID is not the same as that of the PLMN to which the 5G DDNMF belongs, then the 5G DDNMF executes the procedures defined in 3GPP TS 29.555 [9] to obtain the ProSe query code, the ProSe response code, the associated validity timer T5070 and optionally metadata associated with this target RPAUID. Otherwise, the 5G DDNMF shall locate the discoverer UE context and retrieve the corresponding ProSe query code and ProSe response code and the validity timer T5070 and optionally metadata associated with this RPAUID. Then, the 5G DDNMF in the HPLMN builds one or more discovery response filter(s)

based on the respective ProSe response code and associate the discovery response filter(s) and ProSe query code with a new validity timer T5071 based on the remaining value of T5071; and

NOTE 1: If the 5G DDNMF cannot retrieve the corresponding discoveree UE context for a target RPAUID, e.g., the target RPAUID has not yet been requested to be discovered by Model B in a discoveree request procedure, or the discoveree UE context expires, the 5G DDNMF can skip the processing of this target RPAUID.

NOTE 2: The 5G DDNMF can choose the value of T5070 to be longer than the remaining value of T5069, so that the discoverer UE sends a new discoverer request for renewing the query-related information no earlier than the discoveree UE renewing its own ProSe response code with the 5G DDNMF.

- 2) the 5G DDNMF associates the ProSe query code and corresponding discovery response filter(s), target RPAUID and optionally metadata associated with the target RPAUID with a new discovery entry in the discoverer UE's context; and
- c) the 5G DDNMF starts timer T5071 assigned for each ProSe query code and discovery response filter(s) (of each target RPAUID) under this discovery entry of the discoverer UE context. For a given ProSe query code and the corresponding discovery response filter(s), timer T5071 shall be longer than timer T5070. By default, the value of timer T5071 is 4 minutes greater than the value of timer T5070.

If the discovery entry ID included in the DISCOVERY_REQUEST message is not set to 0 and if there is an existing discovery entry for this discovery entry ID value in the UE's context, the 5G DDNMF shall still process the above steps, but update the discovery entry instead of creating a new discovery entry.

If the discovery entry ID contained in the DISCOVERY_REQUEST message is not found in the UE context or there is no UE context in the 5G DDNMF, the 5G DDNMF shall behave as if the discovery entry ID included in the DISCOVERY_REQUEST message was set to 0 and the 5G DDNMF shall allocate a new non-zero discovery entry ID for this entry.

If a new UE context was created or an existing UE context was updated, the UE is currently roaming or the announcing PLMN ID is included in the DISCOVERY_REQUEST message, the 5G DDNMF checks with the 5G DDNMF of the VPLMN or the local PLMN indicated by the announcing PLMN ID whether the UE is authorised for restricted 5G ProSe direct discovery model B discoverer operation as described in 3GPP TS 29.555 [9].

The 5G DDNMF shall then send a DISCOVERY_RESPONSE message containing a <restricted-discoverer-response> element with:

- a) the transaction ID set to the value of the transaction ID received in the DISCOVERY_REQUEST message from the UE;
- b) one or more Subquery Result information elements, each of which includes:
 - 1) a target RPAUID;
 - 2) the ProSe query code set to the ProSe query code for the target RPAUID;
 - 3) one or more discovery response filters which are set to the discovery response filter(s) used to match a potential ProSe response code responding to the ProSe query code;
 - 4) a validity timer T5070 set to the T5070 timer value assigned by the 5G DDNMF to the ProSe query code and the discovery response filter(s);
 - 5) optionally, the metadata associated with the target RPAUID;
 - 6) the code-sending security parameter containing the security-related information needed by the discoverer UE to protect the transmission of ProSe query code; and
 - 7) the code-receiving security parameter containing the security-related information needed by the discoverer UE to undo the protection applied by the discoveree UE;
- c) the discovery entry ID set to the ID of the discovery entry associated with this announce request in the UE context;
- d) the current time set to the current UTC-based time at the 5G DDNMF and the max offset;

- e) optionally, the PC5 security policies that are associated with the ProSe response code and used for 5G ProSe direct link establishment procedure instead of any PC5 security policies configured in the UE as specified in clause 5; and
- f) the selected PC5 ciphering algorithm set to the PC5 ciphering algorithm selected by the 5G DDNMF if the received PC5 UE ciphering algorithm capability includes the selected PC5 ciphering algorithm associated with the ProSe response code corresponding to the discovery response filters.

If T5071 expires, the 5G DDNMF shall remove the corresponding ProSe query code and ProSe response filter(s) from the discovery entry associated with the discoverer UE's context.

The 5G DDNMF uses the information (e.g. application identity) received from the UE in the DISCOVERY_REQUEST message, UE identity in GBA or AKMA information related to TLS tunnel transporting the DISCOVERY_REQUEST message, and other information for charging purposes as specified in 3GPP TS 32.277 [45].

6.2.7.4 Discoverer request procedure completion by the UE

Upon receipt of the DISCOVERY_RESPONSE message, if the transaction ID contained in the <restricted-discoverer-response> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "query" and the discovery model set to "Model B", the UE shall, process as follow:

- a) If the DISCOVERY_RESPONSE creates a new discovery entry, start the validity timer T5070 with the received value for the ProSe query code and the corresponding Discovery Response Filter(s) included for each SubQuery-Result information element received in the DISCOVERY_RESPONSE message and the PLMN ID of the intended announcing PLMN if included in the DISCOVERY_REQUEST message; or
- b) If the DISCOVERY_RESPONSE updates an existing discovery entry, the UE shall:
 - 1) stop the timer T5070 of any ProSe query code(s) and discovery response filter(s) in this discovery entry which are no longer authorized by the 5G DDNMF, ask lower layers to stop announcing the ProSe query code(s) and monitoring ProSe response filter(s) and remove the ProSe query code(s) and discovery response filter(s) from the existing discovery entry;
 - 2) restart the T5070 timer(s) for those remain eligible;
 - 3) start the T5070 timer(s) for any new ProSe query codes and their corresponding discovery response filter(s); and
 - 4) update the PLMN ID of the intended announcing PLMN for this discovery entry if included in the DISCOVERY_REQUEST message.

Otherwise, the UE shall discard the DISCOVERY_RESPONSE message and shall not perform the discoverer UE procedure for 5G ProSe direct discovery as described in clause 6.2.14.2.2.2. The UE shall set a ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter and store the received max offset parameter.

The UE shall store the selected PC5 ciphering algorithm received in the DISCOVERY_RESPONSE message and use it for protection of the restricted 5G ProSe direct discovery messages over the PC5 interface as specified in clause 6.1.3.2.3 of 3GPP TS 33.503 [34].

For each ProSe query code in this discovery entry, the UE performs the discoverer UE procedure for 5G ProSe direct discovery to announce the ProSe query code in the PC5 interface, as described in clause 6.2.14.2.2.2.

6.2.7.5 Discoverer request procedure not accepted by the 5G DDNMF

If the DISCOVERY_REQUEST message cannot be accepted by the 5G DDNMF, the 5G DDNMF sends a DISCOVERY_RESPONSE message containing a <response-reject> element to the UE including an appropriate PC3a control protocol cause value.

If the application corresponding to the ProSe identifier contained in the DISCOVERY_REQUEST message is not authorised for restricted 5G ProSe direct discovery Model B discoverer operation, the 5G DDNMF shall send the DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #1 "Invalid application".

If the RPAUID contained in the DISCOVERY_REQUEST message is unknown to the 5G DDNMF or ProSe application server, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #9 "Unknown RPAUID".

If the RPAUID contained in the DISCOVERY_REQUEST message does not match the stored RPAUID for the requested discovery entry ID, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #10 "Unknown or invalid discovery entry ID".

If the UE is not authorised for restricted 5G ProSe direct discovery model B discoverer operation, the 5G DDNMF shall send the DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

If the RPAUID contained in the DISCOVERY_REQUEST message is not associated with a PDUID belonging to the requesting UE, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

If the 5G DDNMF fails to retrieve any valid target PDUIDs from ProSe application server based on the application level container contained in the DISCOVERY_REQUEST message, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #11 "Invalid discovery target".

If the 5G DDNMF fails to retrieve any valid discoveree UE contexts for the valid target RPAUIDs contained in the application level container contained in the DISCOVERY_REQUEST message, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #11 "Invalid discovery target".

If the PC5 UE ciphering algorithm capability contained in the DISCOVERY_REQUEST message is not compatible with the selected PC5 ciphering algorithm for the ProSe response code and the ProSe query code, the 5G DDNMF shall send a DISCOVERY_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #19 "Not compatible PC5 UE ciphering algorithm capability".

6.2.7.6 Abnormal cases

6.2.7.6.1 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of DISCOVERY_REQUEST message (e.g., after TCP retransmission timeout)

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the discoverer request procedure.

NOTE 1: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

- b) No response from the 5G DDNMF after the DISCOVERY_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the DISCOVERY_REQUEST message)

The UE shall retransmit the DISCOVERY_REQUEST message.

NOTE 2: The UE can abort this procedure when detecting loss of NG-RAN coverage in its serving PLMN or its subscribed SNPN.

NOTE 3: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

- c) Indication from upper layers that the request to discover the target RPAUID(s) is no longer in place after sending the DISCOVERY_REQUEST message, but before the discoverer request procedure is completed

The UE shall acknowledge the DISCOVERY_RESPONSE message received from the 5G DDNMF but discard its contents and then abort the procedure.

- d) Change of PLMN

If a PLMN change occurs before the discoverer request procedure is completed, the procedure shall be aborted.
If the UE is authorized to perform restricted 5G ProSe direct discovery discoverer operation Model B in the new PLMN, the procedure shall be restarted once the UE is registered on the new PLMN.

6.2.7.6.2 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of DISCOVERY_RESPONSE message

After receiving an indication from lower layer that the DISCOVERY_RESPONSE message has not been successfully acknowledged (e.g., TCP ACK is not received), the 5G DDNMF shall abort the procedure and stop any associated timer(s) T5071, if running.

6.2.8 Match report procedure for open 5G ProSe direct discovery

6.2.8.1 General

The purpose of the match report procedure for open 5G ProSe direct discovery is to allow a UE to send a ProSe application code that was matched during the monitoring operation and receive the corresponding ProSe application ID or the updated metadata, if there is no such a mapping stored locally or the metadata index in the ProSe application code indicates the metadata is updated.

The UE shall only initiate the match report procedure if it has been authorized for open 5G ProSe direct discovery monitoring in the monitored PLMN or its subscribed SNPN based on the service authorization procedure.

As a result of the match report procedure completing successfully, the UE obtains a ProSe application ID and potentially other information, which the UE may store locally and pass to the upper layers.

6.2.8.2 Match report procedure initiation

The UE shall meet the following pre-conditions before initiating this procedure:

- a) a request from upper layers to monitor for the ProSe application ID, which resulted in the matched ProSe application code, is still in place;
- b) the lower layers have provided a "Monitored PLMN ID" value and UTC time information, along with the discovery message containing a ProSe application code; and
- c) the TTL timer T5064 associated with the discovery filter, which resulted in a match event of the ProSe application code, has not expired.

If the UE is authorized to perform open 5G ProSe direct discovery monitoring in the monitored PLMN or its subscribed SNPN, it should initiate a match report procedure:

- a) when there is a match event of one of the ProSe application codes received from the lower layers and the UE does not have a corresponding ProSe application ID already locally stored;
- b) when the UE has a locally stored mapping for the ProSe application code that resulted in a match event, but the validity timer T5072 of the ProSe application ID has expired;
- c) when the UE has a locally stored mapping for the ProSe application code that resulted in a match event, but the match report refresh timer T5074 of the ProSe application filter has expired;
- d) when there is a match event of one of the ProSe application codes received from the lower layers and the UE has a locally stored ProSe application code excluding the metadata index portion located by the locally stored metadata index mask; or
- e) when there is a match event of one of the ProSe application codes received from the lower layer and the UE has not checked the MIC for the discovered ProSe application code previously.

The UE initiates the match report procedure for open 5G ProSe direct discovery by sending a MATCH_REPORT message with a new transaction ID and shall set the message contents as follows:

- a) the UE shall include the entire PROSE PC5 DISCOVERY message which contains the ProSe application code for which there was a match event;
- b) the UE shall set the UTC-based counter as follows:
 - 1) the UE shall generate two UTC-based counters with:
 - i) the first counter composed of:
 - A) the 27 most significant bits of the UTC-based counter set to the 27 most significant bits of the UTC time provided by the lower layers for the PROSE PC5 DISCOVERY message that contained the ProSe application code for which there was a match event encoded as specified in clause 11.2.5;
 - B) the 28th most significant bit of the UTC-based counter set to '0'; and
 - C) the 4 least significant bits of the UTC-based counter shall be set to the 4 least significant bits of the UTC-based counter contained in the PROSE PC5 DISCOVERY message that contained the ProSe application code for which there was a match event, as specified in 3GPP TS 33.503 [34]; and
 - ii) the second counter composed of:
 - A) the 27 most significant bits of the UTC-based counter set to the 27 most significant bits of the UTC time provided by the lower layers for the PROSE PC5 DISCOVERY message that contained the ProSe application code for which there was a match event encoded as specified in clause 11.2.5;
 - B) the 28th most significant bit of the UTC-based counter set to '1'; and
 - C) the 4 least significant bits of the UTC-based counter set to the 4 least significant bits of the UTC-based counter contained in the PROSE PC5 DISCOVERY message that contained the ProSe application code for which there was a match event, as specified in 3GPP TS 33.503 [34]; and
 - 2) then the UE shall select, among the two counters described above, the counter that is nearest to the UTC time provided by the lower layers for the PROSE PC5 DISCOVERY message that contained the ProSe application code for which there was a match event encoded as specified in clause 11.2.5 and set the UTC-based counter in the MATCH_REPORT message to that counter;
- c) the UE shall set the monitored PLMN ID to the PLMN ID of the PLMN where the PROSE PC5 DISCOVERY message was received, as provided by the lower layers;
- d) if the UE was roaming when the match event occurred, the UE shall set the VPLMN ID to the PLMN ID of the PLMN in which the UE was registered when the match event occurred; and
- e) the UE shall set the metadata flag to indicate whether or not it wishes to receive metadata information associated with the ProSe application ID in the MATCH_REPORT_ACK message from the 5G DDNMF.

NOTE 1: A UE can include one or multiple transactions in one MATCH_REPORT message for different ProSe application codes and receive corresponding <match-ack> element or <match-reject> element in the MATCH_REPORT_ACK message for each respective transaction. In the following description of match report procedure, only one transaction is included.

NOTE 2: The value of the metadata flag is determined through an indication from upper layers in the original request to monitor for a ProSe application ID.

When the 5G DDNMF receives the MATCH_REPORT message from the UE, the 5G DDNMF checks MIC for the received PROSE PC5 DISCOVERY message as specified in 3GPP TS 33.503 [34].

Figure 6.2.8.2.1 illustrates the interaction between the UE and the 5G DDNMF in the match report procedure.

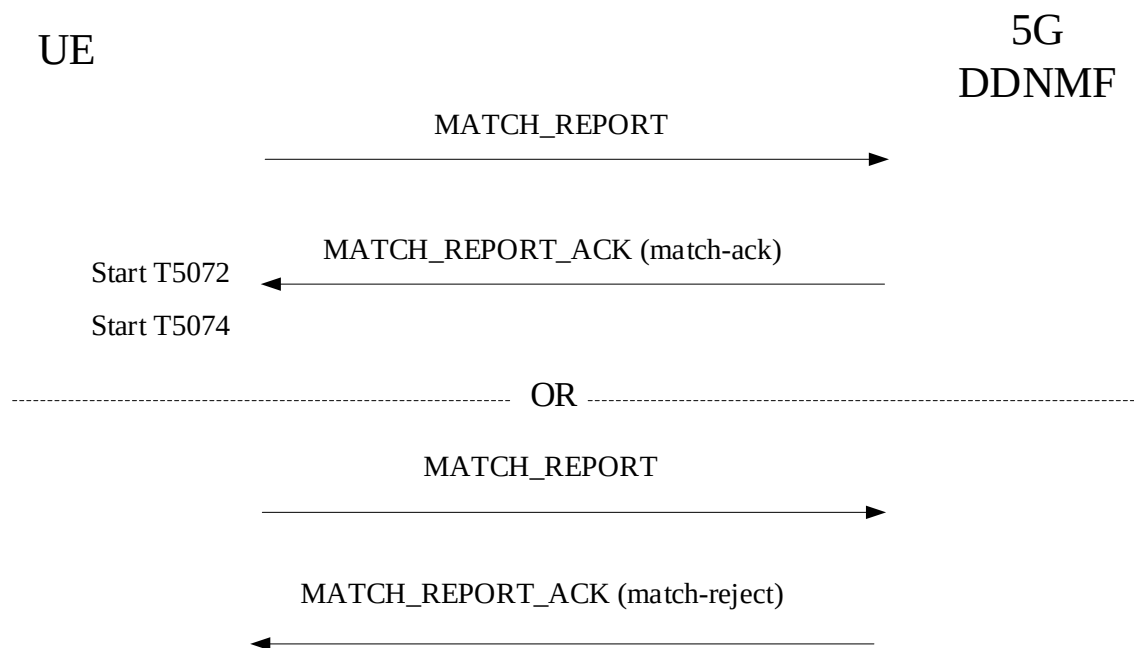


Figure 6.2.8.2.1: Match report procedure

6.2.8.3 Match report procedure accepted by the 5G DDNMF

Upon receiving a MATCH_REPORT message, the 5G DDNMF shall check whether there is an existing context for the UE identified by its SUPI. If there is no associated UE context, the 5G DDNMF checks with the UDM whether the UE is authorized for open 5G ProSe direct discovery monitoring as described in 3GPP TS 29.503 [10].

The 5G DDNMF shall also check the PLMN ID in the ProSe application code received from the UE. If the PLMN ID in the ProSe application code is not the same of that of the PLMN to which the 5G DDNMF belongs, the 5G DDNMF shall execute the procedures defined in 3GPP TS 29.555 [9]. Otherwise, the 5G DDNMF shall check whether the received ProSe application code is authorized to be transmitted on the monitored PLMN indicated in the Monitored PLMN ID in the received message. In SNPN, the 5G DDNMF shall check whether the ProSe application code received from the UE is authorized to be transmitted on the UE's subscribed SNPN.

If the ProSe application code is PLMN-specific, the 5G DDNMF shall verify if the PLMN ID in the ProSe application code is the same as the PLMN of the 5G DDNMF. If so, the 5G DDNMF shall map the ProSe application code to the corresponding ProSe application ID from the PLMN-specific database. If the ProSe application code is country-specific, as specified in clause 24.3 of 3GPP TS 23.003 [4], the 5G DDNMF shall check whether the MCC of the PLMN ID part of the ProSe application code corresponds to the country of the 5G DDNMF. If so, the 5G DDNMF shall map the ProSe application code to the corresponding ProSe application ID from the country-specific database. If the ProSe application code is global as specified in clause 24.3 of 3GPP TS 23.003 [4], the 5G DDNMF shall map the ProSe application code to the corresponding ProSe application ID from the global database. If the ProSe application code contains a ProSe application code prefix, the 5G DDNMF maps the ProSe application code prefix to the corresponding ProSe application ID.

The 5G DDNMF shall analyze the ProSe application code received from the UE and determine the validity of the ProSe application code.

NOTE: This might require the 5G DDNMF to execute procedures defined in 3GPP TS 29.555 [9].

The 5G DDNMF shall check if the MIC value and its corresponding UTC-based counter are valid, as defined in 3GPP TS 33.503 [34].

The 5G DDNMF uses the information (e.g. ProSe application code, monitored PLMN ID, VPLMN ID if included) received from the UE in the DISCOVERY_REQUEST message, UE identity in GBA or AKMA information related to TLS tunnel transporting the DISCOVERY_REQUEST message, and other information for charging purposes as specified in 3GPP TS 32.277 [45].

If the outcome of above processing is successful, the 5G DDNMF shall send a MATCH_REPORT_ACK message containing a <match-ack> element with:

- a) the transaction ID set to the value of the transaction ID received in the MATCH_REPORT message from the UE;
- b) the ProSe application ID set to the ProSe application ID provided by the 5G DDNMF and corresponding to the ProSe application code contained in the MATCH_REPORT message;
- c) the validity timer T5072 set to indicate for how long this ProSe application ID is valid;
- d) the match report refresh timer T5074 set to indicate for how long the UE will wait before sending a new match report for this ProSe application code;
- e) the current time set to the current UTC-based time at the 5G DDNMF; and
- f) optionally, the metadata set to the metadata information associated with the ProSe application code received in the MATCH_REPORT message and set the metadata index mask to the metadata index mask allocated by the 5G DDNMF for the ProSe application code received in the MATCH_REPORT message, if the UE has set the metadata flag to indicate that it wishes to receive metadata information associated with the ProSe application ID.

6.2.8.4 Match report procedure completion by the UE

Upon receipt of the MATCH_REPORT_ACK message, if the transaction ID contained in the <match-ack> element matches the value sent by the UE in a MATCH_REPORT message, the UE shall store the mapping between the ProSe application code and ProSe application ID locally, start timers T5072 and T5074 and may inform the upper layers of this match of the ProSe application ID. If the metadata index mask is contained in the MATCH_REPORT_ACK message, the UE shall also store the metadata index mask with the ProSe application code and the ProSe application ID locally. If there is a locally stored mapping between the ProSe application ID and a ProSe application code, the UE shall delete the old mapping. Otherwise, the UE shall discard the MATCH_REPORT_ACK message. The UE shall update the ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter.

Upon receipt of the MATCH_REPORT_ACK message, if the transaction ID contained in the <match-reject> element matches the value sent by the UE in a MATCH_REPORT message and if the received PC3a control protocol cause value is #5 "Invalid MIC", as specified in clause 6.2.8.5, the UE shall stop timer T5072 if it is running.

NOTE 1: It is an implementation specific choice whether the UE informs the upper layers every time a ProSe application ID triggers a match event, or only the first time this match occurs.

NOTE 2: The UE can also inform the upper layers if a ProSe application ID is no longer matched, because the validity timer T5072 of the corresponding ProSe application code expires.

NOTE 3: The UE can also inform the upper layers if a ProSe application ID is no longer matched, because the validity timer T5072 of the corresponding ProSe application code is stopped upon receiving MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #5 "Invalid MIC".

6.2.8.5 Match report procedure not accepted by the 5G DDNMF

If the MATCH_REPORT message is not accepted by the 5G DDNMF, the 5G DDNMF sends a MATCH_REPORT_ACK message with a <match-reject> element to the UE including an appropriate PC3a control protocol cause value.

If the ProSe application code contained in the MATCH_REPORT message is unknown by the 5G DDNMF, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #4 "Unknown ProSe application code".

If the check of the MIC contained in the MATCH_REPORT message fails, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #5 "Invalid MIC".

If the check of the UTC-based counter contained in the MATCH_REPORT message fails, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #6 "Invalid UTC-based counter".

If the UE is not authorized for open 5G ProSe direct discovery monitoring in the monitored PLMN or its subscribed SNPN contained in the MATCH_REPORT message, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

6.2.8.6 Abnormal cases

6.2.8.6.1 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of MATCH_REPORT message (e.g., after TCP retransmission timeout)

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the match report procedure.

- b) No response from the 5G DDNMF after the MATCH_REPORT message has been successfully delivered (e.g., TCP ACK has been received for the MATCH_REPORT message)

If the TTL timer T5064 associated with the discovery filter which resulted in a match event has not expired, the UE shall retransmit the MATCH_REPORT message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

- c) Change of PLMN

If a PLMN change occurs before the match report procedure is completed, the procedure shall be aborted.

6.2.9 Match report procedure for restricted 5G ProSe direct discovery model A

6.2.9.1 General

The purpose of the match report procedure is to allow a UE to send a ProSe restricted code that was matched during the monitoring operation and receive the corresponding RPAUID, if there is no such a mapping stored locally.

The UE shall only initiate the match report procedure if it has been authorized for restricted 5G ProSe direct discovery monitoring model A in the monitored PLMN or its subscribed SNPN based on the service authorization procedure.

As a result of the match report procedure completing successfully, the UE obtains a RPAUID and potentially other information, which the UE may store locally and pass to the upper layers.

6.2.9.2 Match report procedure initiation

The UE shall meet the following pre-conditions before initiating this procedure:

- a) a request from upper layers to monitor for the target RPAUID, which resulted in the matched ProSe restricted code, is still in place;
- b) the lower layers have provided UTC time information, along with the discovery message containing the ProSe restricted code; and

- c) the TTL timer T5066 associated with the Restricted discovery filter, whose use resulted in a match event of the ProSe restricted code, has not expired.

If the UE is authorized to perform restricted 5G ProSe direct discovery monitoring model A in the monitored PLMN or its subscribed SNPN, it should initiate a match report procedure:

- a) when there is a match event after applying one of the Restricted discovery filter(s) to a ProSe restricted code received from the lower layers and the UE does not have a corresponding RPAUID already locally stored;
- b) when the UE has a locally stored mapping for the ProSe restricted code that resulted in a match event, but the validity timer T5076 of the ProSe restricted code has expired;
- c) when the UE has a locally stored mapping for the ProSe restricted code that resulted in a match event, but the match report refresh timer T5077 of the ProSe restricted code has expired;
- d) when the UE desires to obtain the metadata associated with the discovered ProSe restricted code; or
- e) when the UE has a locally stored mapping for the ProSe restricted code that resulted in a match event, but the UE does not have a running match report refresh timer T5077 for this ProSe restricted code and the UE is directed by the 5G DDNMF to perform the required MIC check via the match report procedure.

NOTE 1: The 5G DDNMF directs the UE to use the match report procedure to perform the MIC check by including the MIC Check Indicator parameter in the DISCOVERY_RESPONSE message.

The UE initiates the match report procedure by sending a MATCH_REPORT message with a new transaction ID and shall set the message contents as follows:

- a) the RPAUID set to the UE's RPAUID which has requested the corresponding monitoring operation that resulted this match event;
- b) the discovery type set to "Restricted discovery";
- c) the application identity set to the ProSe identifier of the upper layer application that triggered the monitoring operation as specified in clause 5.2.3;
- d) if it is not required to check the MIC via the match report procedure, the ProSe restricted code set to the ProSe restricted code for which there was a match event;
- e) if it is required to check the MIC via the match report procedure, the entire PROSE PC5 DISCOVERY message that contained the ProSe restricted code for which there was a match event;
- f) if it is required to check the MIC via the match report procedure, the UTC-based counter set as follows:
 - 1) the UE shall generate two UTC-based counters with:
 - i) the first counter composed of:
 - A) the 27 most significant bits of the UTC-based counter set to the 27 most significant bits of the UTC time provided by the lower layers for the PROSE PC5 DISCOVERY message that contained the ProSe restricted code for which there was a match event encoded as specified in clause 11.2.5;
 - B) the 28th most significant bit of the UTC-based counter set to '0'; and
 - C) the 4 least significant bits of the UTC-based counter set to the 4 least significant bits of the UTC-based counter contained in the PROSE PC5 DISCOVERY message that contained the ProSe restricted code for which there was a match event, as specified in 3GPP TS 33.503 [34]; and
 - ii) the second counter composed of:
 - A) the 27 most significant bits of the UTC-based counter set to the 27 most significant bits of the UTC time provided by the lower layers for the PROSE PC5 DISCOVERY message that contained the ProSe restricted code for which there was a match event encoded as specified in clause 11.2.5;
 - B) the 28th most significant bit of the UTC-based counter set to '1'; and

- C) the 4 least significant bits of the UTC-based counter set to the 4 least significant bits of the UTC-based counter contained in the PROSE PC5 DISCOVERY message that contained the ProSe restricted code for which there was a match event, as specified in 3GPP TS 33.503 [34]; and
- 2) then the UE shall select, among the two counters described above, the counter that is nearest to the UTC time provided by the lower layers for the PROSE PC5 DISCOVERY message that contained the ProSe restricted code for which there was a match event encoded as specified in clause 11.2.5 and set the UTC-based counter in the MATCH_REPORT message to that counter; and
- g) the metadata flag set to indicate whether or not the UE wishes to receive the latest metadata information associated with the RPAUID in the MATCH_REPORT_ACK message from the 5G DDNMF.

NOTE 2: A UE can include one or multiple transactions in one MATCH_REPORT message for different ProSe restricted codes and receive a corresponding <restricted-match-ack> element or <match-reject> element in the MATCH_REPORT_ACK message for each respective transaction. In the following description of match report procedure, only one transaction is included.

If it is required to check the MIC via the match report procedure, the 5G DDNMF checks MIC for the received PROSE PC5 DISCOVERY message included in the MATCH_REPORT message as specified in 3GPP TS 33.503 [34].

Figure 6.2.9.2.1 illustrates the interaction between the UE and the 5G DDNMF in the match report procedure.

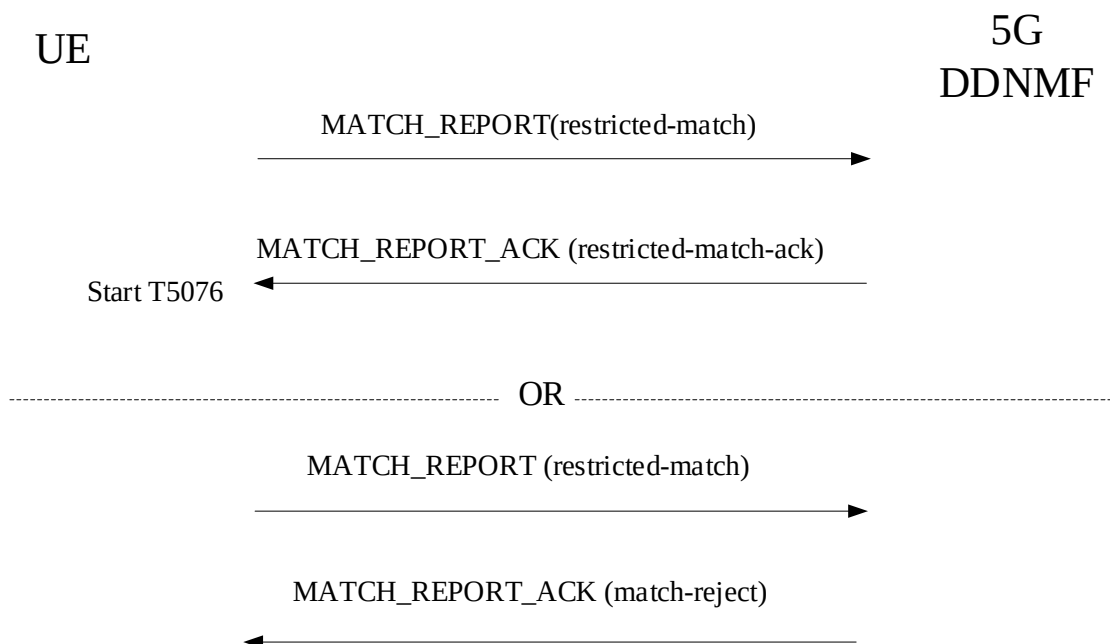


Figure 6.2.9.2.1: Match report procedure for restricted discovery model A

6.2.9.3 Match report procedure accepted by the 5G DDNMF

Upon receiving a MATCH_REPORT message, the 5G DDNMF shall check whether there is an existing context for the UE identified by its SUPI.

The 5G DDNMF shall analyze the ProSe restricted code received from the UE in the MATCH_REPORT message. If the MIC value and its corresponding UTC-based counter are included, the 5G DDNMF shall check whether the MIC value and the UTC-based counter are valid and within the acceptable range respectively as defined in 3GPP TS 33.503 [34]. The 5G DDNMF shall then check in the UE context if the ProSe restricted code matches any restricted discovery filter(s) allocated for the particular application identified by the ProSe identifier received in the MATCH_REPORT message. If such a discovery filter exists, the target RPAUID associated with the filter(s) shall be

identified as the corresponding RPAUID for this code. Optionally, the 5G DDNMF may further invoke the procedure defined in 3GPP TS 29.503 [10] to verify if the target RPAUID is allowed to be discovered by the RPAUID of the requesting UE that has sent the MATCH_REPORT message, or to retrieve metadata associated for the target RPAUID if metadata flag is set to "True" in the MATCH_REPORT message and the 5G DDNMF does not have the latest metadata.

If the outcome of the above processing is successful, the 5G DDNMF shall send a MATCH_REPORT_ACK message containing a <restricted-match-ack> element with:

- a) the transaction ID set to the value of the transaction ID received in the MATCH_REPORT message from the UE;
- b) the RPAUID set to the target RPAUID retrieved from the UE context at the 5G DDNMF which corresponds to the ProSe restricted code contained in the MATCH_REPORT message;
- c) the validity timer T5076 set to indicate for how long this ProSe restricted code is valid;
- d) the match report refresh timer T5077 to indicate for how long the UE will wait before sending a new match report for this ProSe restricted code if the MIC value and the UTC-based counter are included in the MATCH_REPORT message;
- e) the current time set to the current UTC-based time at the 5G DDNMF; and
- f) the metadata set to the associated metadata information, if there exists metadata information associated with this target RPAUID and the metadata flag is set to "True" in the MATCH_REPORT message.

If the corresponding PDUID of the target RPAUID does not belong to the HPLMN of the requesting UE, the 5G DDNMF may optionally invoke the procedure defined in 3GPP TS 29.555 [9] to inform the 5G DDNMF of the announcing UE about the match event.

The 5G DDNMF uses the information (e.g. application identity) received from the UE in the MATCH_REPORT message, UE identity in GBA or AKMA information related to TLS tunnel transporting the MATCH_REPORT message, and other information for charging purposes as specified in 3GPP TS 32.277 [45].

6.2.9.4 Match report procedure completion by the UE

Upon receipt of the MATCH_REPORT_ACK message, if the transaction ID contained in the <restricted-match-ack> element matches the value sent by the UE in a MATCH_REPORT message, the UE shall store the mapping between the ProSe restricted code and RPAUID locally, start timers T5076 and T5077 and may inform the upper layers of this match of the RPAUID. Otherwise, the UE shall discard the MATCH_REPORT_ACK message. The UE shall update the ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter.

Upon receipt of the MATCH_REPORT_ACK message, if the transaction ID contained in the <match-reject> element matches the value sent by the UE in a MATCH_REPORT message and if the received PC3a control protocol cause value is #5 "Invalid MIC", as specified in clause 6.2.9.5, the UE shall stop timer T5076 if it is running.

NOTE 1: It is an implementation specific choice whether the UE informs the upper layers every time an RPAUID triggers a match event, or only the first time this match occurs.

NOTE 2: The UE can also inform the upper layers if an RPAUID is no longer matched, because the validity timer T5076 of the corresponding ProSe restricted code expires.

NOTE 3: The UE can also inform the upper layers if a ProSe restricted code is no longer matched, because the validity timer T5076 of the corresponding ProSe restricted code is stopped upon receiving MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #5 "Invalid MIC".

6.2.9.5 Match report procedure not accepted by the 5G DDNMF

If the MATCH_REPORT message is not accepted by the 5G DDNMF, the 5G DDNMF sends a MATCH_REPORT_ACK message with a <match-reject> element to the UE including an appropriate PC3a control protocol cause value.

If there is no associated UE context for the SUPI of the UE, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #16 "Invalid match event".

If the ProSe restricted code contained in the MATCH_REPORT message does not match any Restricted discovery filter(s) allocated for the requesting UE for the corresponding application, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #16 "Invalid match event".

If the check of the MIC contained in the MATCH_REPORT message fails, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #5 "Invalid MIC".

If the check of the UTC-based counter contained in the MATCH_REPORT message fails, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #6 "Invalid UTC-based counter".

If the UE is not authorized for restricted 5G ProSe direct discovery monitoring, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

6.2.9.6 Abnormal cases

6.2.9.6.1 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of MATCH_REPORT message (e.g., after TCP retransmission timeout)

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the match report procedure.

- b) No response from the 5G DDNMF after the MATCH_REPORT message has been successfully delivered (e.g., TCP ACK has been received for the MATCH_REPORT message)

If the TTL timer T5066 associated with the restricted discovery filter which resulted in a match event has not expired, the UE shall retransmit the MATCH_REPORT message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

6.2.10 Match report procedure for restricted 5G ProSe direct discovery model B

6.2.10.1 General

The purpose of the Match report procedure is to allow a UE to send a ProSe response code that was matched during the restricted 5G ProSe direct discovery Model B discoverer operation and receive the corresponding RPAUID, if there is no such a mapping stored locally.

The UE shall only initiate the match report procedure if it has been authorized for restricted 5G ProSe direct discovery model B discoverer operation in the monitored PLMN or its subscribed SNPN based on the service authorization procedure.

As a result of the match report procedure completing successfully, the UE obtains a RPAUID and potentially other information, which the UE may store locally and pass to the upper layers.

6.2.10.2 Match report procedure initiation

The UE shall meet the following pre-conditions before initiating this procedure:

- a) a request from upper layers to discover the target RPAUID with restricted discovery model B, which resulted in the matched ProSe response code, is still in place;
- b) the lower layers have provided UTC time information, along with the discovery message containing the ProSe response code; and
- c) the validity timer T5070 associated with the discovery response filter, whose use resulted in a match event of the ProSe response code, has not expired.

If the UE is authorized to perform restricted 5G ProSe direct discovery model B discoverer operation in the monitored PLMN or its subscribed SNPN, it should initiate a match report procedure:

- a) when there is a match event when applying one of the discovery response filter(s) to one of the ProSe response codes received from the lower layers and the UE does not have a corresponding RPAUID already locally stored;
- b) when the UE has a locally stored mapping for the ProSe response code that resulted in a match event, but the validity timer T5076 of the ProSe response code has expired;
- c) when the UE has a locally stored mapping for the ProSe response code that resulted in a match event, but the match report refresh timer T5077 of the ProSe response code has expired;
- d) when the UE desires to obtain the metadata associated with the discovered ProSe response code; or
- e) when the UE has a locally stored mapping for the ProSe response code that resulted in a match event, but the UE does not have a running match report refresh timer T5077 for this ProSe response code and the UE is directed by the 5G DDNMF to perform the required MIC check via the match report procedure.

NOTE 1: The 5G DDNMF directs the UE to use the match report procedure to perform the MIC check by including the MIC Check Indicator parameter in the DISCOVERY_RESPONSE message.

The UE initiates the match report procedure by sending a MATCH_REPORT message with a new transaction ID and shall set the message contents as follows:

- a) the RPAUID set to the UE's RPAUID which has requested the corresponding restricted discovery model B discoverer operation that resulted this match event;
- b) the discovery type set to "Restricted discovery";
- c) the application identity set to the ProSe identifier of the upper layer application that triggered the restricted direct discovery Model B discoverer operation as described in clause 5.2.3;
- d) if it is not required to check the MIC via the match report procedure, the ProSe restricted code set to the ProSe restricted code for which there was a match event;
- e) if it is required to check the MIC via the match report procedure, the entire PROSE PC5 DISCOVERY message that contained the ProSe restricted code for which there was a match event;
- f) if it is required to check the MIC via the match report procedure, the UTC-based counter set as follows:
 - 1) the UE shall generate two UTC-based counters with:
 - i) the first counter composed of:
 - A) the 27 most significant bits of the UTC-based counter set to the 27 most significant bits of the UTC time provided by the lower layers for the PROSE PC5 DISCOVERY message that contained the ProSe response code for which there was a match event encoded as specified in clause 11.2.5;
 - B) the 28th most significant bit of the UTC-based counter set to '0'; and
 - C) the 4 least significant bits of the UTC-based counter shall be set to the 4 least significant bits of the UTC-based counter contained in the PROSE PC5 DISCOVERY message that contained the ProSe response code for which there was a match event, as specified in 3GPP TS 33.503 [34]; and
 - ii) the second counter composed of:

- A) the 27 most significant bits of the UTC-based counter set to the 27 most significant bits of the UTC time provided by the lower layers for the PROSE PC5 DISCOVERY message that contained the ProSe response code for which there was a match event encoded as specified in clause 11.2.5;
 - B) the 28th most significant bit of the UTC-based counter set to '1'; and
 - C) the 4 least significant bits of the UTC-based counter set to the 4 least significant bits of the UTC-based counter contained in the PROSE PC5 DISCOVERY message that contained the ProSe response code for which there was a match event, as specified in 3GPP TS 33.503 [34]; and
- 2) then the UE shall select, among the two counters described above, the counter that is nearest to the UTC time provided by the lower layers for the PROSE PC5 DISCOVERY message that contained the ProSe response code for which there was a match event encoded as specified in clause 11.2.5 and set the UTC-based counter in the MATCH_REPORT message to that counter; and
- g) the metadata flag set to indicate whether or not the UE wishes to receive the latest metadata information associated with the RPAUID in the MATCH_REPORT_ACK message from the 5G DDNMF.

NOTE 2: A UE can include one or multiple transactions in one MATCH_REPORT message for different ProSe response codes and receive corresponding <restricted-match-ack> element or <match-reject> element in the MATCH_REPORT_ACK message for each respective transaction. In the following description of match report procedure, only one transaction is included.

If it is required to check the MIC via the match report procedure, the 5G DDNMF checks MIC for the received PROSE PC5 DISCOVERY message included in the MATCH_REPORT message as specified in 3GPP TS 33.503 [34].

Figure 6.2.10.2.1 illustrates the interaction between the UE and the 5G DDNMF in the match report procedure.

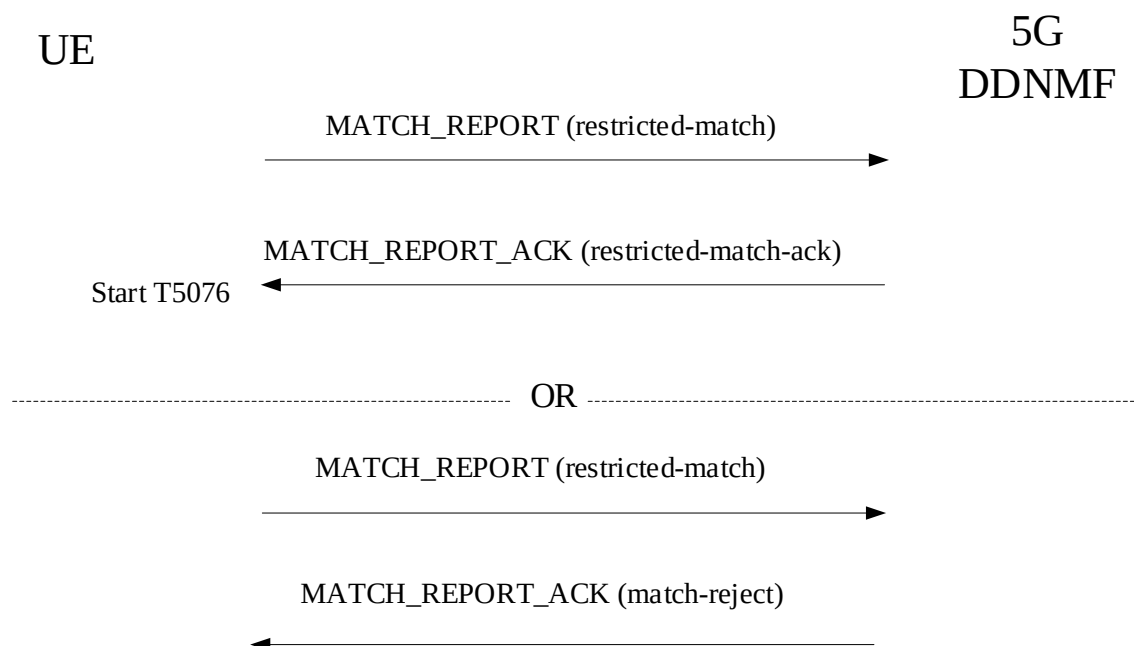


Figure 6.2.10.2.1: Match report procedure for restricted discovery model B

6.2.10.3 Match report procedure accepted by the 5G DDNMF

Upon receiving a MATCH_REPORT message, the 5G DDNMF shall check whether there is an existing discoverer UE context for the UE identified by its SUPI.

The 5G DDNMF shall analyze the ProSe response code received from the UE in the MATCH_REPORT message. If the MIC value and its corresponding UTC-based counter are included, the 5G DDNMF shall check whether the MIC value and the UTC-based counter are valid and within the acceptable range respectively, as defined in 3GPP TS 33.503 [34]. The 5G DDNMF shall then check in the UE context if the ProSe response code matches any discovery response filter(s) allocated for the particular application identified by the ProSe identifier received in the MATCH_REPORT message. If such a discovery filter exists, the target RPAUID associated with the filter(s) shall be identified as the corresponding RPAUID for this code. Optionally, the 5G DDNMF may further invoke the procedure defined in 3GPP TS 29.503 [10] to verify if the target RPAUID is allowed to be discovered by the RPAUID of the requesting UE that has sent the MATCH_REPORT message, or to retrieve metadata associated for the target RPAUID if metadata flag is set to "True" in the MATCH_REPORT message and the 5G DDNMF does not have the latest metadata.

If the outcome of the above processing is successful, the 5G DDNMF shall send a MATCH_REPORT_ACK message containing a <restricted-match-ack> element with:

- a) the transaction ID set to the value of the transaction ID received in the MATCH_REPORT message from the UE;
- b) the RPAUID set to the target RPAUID retrieved from the UE context at the 5G DDNMF which corresponds to the ProSe response code contained in the MATCH_REPORT message;
- c) the validity timer T5076 set to indicate for how long the RPAUID is matched;
- d) the match report refresh timer T5077 set to indicate for how long the UE will wait before sending a new match report for this ProSe response code if the MIC value and the UTC-based counter are included in the MATCH_REPORT message;
- e) the current time set to the current UTC-based time at the 5G DDNMF; and
- f) optionally, the metadata set to the associated metadata information, if there exists metadata information associated with this target RPAUID.

If the corresponding PDUID of the target RPAUID does not belong to the HPLMN of the requesting UE, the 5G DDNMF may optionally invoke the procedure defined in 3GPP TS 29.555 [9] to inform the 5G DDNMF of the discoveree UE about the match event.

The 5G DDNMF uses the information (e.g. application identity) received from the UE in the MATCH_REPORT message, UE identity in GBA or AKMA information related to TLS tunnel transporting the MATCH_REPORT message, and other information for charging purposes as specified in 3GPP TS 32.277 [45].

6.2.10.4 Match report procedure completion by the UE

Upon receipt of the MATCH_REPORT_ACK message, if the transaction ID contained in the <restricted-match-ack> element matches the value sent by the UE in a MATCH_REPORT message, the UE shall store the mapping between the ProSe response code and the RPAUID locally, start timers T5076 and T5077 and may inform the upper layers of this match of the RPAUID. Otherwise, the UE shall discard the MATCH_REPORT_ACK message. The UE shall update the ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter.

Upon receipt of the MATCH_REPORT_ACK message, if the transaction ID contained in the <match-reject> element matches the value sent by the UE in a MATCH_REPORT message and if the received PC3a control protocol cause value is #5 "Invalid MIC", as specified in clause 6.2.10.5, the UE shall stop timer T5076 if it is running.

NOTE 1: It is an implementation specific choice whether the UE informs the upper layers every time a RPAUID triggers a match event, or only the first time this match occurs.

NOTE 2: The UE can also inform the upper layers if an RPAUID is no longer matched, because the validity timer T5076 of the corresponding ProSe response code expires.

NOTE 3: The UE can also inform the upper layers if a ProSe response code is no longer matched, because the validity timer T5076 of the corresponding ProSe response code is stopped upon receiving MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #5 "Invalid MIC".

6.2.10.5 Match report procedure not accepted by the 5G DDNMF

If the MATCH_REPORT message is not accepted by the 5G DDNMF, the 5G DDNMF sends a MATCH_REPORT_ACK message with a <match-reject> element to the UE including an appropriate PC3a control protocol cause value.

If there is no associated UE context for the SUPI of the UE, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #16 "Invalid match event".

If the ProSe response code contained in the MATCH_REPORT message does not match any Discovery Response Filter(s) allocated for the requesting UE for the corresponding application, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #16 "Invalid match event".

If the check of the MIC contained in the MATCH_REPORT message fails, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #5 "Invalid MIC".

If the check of the UTC-based counter contained in the MATCH_REPORT message fails, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #6 "Invalid UTC-based counter".

If the UE is not authorized for restricted 5G ProSe direct discovery model B discoverer operation, the 5G DDNMF shall send the MATCH_REPORT_ACK message with a <match-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

6.2.10.6 Abnormal cases

6.2.10.6.1 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of MATCH_REPORT message (e.g., after TCP retransmission timeout)

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the match report procedure.

- b) No response from the 5G DDNMF after the MATCH_REPORT message has been successfully delivered (e.g., TCP ACK has been received for the MATCH_REPORT message)

If the validity timer T5070 associated with the Discovery Response Filter which resulted in a match event has not expired, the UE shall retransmit the MATCH_REPORT message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

6.2.11 Direct discovery update procedure for open discovery

6.2.11.1 General

The direct discovery update procedure is used to update or revoke a previously allocated ProSe application code, or discovery filter(s) as specified in 3GPP TS 23.304 [2].

6.2.11.2 Direct discovery update procedure initiation

When triggered to revoke a previously allocated ProSe application code for an announcing UE or revoke discovery filter(s) for a monitoring UE, the 5G DDNMF in the HPLMN or the subscribed SNPN sends a DISCOVERY_UPDATE_REQUEST message to the UE with:

- a) a new DDNMF transaction ID not used in any other direct discovery procedures in PC3a interface; and

- b) the discovery entry ID set to the discovery entry ID of the corresponding discovery entry that contains the ProSe application code or the discovery filter(s) to be revoked.

When triggered to update a previously allocated ProSe application code for an announcing UE, the 5G DDNMF in the HPLMN or the subscribed SNPN shall allocate a new ProSe application code for the ProSe application ID with a new validity timer T5060, associate the discovery entry with the new ProSe application code and restart timer T5061. Then the 5G DDNMF sends a DISCOVERY_UPDATE_REQUEST message to the UE with:

- a) a new DDNMF transaction ID not used in any other direct discovery procedures in PC3a interface;
- b) the discovery entry ID set to the discovery entry ID of the corresponding discovery entry that contains the ProSe application code to be updated; and
- c) the Update info containing the ProSe application code set to the new ProSe application code allocated by the 5G DDNMF and a validity timer T5060 set to the T5060 timer value assigned by the 5G DDNMF to the new ProSe application code.

When triggered to update discovery filter(s) for a monitoring UE, the 5G DDNMF in the HPLMN or the subscribed SNPN updates the content of discovery filter(s), associate the discovery entry with the updated discovery filter(s) and restart timer T5063 for each filter. The update of discovery filter content includes setting new TTL timer(s) and if necessary, assigning new ProSe application code and ProSe application mask(s). Then the 5G DDNMF shall send a DISCOVERY_UPDATE_REQUEST message to the UE with:

- a) a new DDNMF transaction ID not used in any other direct discovery procedures in PC3a interface;
- b) the discovery entry ID set to the discovery entry ID of the corresponding discovery entry that contains the discovery filter(s) to be updated; and
- c) the Update info containing the discovery filter(s) set to the new discovery filter(s) allocated by the 5G DDNMF.

NOTE 1: The 5G DDNMF can include one or multiple transactions in one DISCOVERY_UPDATE_REQUEST message for ProSe App Codes or discovery filter(s) contained in different discovery entries and receive corresponding <discovery-update-response> element or <response-reject> element in a DISCOVERY_UPDATE_RESPONSE message for each respective transaction. In the following description of direct discovery update request procedure, only one transaction is included.

Figure 6.2.11.2.1 illustrates the interaction of the UE and the 5G DDNMF in the direct discovery update procedure.

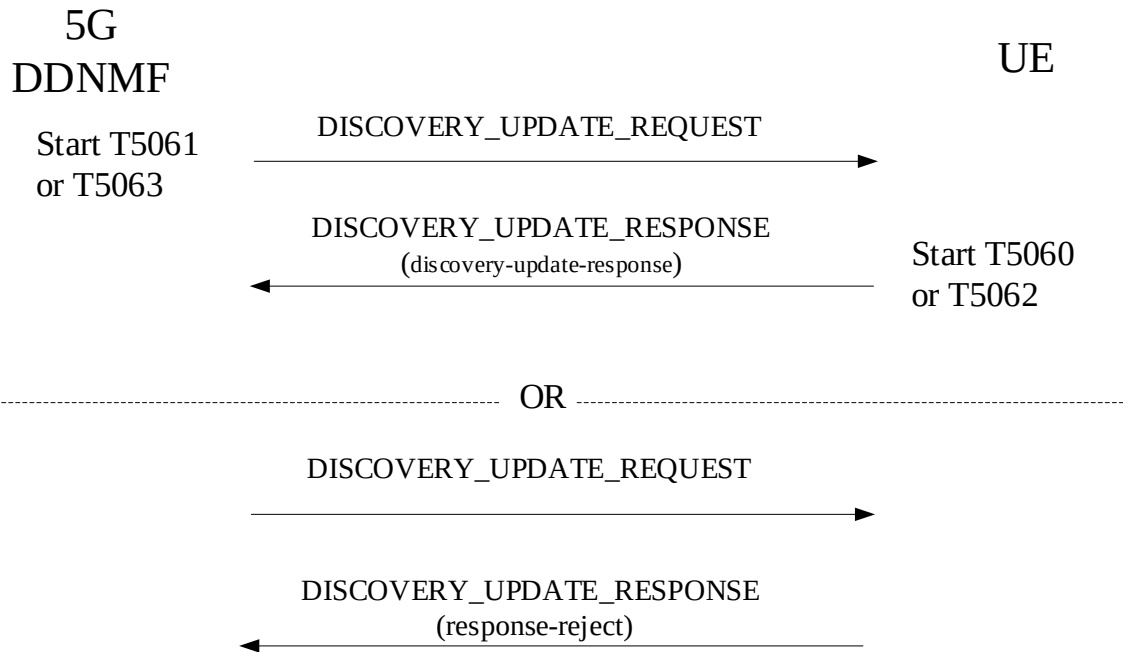


Figure 6.2.11.2.1: Direct discovery update procedure for open discovery

NOTE 2: In the figure 6.2.11.2.1, the timers are started only when the procedure is triggered to update a previously allocated ProSe application code for an announcing UE or update discovery filter(s) for a monitoring UE.

6.2.11.3 Direct discovery update procedure accepted by the UE

Upon receiving a **DISCOVERY_UPDATE_REQUEST** message, the UE shall check if the discovery entry ID contained in the **DISCOVERY_UPDATE_REQUEST** message is known. If the discovery entry ID is known, the UE shall proceed with the following direct discovery update procedure.

If the Update info is not included in the **DISCOVERY_UPDATE_REQUEST** message, the UE shall stop running timers corresponding to the discovery entry and delete the discovery entry corresponding to the discovery entry ID contained in the **DISCOVERY_UPDATE_REQUEST** message. The UE informs the lower layers to stop announcing or monitoring corresponding to the discovery entry ID contained in the **DISCOVERY_UPDATE_REQUEST** message.

If the Update info is included in the **DISCOVERY_UPDATE_REQUEST** message, the UE shall replace the existing ProSe application code or the discovery filter(s) with new ProSe application code or the discovery filter(s) contained in the Update info correspondingly. The announcing UE shall stop the timer T5060, start the validity timer T5060 with the received value for the new ProSe application code and perform open 5G ProSe direct discovery announcing with the new ProSe application code as described in clause 6.2.2.4. The monitoring UE shall stop TTL timer T5062, start TTL timer T5062 with the received value for each new discovery filter(s) and perform open 5G ProSe direct discovery monitoring with each new discovery filter(s) as described in clause 6.2.5.4.

Then the UE shall send a **DISCOVERY_UPDATE_RESPONSE** message containing a <response-update> element with:

- the DDNMF transaction ID set to the value of the DDNMF transaction ID received in the **DISCOVERY_UPDATE_REQUEST** message; and
- the discovery entry ID set to the value of the discovery entry ID received in the **DISCOVERY_UPDATE_REQUEST** message.

6.2.11.4 Direct discovery update procedure completed by the 5G DDNMF

Upon receiving a DISCOVERY_UPDATE_RESPONSE message, if the DDNMF transaction ID contained in the <response-update> element does not match the value sent by the 5G DDNMF in a DISCOVERY_UPDATE_REQUEST message, the 5G DDNMF shall discard the DISCOVERY_UPDATE_RESPONSE message. Otherwise, the 5G DDNMF shall perform the following procedure.

When the UE is an announcing UE and the radio resources that the UE intends to use are operated by a PLMN other than the HPLMN, the 5G DDNMF shall execute the procedures defined in 3GPP TS 29.555 [9] to inform the 5G DDNMF in VPLMN or local PLMN.

When the UE is a monitoring UE and the ProSe application ID monitored by the UE is PLMN-specific and that PLMN ID indicated by the ProSe application ID is not the same as that of the PLMN or the subscribed SNPN to which the 5G DDNMF belongs, the 5G DDNMF executes the procedures defined in 3GPP TS 29.555 [9] to inform the 5G DDNMF in the PLMN or the subscribed SNPN indicated by the ProSe application ID.

For each discovery entry ID received in the DISCOVERY_UPDATE_RESPONSE message, if the procedure is to revoke a previously allocated ProSe application code or discovery filter(s), the 5G DDNMF shall delete the discovery entry indicated by the discovery entry ID from the UE's context and release the associated resources.

6.2.11.5 Direct discovery update procedure not accepted by the UE

If the DISCOVERY_UPDATE_REQUEST message cannot be accepted by the UE, the UE sends a DISCOVERY_UPDATE_RESPONSE message containing a <response-reject> element to the 5G DDNMF including an appropriate PC3a control protocol cause value.

If the discovery entry ID contained in the DISCOVERY_UPDATE_REQUEST message is unknown, the UE shall send the DISCOVERY_UPDATE_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value # 10 "Unknown or invalid discovery entry ID".

6.2.11.6 Abnormal cases

6.2.11.6.1 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of DISCOVERY_UPDATE_REQUEST message (e.g., after TCP retransmission timeout)

The 5G DDNMF shall close the existing secure connection to the UE.

- b) No response from the UE after the DISCOVERY_UPDATE_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the DISCOVERY_UPDATE_REQUEST message)

The 5G DDNMF shall retransmit the DISCOVERY_UPDATE_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are 5G DDNMF implementation specific.

6.2.11.6.2 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of DISCOVERY_UPDATE_RESPONSE message.

After receiving an indication from lower layer that the DISCOVERY_UPDATE_RESPONSE message has not been successfully acknowledged (e.g., TCP ACK is not received), the UE shall abort the procedure.

6.2.12 Direct discovery update procedure for restricted discovery

6.2.12.1 General

The discovery update procedure is used to update the discovery filters and/or allocate a new ProSe restricted code as defined in 3GPP TS 23.304 [2]. The 5G DDNMF can at any time update/revoke a previously allocated ProSe restricted code, or discovery filters.

6.2.12.2 Revocation of restricted discovery filters

6.2.12.2.1 Restricted discovery filters revocation procedure initiation

The 5G DDNMF in the HPLMN or the subscribed SNPN shall initiate the restricted discovery filters revocation procedure by sending the DISCOVERY_UPDATE_REQUEST to the UE with:

- a) a new DDNMF transaction ID not used in any other direct discovery procedures in PC3a interface;
- b) the discovery entry ID set to the discovery entry ID of the corresponding discovery entry that contains the restricted discovery filter to be revoked; and
- c) optionally update info containing the restricted discovery filters that replace the existing ones, if the 5G DDNMF decides to remove only certain filter(s) and not others.

NOTE: The 5G DDNMF can include one or multiple transactions in one DISCOVERY_UPDATE_REQUEST message for different Restricted discovery filters and receive corresponding <response-update> element or <response-reject> element in a DISCOVERY_UPDATE_RESPONSE message for each respective transaction. In the following description of the network initiated direct discovery update request procedure, only one transaction is included.

Figure 6.2.12.2.1 illustrates the interaction of the UE and the 5G DDNMF in the restricted discovery filters revocation procedure.

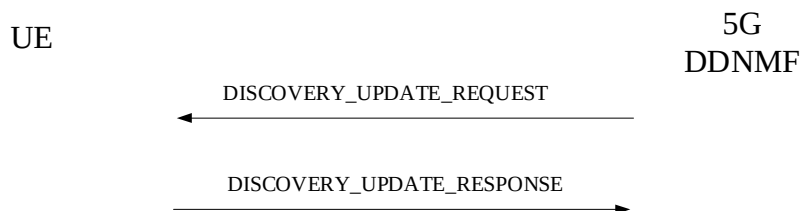


Figure 6.2.12.2.1.1: Restricted discovery filters revocation procedure

6.2.12.2.2 Restricted discovery filters revocation procedure accepted by the UE

Upon receiving a DISCOVERY_UPDATE_REQUEST message, the UE shall check if the discovery entry ID contained in the DISCOVERY_UPDATE_REQUEST message is valid. If the discovery entry ID is valid, the UE shall proceed with the following direct discovery update procedure.

The UE shall remove all the restricted discovery filters corresponding to the discovery entry ID if the Update info is not included in the DISCOVERY_UPDATE_REQUEST message or shall remove the old restricted discovery filters and store the restricted discovery filter included in the Update info in the DISCOVERY_UPDATE_REQUEST message. Then the UE shall send a DISCOVERY_UPDATE_RESPONSE message to the 5G DDNMF with the <response-update> element which contains:

- a) the DDNMF transaction ID set to the value of the DDNMF transaction ID received in the DISCOVERY_UPDATE_REQUEST message; and
- b) discovery entry ID set to the value of the discovery entry ID received in the DISCOVERY_UPDATE_REQUEST message.

6.2.12.2.3 Restricted discovery filters revocation procedure completion by the 5G DDNMF

Upon receipt of the DISCOVERY_UPDATE_RESPONSE message by the 5G DDNMF, if the DDNMF transaction ID contained in the <response-update> element does not match the value sent by the 5G DDNMF in a DISCOVERY_UPDATE_REQUEST message, the 5G DDNMF shall discard the DISCOVERY_UPDATE_RESPONSE message. Upon receipt of the DISCOVERY_UPDATE_RESPONSE message by the 5G DDNMF, if the DDNMF transaction ID contained in the <response-update> element matches the value sent by the 5G DDNMF in a DISCOVERY_UPDATE_REQUEST message, the restricted discovery filters revocation procedure is complete.

6.2.12.2.4 Restricted discovery filters revocation procedure not accepted by the UE

If the DISCOVERY_UPDATE_REQUEST message cannot be accepted by the UE, the UE sends a DISCOVERY_UPDATE_RESPONSE message containing a <response-reject> element to the 5G DDNMF including an appropriate PC3a control protocol cause value.

If the discovery entry ID contained in the DISCOVERY_UPDATE_REQUEST message is not found in the UE context, the UE shall send a DISCOVERY_UPDATE_RESPONSE message containing a <response-reject> element with PC3 control protocol cause value #10 "Unknown or Invalid discovery entry ID".

6.2.12.2.5 Abnormal cases

6.2.12.2.5.1 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of DISCOVERY_UPDATE_REQUEST message (e.g., after TCP retransmission timeout)

The 5G DDNMF shall close the existing secure connection to the UE.

- b) No response from the UE after the DISCOVERY_UPDATE_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the DISCOVERY_UPDATE_REQUEST message)

The 5G DDNMF shall retransmit the DISCOVERY_UPDATE_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are 5G DDNMF implementation specific.

6.2.12.2.5.2 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of DISCOVERY_UPDATE_RESPONSE message.

After receiving an indication from lower layer that the DISCOVERY_UPDATE_RESPONSE message has not been successfully acknowledged (e.g., TCP ACK is not received), the UE shall abort the procedure.

6.2.12.3 Allocation of new ProSe restricted code

6.2.12.3.1 New ProSe restricted code allocation procedure initiation

The 5G DDNMF in the HPLMN or the subscribed SNPN shall initiate the ProSe restricted code allocation procedure by sending the DISCOVERY_UPDATE_REQUEST to the UE with:

- a) a new DDNMF transaction ID not used in any other direct discovery procedures in PC3a interface;
- b) the discovery entry ID set to the discovery entry ID of the corresponding discovery entry that contains the ProSe restricted code to be replaced; and
- c) update info containing the ProSe restricted code set to the ProSe restricted code to be replaced and a validity timer T5062 set to the T5062 timer value assigned by the 5G DDNMF to the ProSe restricted code.

Figure 6.2.12.3.1.1 illustrates the interaction of the UE and the 5G DDNMF in the ProSe restricted code allocation procedure.

NOTE: The 5G DDNMF can include one or multiple transactions in one DISCOVERY_UPDATE_REQUEST message for different ProSe restricted codes and receive corresponding <response-update> element or <response-reject> element in a DISCOVERY_UPDATE_RESPONSE message for each respective transaction. In the following description of the network initiated direct discovery update request procedure, only one transaction is included.

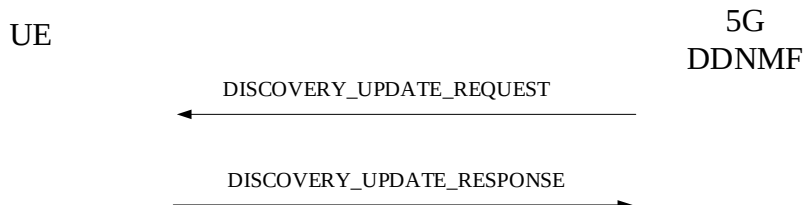


Figure 6.2.12.3.1.1: New ProSe restricted code allocation procedure

6.2.12.3.2 ProSe restricted code allocation procedure accepted by the UE

Upon receiving a DISCOVERY_UPDATE_REQUEST message, the UE shall check if the discovery entry ID contained in the DISCOVERY_UPDATE_REQUEST message is valid. If the discovery entry ID is valid, the UE shall proceed with the following direct discovery update procedure.

The UE shall replace the ProSe restricted code corresponding to the discovery entry ID included in the DISCOVERY_UPDATE_REQUEST message. The UE shall stop the validity timer T5062 if running and start the validity timer T5062 with the received value. Then the UE shall send a DISCOVERY_UPDATE_RESPONSE message to the 5G DDNMF with the <response-update> element which contains:

- a) the DDNMF transaction ID set to the value of the DDNMF transaction ID received in the DISCOVERY_UPDATE_REQUEST message; and
- b) discovery entry ID set to the value of the discovery entry ID received in the DISCOVERY_UPDATE_REQUEST message.

6.2.12.3.3 ProSe restricted code allocation procedure completion by the 5G DDNMF

Upon receipt of the DISCOVERY_UPDATE_RESPONSE message by the 5G DDNMF, if the DDNMF transaction ID contained in the <response-update> element does not match the value sent by the 5G DDNMF in a DISCOVERY_UPDATE_REQUEST message, the 5G DDNMF shall discard the DISCOVERY_UPDATE_RESPONSE message. Upon receipt of the DISCOVERY_UPDATE_RESPONSE message by the 5G DDNMF, if the DDNMF transaction ID contained in the <response-update> element matches the value sent by the 5G DDNMF in a DISCOVERY_UPDATE_REQUEST message, the ProSe restricted code allocation procedure is complete.

6.2.12.3.4 ProSe restricted code allocation procedure not accepted by the UE

If the DISCOVERY_UPDATE_REQUEST message cannot be accepted by the UE, the UE sends a DISCOVERY_UPDATE_RESPONSE message containing a <response-reject> element to the 5G DDNMF including an appropriate PC3a control protocol cause value.

If the discovery entry ID contained in the DISCOVERY_UPDATE_REQUEST message is not found in the UE context, the UE shall send a DISCOVERY_UPDATE_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #10 "Unknown or invalid discovery entry ID".

6.2.12.3.5 Abnormal cases

6.2.12.3.5.1 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of DISCOVERY_UPDATE_REQUEST message (e.g., after TCP retransmission timeout)

The 5G DDNMF shall close the existing secure connection to the UE.

- b) No response from the UE after the DISCOVERY_UPDATE_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the DISCOVERY_UPDATE_REQUEST message)

The 5G DDNMF shall retransmit the DISCOVERY_UPDATE_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are 5G DDNMF implementation specific.

6.2.12.3.5.2 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of DISCOVERY_UPDATE_RESPONSE message.

After receiving an indication from lower layer that the DISCOVERY_UPDATE_RESPONSE message has not been successfully acknowledged (e.g., TCP ACK is not received), the UE shall abort the procedure.

6.2.13 Announcing alert procedure

6.2.13.1 General

The purpose of the announcing alert procedure is for the 5G DDNMF in HPLMN or subscribed SNPN to send to the announcing UE the ProSe restricted code generated in the announce request procedure for restricted 5G ProSe direct discovery model A as specified in clause 6.2.3.

Before initiating the announcing alert procedure, the 5G DDNMF shall determine whether the announcing UE and the monitoring UE are close enough to trigger the announcing alert procedure.

The announcing UE includes the ProSe restricted code in a PROSE PC5 DISCOVERY message and passes the PROSE PC5 DISCOVERY message to the lower layers for transmission over the PC5 interface in the registered PLMN or local PLMN or subscribed SNPN as a result of a successful announcing alert procedure.

6.2.13.2 Announcing alert procedure initiation

If the UE has initiated an announce request procedure for restricted 5G ProSe direct discovery model A before as specified in clause 6.2.3 and the on demand announcing enabled indicator associated with the RPAUID in the announcing UE context is set to 1, the 5G DDNMF shall initiate an announcing alert procedure:

- a) when the 5G DDNMF receives a pair of target PDUID - target RPAUID from the ProSe application server as described in 3GPP TS 29.557 [19] or as described in 3GPP TS 29.343 [57], the target RPAUID is the same as the RPAUID stored in the announcing UE context and 5G DDNMF determines the monitoring UE is in the vicinity of the announcing UE; or
- b) when the 5G DDNMF receives a pair of target PDUID - target RPAUID from other 5G DDNMF as described in 3GPP TS 29.555 [9], the target RPAUID is the same as the RPAUID stored in the announcing UE context and the 5G DDNMF determines the monitoring UE is in the vicinity of the announcing UE.

NOTE: How the 5G DDNMF in the HPLMN or subscribed SNPN determines whether the announcing UE and the monitoring UE are close enough to trigger the announcing alert procedure is left to the implementation of 5G DDNMF.

The 5G DDNMF shall initiate the announcing alert procedure by sending an ANNOUNCING_ALERT_REQUEST message with:

- a) a new DDNMF transaction ID;
- b) the RPAUID set to the Target RPAUID received from ProSe application server as specified in 3GPP TS 29.557 [19] or as described in 3GPP TS 29.343 [57], or from other 5G DDNMF as specified in 3GPP TS 29.555 [9];
- c) the ProSe restricted code set to the ProSe restricted code or the ProSe restricted code prefix. If restricted Direct Discovery with application-controlled extension was requested by the announcing UE, the ANNOUNCING_ALERT_REQUEST message also contains one or more ProSe restricted code suffix Ranges which contain the suffix(es) for the RPAUID retrieved from the announcing UE context; and
- d) the discovery entry ID set to the identifier associated with the corresponding discovery entry in the UE's context.

Figure 6.2.13.2.1 illustrates the interaction of the 5G DDNMF and the UE in the Announce Alert procedure.

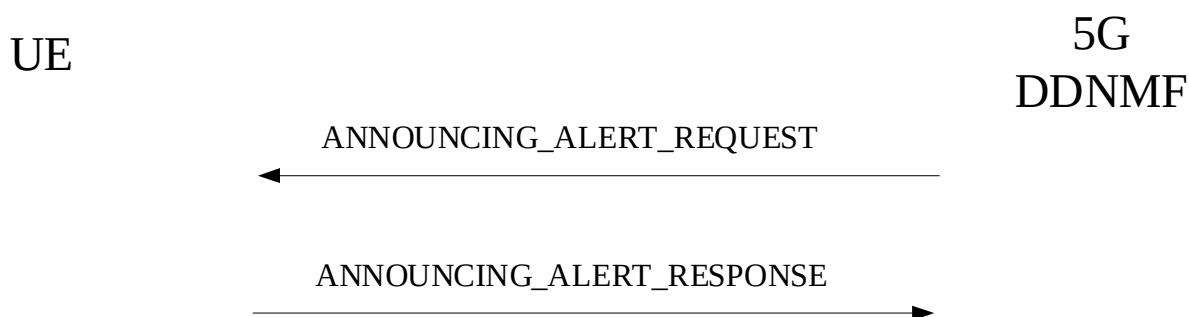


Figure 6.2.13.2.1: Announcing alert procedure

6.2.13.3 Announcing alert procedure accepted by the UE

Upon receipt of the ANNOUNCING_ALERT_REQUEST message, the UE shall check whether there is an existing discovery entry identified by the discovery entry ID included in the ANNOUNCING_ALERT_REQUEST message. If the discovery entry exists in the UE, the UE shall send an ANNOUNCING_ALERT_RESPONSE message to the 5G DDNMF with a DDNMF transaction ID set to the value of the DDNMF transaction ID received in the ANNOUNCING_ALERT_REQUEST message.

Then, the UE may perform restricted 5G ProSe direct discovery model A announcing as described below.

The UE requests the parameters from the lower layers for restricted 5G ProSe direct discovery model A announcing (see 3GPP TS 38.331 [13]). The UE shall perform restricted 5G ProSe direct discovery model A announcing only if the lower layers indicate that ProSe direct discovery is supported by the network. If the UE in 5GMM-IDLE mode has to request resources for ProSe direct discovery announcing as specified in 3GPP TS 38.331 [13], the UE shall perform a service request procedure or registration procedure as specified in 3GPP TS 24.501 [11]. The UE shall obtain the UTC time for the next discovery transmission opportunity for ProSe direct discovery from the lower layers.

If a valid UTC time is obtained, the UE shall generate the UTC-based counter corresponding to this UTC time as specified in clause 11.2.5. If the resulting UTC-based counter is within Max Offset of the time shown by the clock used for ProSe by the UE, the UE shall use the UTC-based counter and the DUIK contained in the <restricted-announce-response> element of the DISCOVERY_RESPONSE message to compute the MIC field for the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34].

The UE shall either use the ProSe restricted code received in the ANNOUNCING_ALERT_REQUEST message, or select one ProSe restricted code based on the ProSe restricted code prefix and ProSe restricted code suffix Range(s) received in the ANNOUNCING_ALERT_REQUEST message as announced ProSe restricted code, along with the MIC and the eight least significant bits of the UTC-based counter, in order to construct a PROSE PC5 DISCOVERY message, according to the format defined in clause 10.2.5.

NOTE: The UE can use different codes formed based on different ProSe restricted code suffixes to announce, without having to send a new DISCOVERY_REQUEST message to the 5G DDNMF, as long as the validity timer T5062 of the ProSe restricted code prefix has not expired.

The UE then passes the PROSE PC5 DISCOVERY message to the lower layers for transmission if:

- a) the UE is currently authorized to perform restricted 5G ProSe direct discovery model A announcing in the registered PLMN or the local PLMN or subscribed SNPN operating the radio resources that the UE intends to use;
- b) the validity timer T5062 for the corresponding discovery entry allocated ProSe restricted code or ProSe restricted code prefix has not expired; and
- c) a request from upper layers to announce the RPAUID associated with both the ProSe restricted code or ProSe restricted code prefix and the authorized ProSe identifier, is still in place.

The UE shall ensure that it keeps on passing PROSE PC5 DISCOVERY messages to the lower layers for transmission until the validity timer T5062 of the ProSe restricted code or ProSe restricted code prefix expires. How this is achieved is left up to UE implementation.

During the announcing operation, if one of the above conditions is no longer met, the UE may instruct the lower layers to stop announcing. When the UE stops announcing, if the lower layers indicate that the UE is required to send a discovery indication to the NG-RAN and the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

6.2.13.4 Announcing alert procedure completion by the 5G DDNMF

Upon receipt of the ANNOUNCING_ALERT_RESPONSE message with a DDNMF transaction ID set to the value of the DDNMF transaction ID included in the ANNOUNCING_ALERT_REQUEST message, the 5G DDNMF will set the associated on demand announcing enabled indicator to 0. Then the announcing alert procedure is successfully completed.

6.2.13.5 Announcing alert procedure not accepted by the UE

If the ANNOUNCING_ALERT_REQUEST message cannot be accepted by the UE, the UE sends an ANNOUNCING_ALERT_RESPONSE message containing a <response-reject> element to the 5G DDNMF including an appropriate PC3a control protocol cause value.

If the discovery entry ID contained in the ANNOUNCING_ALERT_REQUEST message is unknown, the UE shall send the ANNOUNCING_ALERT_RESPONSE message containing a <response-reject> element with PC3a control protocol cause value #10"Unknown or invalid discovery entry ID".

6.2.13.6 Abnormal cases

6.2.13.6.1 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of ANNOUNCING_ALERT_REQUEST message (e.g., after TCP retransmission timeout)

The 5G DDNMF shall close the existing secure connection to the UE.

- b) No response from the UE after the ANNOUNCING_ALERT_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the ANNOUNCING_ALERT_REQUEST message)

The 5G DDNMF shall retransmit the ANNOUNCING_ALERT_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are 5G DDNMF implementation specific.

6.2.13.6.2 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of ANNOUNCING_ALERT_RESPONSE message.

After receiving an indication from lower layer that the ANNOUNCING_ALERT_RESPONSE message has not been successfully acknowledged (e.g., TCP ACK is not received), the UE shall abort the procedure.

6.2.14 5G ProSe direct discovery procedure over PC5 interface

6.2.14.1 General

This clause describes the procedures for 5G ProSe direct discovery procedure over PC5 interface. The purpose of the 5G ProSe direct discovery procedure over PC5 interface is to enable a ProSe-enabled UE to detect and identify another ProSe-enabled UE over PC5 interface.

To perform 5G ProSe direct discovery procedure over PC5 interface, the UE is configured with the related information as described in clause 5.2.3 and the UE interacts with 5G DDNMF as specified in clause 6.2 when it is in coverage to obtain the related parameters (e.g. ProSe application code, ProSe restricted code). If a UE cannot derive any of the necessary configurations (e.g. default destination layer-2 ID for initial discovery signalling) according to the mapping rules for the ProSe identifier of a ProSe service (see 3GPP TS 24.555 [17]), then the UE is not allowed to perform any operation as specified in clause 6.2.14 for the ProSe service.

The following models for 5G ProSe direct discovery procedure over PC5 interface as specified in 3GPP TS 23.304 [2] are supported:

- a) Model A uses a single discovery protocol message (Announcement); and
- b) Model B uses two discovery protocol messages (Solicitation and Response).

NOTE: If the UE is authorized to perform both 5G ProSe direct discovery Model A and 5G ProSe direct discovery Model B, it is up to UE implementation to select which model to perform or perform both models simultaneously.

The UE may use the PC5 DRX mechanism to perform 5G ProSe direct discovery over PC5 interface when the UE is not served by NG-RAN as specified in clause 5.2.3.

The following procedures are defined for 5G ProSe direct discovery procedure over PC5 interface:

- a) 5G ProSe direct discovery procedure over PC5 interface with Model A:
 - 1) Announcing UE procedure for 5G ProSe direct discovery initiation;
 - 2) Announcing UE procedure for 5G ProSe direct discovery completion;
 - 3) Monitoring UE procedure for 5G ProSe direct discovery initiation; and
 - 4) Monitoring UE procedure for 5G ProSe direct discovery completion; and
- b) 5G ProSe direct discovery procedure over PC5 interface with Model B:
 - 1) Discoverer UE procedure for 5G ProSe direct discovery initiation;
 - 2) Discoverer UE procedure for 5G ProSe direct discovery completion;
 - 3) Discoveree UE procedure for 5G ProSe direct discovery initiation; and
 - 4) Discoveree UE procedure for 5G ProSe direct discovery completion.

6.2.14.2 Procedures

6.2.14.2.1 5G ProSe direct discovery procedure over PC5 interface with model A

6.2.14.2.1.1 General

In this procedure, the UE sending the PROSE PC5 DISCOVERY message is called the "announcing UE" and the "monitoring UE" is the UE that triggers the lower layer to start monitoring for PROSE PC5 DISCOVERY message.

6.2.14.2.1.2 Announcing UE procedure for 5G ProSe direct discovery initiation

The UE is authorised to perform the announcing UE procedure for 5G ProSe direct discovery if:

- a) the UE is not served by NG-RAN, is authorised to perform 5G ProSe direct discovery using announcing procedure when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;
- b) the UE is served by NG-RAN and is authorised to perform 5G ProSe direct discovery using announcing in the PLMN or the subscribed SNPN indicated by the serving cell; or
- c) the UE is:
 - 1) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - i) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - ii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - iii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - 2) authorised to perform 5G ProSe direct discovery using announcing when the UE is not served by NG-RAN; and:
 - i) configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN; or
 - ii) the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure.

NOTE 1: When the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure, the serving cell broadcasts a common radio resources pool for ProSe discovery transmission and the UE can use this common radio resources pool while in limited service state.

otherwise, the UE is not authorised to perform the announcing UE procedure for 5G ProSe direct discovery.

Figure 6.2.14.2.1.2.1 illustrates the interaction of the UEs in the announcing UE procedure for 5G ProSe direct discovery.

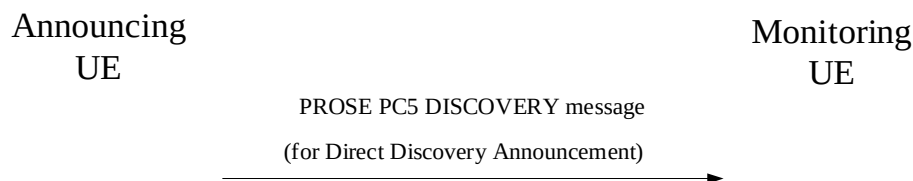


Figure 6.2.14.2.1.2.1: Announcing UE procedure for 5G ProSe direct discovery

When the UE is triggered by an upper layer application to perform announcing UE procedure for 5G ProSe direct discovery announcing procedure, if the UE is authorised to perform the announcing UE procedure for 5G ProSe direct discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11];
 - b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
 - c) shall generate a PROSE PC5 DISCOVERY message for 5G ProSe direct discovery announcement if the resulting UTC-based counter is within the max offset of the time shown by the clock used for ProSe by the UE and if the timer T5060 or T5062 does not expire. In the PROSE PC5 DISCOVERY message for direct discovery announcement, the UE:
 - 1) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.1 or table 10.2.1.2;
 - 2) shall include either ProSe application code or ProSe restricted code;
 - 3) shall include the MIC field computed as described in 3GPP TS 33.503 [34], by using the UTC-based counter and the discovery key contained in the <response-announce> element of the DISCOVERY_RESPONSE message for open 5G ProSe direct discovery, or using the UTC-based counter and the DUIK contained in the <restricted-announce-response> element of the DISCOVERY_RESPONSE message for restricted 5G ProSe direct discovery model A;
 - 4) may include the Metadata IE to provide the application layer metadata information; and
 - 5) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - d) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503[34], for restricted 5G ProSe direct discovery;
 - e) shall set the destination layer-2 ID to the default destination layer-2 ID as specified in clause 5.2.3 and self-assign a source layer-2 ID for sending the direct discovery announcement; and
- NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.2.2, clause 6.2.15.2.2.2 and clause 8.2.1.3.1.2.
- f) shall pass the resulting PROSE PC5 DISCOVERY message along with the source layer-2 ID and destination layer-2 ID for direct discovery announcement and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

In case of open 5G ProSe direct discovery, the UE shall either use the ProSe application code received in the DISCOVERY_RESPONSE message from the 5G DDNMF, or select one ProSe application code based on the ProSe application code prefix and ProSe application code suffix range(s) received in the DISCOVERY_RESPONSE message from the 5G DDNMF as announced ProSe application code, along with the MIC and the four least significant bits of the UTC-based counter.

NOTE 2: The UE can use different codes formed based on different ProSe application code suffixes to announce, without having to send a new request to the 5G DDNMF, as long as the validity timer T5060 of the ProSe application code prefix has not expired.

In case of restricted 5G ProSe direct discovery model A, the UE shall either use the ProSe restricted code received in the DISCOVERY_RESPONSE message, or select one ProSe restricted code based on the ProSe restricted code prefix and ProSe restricted code suffix range(s) received in the DISCOVERY_RESPONSE message from the 5G DDNMF as announced ProSe restricted code, along with the 4 least significant bits of the UTC-based counter.

NOTE 3: The UE can use different codes formed based on different ProSe restricted code suffixes to announce, without having to send a new DISCOVERY_REQUEST message to the 5G DDNMF, as long as the validity timer T5062 of the ProSe restricted code prefix has not expired.

The announcing UE shall ensure that it keeps on passing the same PROSE PC5 DISCOVERY message to the lower layers for transmission until the request from upper layers to perform announcing UE procedure for 5G ProSe direct discovery is still in place, or the validity timer of the ProSe application code or ProSe application code prefix in case of open 5G ProSe direct discovery or the validity timer of the ProSe restricted code or ProSe restricted code prefix in case of restricted 5G ProSe direct discovery expires. How this is achieved is left up to UE implementation.

NOTE 4: The announcing UE can stop announcing UE procedure for 5G ProSe direct discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

6.2.14.2.1.3 Announcing UE procedure for 5G ProSe direct discovery completion

When the request from upper layers to perform announcing UE procedure for 5G ProSe direct discovery is not in place, or the validity timer of the ProSe application code or ProSe application code prefix in case of open 5G ProSe direct discovery or the validity timer of the ProSe restricted code or ProSe restricted code prefix in case of restricted 5G ProSe direct discovery expires, the UE may instruct the lower layers to stop announcing.

NOTE: The announcing UE can stop announcing UE procedure for 5G ProSe direct discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops announcing, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

6.2.14.2.1.4 Monitoring UE procedure for 5G ProSe direct discovery initiation

The UE is authorised to perform the monitoring UE procedure for 5G ProSe direct discovery if:

- a) the UE is not served by NG-RAN, is authorised to perform 5G ProSe direct discovery using monitoring when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;
- b) the UE is served by NG-RAN and is authorised to perform 5G ProSe direct discovery monitoring in at least one PLMN or the subscribed SNPN; or
- c) the UE is:
 - 1) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - i) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - ii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - iii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - 2) authorised to perform 5G ProSe direct discovery using monitoring when the UE is not served by NG-RAN; and:
 - i) configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN; or
 - ii) the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure.

NOTE 1: When the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure, the serving cell broadcasts a common radio resources pool for ProSe discovery transmission and the UE can use this common radio resources pool while in limited service state.

otherwise, the UE is not authorised to perform the monitoring UE procedure for 5G ProSe direct discovery procedure.

Figure 6.2.14.2.1.4.1 illustrates the interaction of the UEs in the monitoring UE procedure for 5G ProSe direct discovery procedure.

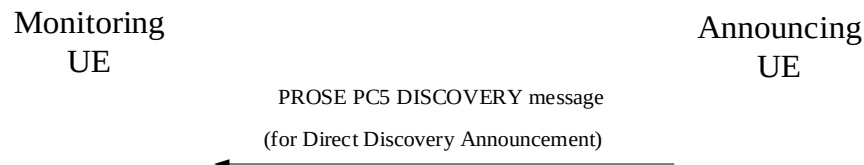


Figure 6.2.14.2.1.4.1: Monitoring UE procedure for 5G ProSe direct discovery

When the UE is triggered by an upper layer application to perform monitoring UE procedure for 5G ProSe direct discovery for a ProSe application code or ProSe restricted code; and:

- a) if the UE is authorised to perform the monitoring UE procedure for 5G ProSe direct discovery;
- b) if the difference between UTC-based counter associated with that discovery slot and UE's ProSe clock is not greater than the max offset of the monitoring UE's ProSe clock; and
- c) if the timer T5060 or T5062 does not expire;

then the UE shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY message.

In the case of restricted 5G ProSe direct discovery, upon reception of a PROSE PC5 DISCOVERY message for 5G ProSe direct discovery announcement for the destination layer-2 ID to be monitored, the UE shall use the associated DUSK, if received from the 5G DDNMF and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF, the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF, the UE shall use the DUIK and UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for 5G ProSe direct discovery announcement.

NOTE 2: The use of an erroneous UTC-based counter for processing received PROSE PC5 DISCOVERY messages at the ProSe-enabled UE can cause MIC check failure after DUIK is used for integrity check and malformed contents after DUSK is used for unscrambling or DUCK is used for deciphering. How a ProSe-enabled UE ensures the accuracy of the UTC-based counter is left to UE implementation.

NOTE 3: The UE can determine the received PROSE PC5 DISCOVERY message for 5G ProSe direct discovery announcement is for 5G ProSe direct discovery based on an indication from the lower layer.

In case of open 5G ProSe direct discovery, for a ProSe application ID requested by the monitoring UE, the 5G DDNMF may have assigned one or more discovery filters. If application-controlled extension is used, the UE may further apply additional filtering on the part corresponding to the ProSe application code suffix. The UE should apply all assigned discovery filters to its monitoring operation. Using these discovery filters may result in a match event. The UE shall consider that the ProSe application code it seeks to monitor has been discovered if there is a match event as following:

When, for any of the ProSe application masks in a discovery filter, the output of a bitwise AND operation between the ProSe application code contained in the received PROSE PC5 DISCOVERY message and the ProSe application mask, matches the output of a bitwise AND operation between the ProSe application mask and the ProSe application code contained in the same discovery filter.

NOTE 4: A ProSe application mask with all bits set to "1" is assigned by the 5G DDNMF for full matching.

In case of restricted 5G ProSe direct discovery model A, the UE provides the application level container, which contains the authorized Target RPAUID(s), to the upper layer applications. For each authorized target RPAUID, the 5G DDNMF may have assigned one or more restricted discovery filters. If application-controlled extension is used, the UE may further apply additional filtering on the part corresponding to the ProSe restricted code suffix. The UE should then apply all restricted discovery filters to its monitoring operation. Using these restricted discovery filters may result in a match event. The UE shall consider that the target RPAUID it seeks to monitor has been discovered if there is a match event as follows:

When, for any of the masks in a restricted discovery filter, the output of a bitwise AND operation between the ProSe restricted code contained in the received PROSE PC5 DISCOVERY message and the mask, matches the output of a bitwise AND operation between the mask and the code contained in the same restricted discovery filter.

NOTE 5: In a restricted discovery filter, a mask with all bits set to "1" is assigned by the 5G DDNMF for full matching of a ProSe restricted code.

6.2.14.2.1.5 Monitoring UE procedure for 5G ProSe direct discovery completion

During the monitoring UE procedure for 5G ProSe direct discovery, if the request from upper layers to perform the monitoring UE procedure for 5G ProSe direct discovery is not in place, or if the validity timer of the discovery filter or the validity timer of the Restricted discovery filter expires, the UE may instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

6.2.14.2.2 5G ProSe direct discovery procedure over PC5 interface with model B

6.2.14.2.2.1 General

In this procedure, the UE sending the PROSE PC5 DISCOVERY message is called the "Discoverer UE" and the other UE is called the "Discoveree UE".

6.2.14.2.2.2 Discoverer UE procedure for 5G ProSe direct discovery initiation

The UE is authorised to perform the discoverer UE procedure for 5G ProSe direct discovery if:

- a) the UE is not served by NG-RAN, is authorised to perform 5G ProSe direct discovery discoverer operation when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;
- b) the UE is served by NG-RAN and is authorised to perform 5G ProSe direct discovery discoverer operation in the PLMN or the subscribed SNPN indicated by the serving cell; or
- c) the UE is:
 - 1) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - i) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - ii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - iii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - 2) authorised to perform 5G ProSe direct discovery discoverer operation when the UE is not served by NG-RAN; and:
 - i) configured with the radio parameters to be used for 5G ProSe direct discovery use when not served by NG-RAN; or
 - ii) the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure.

NOTE 1: When the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure, the serving cell broadcasts a common radio resources pool for ProSe discovery transmission and the UE can use this common radio resources pool while in limited service state.

otherwise, the UE is not authorised to perform the discoverer UE procedure for 5G ProSe direct discovery.

Figure 6.2.14.2.2.1 illustrates the interaction of the UEs in the discoverer UE procedure for 5G ProSe direct discovery.

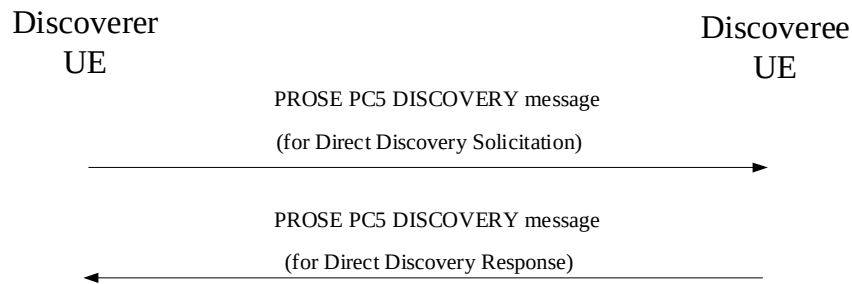


Figure 6.2.14.2.2.1: Discoverer UE procedure for 5G ProSe direct discovery

When the UE is triggered by an upper layer application to query the target RPAUID in restricted discovery Model B, associated with both the ProSe query code and the authorised ProSe identifier; and

- a) if the UE is authorised to perform the discoverer UE procedure for 5G ProSe direct discovery in the registered PLMN or the local PLMN or the subscribed SNPN operating the radio resources that the UE intends to use; and
- b) if the validity timer T5070 for the ProSe query code and corresponding ProSe Response Filter(s) has not expired,

then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time and if the resulting UTC-based counter is within max offset of the time shown by the clock used for ProSe by the UE, the UE shall for each ProSe query code in this discovery entry, use the ProSe query code to construct a PROSE PC5 DISCOVERY message as below;
- c) shall generate a PROSE PC5 DISCOVERY message for 5G ProSe direct discovery solicitation. In the PROSE PC5 DISCOVERY message for 5G ProSe direct discovery solicitation, the UE:
 - 1) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.3;
 - 2) shall include ProSe query code;
 - 3) shall include the MIC field computed as described in 3GPP TS 33.503 [34] by using the UTC-based counter and the DUIK contained in the <restricted-discoverer-response> element of the DISCOVERY_RESPONSE message;
 - 4) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter; and
 - 5) shall include the discoveree user info set to the application layer ID of the discoveree UE if provided by the upper layers to identify a specific discoveree UE;
- d) shall apply the DUIK, DUSK, or DUCK with the associated encrypted bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the destination layer-2 ID to the default destination layer-2 ID as specified in clause 5.2.3 and self-assign a source layer-2 ID for sending the direct discovery announcement; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.1.2, clause 6.2.15.2.1.2, clause 8.2.1.2.2.2 and clause 8.2.1.2.4.2.

- f) shall pass the resulting PROSE PC5 DISCOVERY message along with the source layer-2 ID and destination layer-2 ID for 5G ProSe direct discovery solicitation and the PLMN ID of the intended announcing PLMN if available in the discovery entry and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface and shall instruct the lower layer to start monitoring.

The UE shall ensure that it keeps on passing the same PROSE PC5 DISCOVERY message to the lower layers for transmission until the validity timer T5070 of the ProSe query code expires, or until the request from upper layers to query the target RPAUID in restricted discovery Model B, associated with both the ProSe query code and the authorised application identity, is not in place. How this is achieved is left up to UE implementation.

NOTE 3: The discoverer UE can stop discoverer UE procedure for 5G ProSe direct discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

The UE may apply the discovery response filter(s) received from the 5G DDNMF to its monitoring operation. Using the discovery response filter may result in a match event for the target RPAUID the UE is querying for. There is match event when, for any of the masks in a discovery response filter, the output of a bitwise AND operation between the ProSe response code contained in the received PROSE PC5 DISCOVERY message and the mask, matches the output of a bitwise AND operation between the mask and the code contained in the discovery response filter.

Upon reception of a PROSE PC5 DISCOVERY message for direct discovery response, for the target destination layer-2 ID of the direct discovery to be discovered, the UE shall use the associated DUSK, if received from the 5G DDNMF and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF, the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF, the UE shall use the DUIK and UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for direct discovery response. If a MIC Check Indicator parameter is included instead, the UE shall use the match report procedure described in clause 6.2.10 to trigger checking of the MIC of the PROSE PC5 DISCOVERY message containing the ProSe response code by the 5G DDNMF.

The UE may notify the upper layer application about the match event of restricted 5G ProSe direct discovery model B with the corresponding target RPAUID and metadata, if the RPAUID and metadata are included in the Subquery result element in the DISCOVERY_RESPONSE message from the 5G DDNMF.

6.2.14.2.2.3 Discoverer UE procedure for 5G ProSe direct discovery completion

During the discoverer operation, if

- a) the validity timer T5070 for the ProSe query code and corresponding ProSe Response Filter(s) has expired; and
- b) the request from upper layers to query the target RPAUID in restricted discovery Model B, associated with both the ProSe query code and the authorised ProSe identifier, is not in place,

NOTE: The discoverer UE can stop discoverer UE procedure for 5G ProSe direct discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

then the UE may instruct the lower layers to stop the discoverer operation. When the UE stops discoverer operation, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

6.2.14.2.2.4 Discoveree UE procedure for 5G ProSe direct discovery initiation

The UE is authorised to perform the discoveree UE procedure for 5G ProSe direct discovery if:

- a) the UE is not served by NG-RAN, is authorised to perform 5G ProSe direct discovery discoveree operation when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;
- b) the UE is served by NG-RAN and is authorised to perform 5G ProSe direct discovery discoveree operation in the PLMN or the subscribed SNPN indicated by the serving cell; or
- c) the UE is:

- 1) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - i) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - ii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - iii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
- 2) authorised to perform 5G ProSe direct discovery discoveree operation when the UE is not served by NG-RAN; and:
 - i) configured with the radio parameters to be used for 5G ProSe direct discovery use when not served by NG-RAN; or
 - ii) the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure.

NOTE 1: When the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure, the serving cell broadcasts a common radio resources pool for ProSe discovery transmission and the UE can use this common radio resources pool while in limited service state.

otherwise, the UE is not authorised to perform the discoveree UE procedure for 5G ProSe direct discovery.

Figure 6.2.14.2.2.4.1 illustrates the interaction of the UEs in the discoveree UE procedure for 5G ProSe direct discovery.

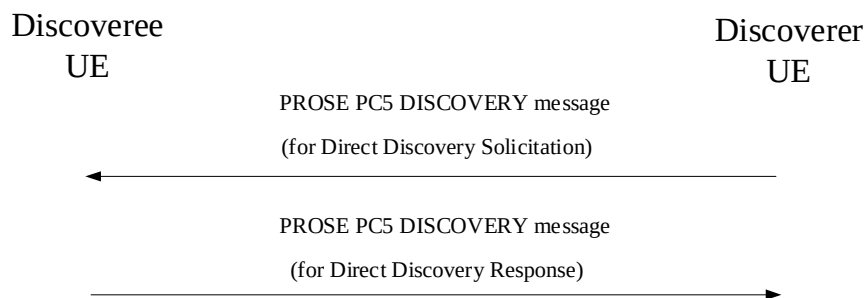


Figure 6.2.14.2.2.4.1: Discoveree UE procedure for 5G ProSe direct discovery

When the UE is triggered by an upper layer application to perform discoveree operation for the RPAUID associated with an authorized ProSe identifier; and if:

- a) the UE is authorised to perform the discoveree UE procedure for 5G ProSe direct discovery;
- b) the UE has obtained the ProSe response code and discovery query filter(s) and the respective validity timer T5068 for the corresponding discovery entry has not expired; and
- c) the difference between UTC-based counter associated with that discovery slot and UE's ProSe clock is not greater than the max offset of the monitoring UE's ProSe clock,

then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure or registration procedure as specified in 3GPP TS 24.501 [11]; and
- b) shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13].

The UE may apply the discovery query filter(s) received from the 5G DDNMF to its monitoring operation. Using the discovery query filter(s) may result in a match event. There is match event when, for any of the masks in a discovery

query filter, the output of a bitwise AND operation between the ProSe query code contained in the received PROSE PC5 DISCOVERY message and the mask, matches the output of a bitwise AND operation between the mask and the code contained in the discovery query filter.

Upon reception of a PROSE PC5 DISCOVERY message for direct discovery solicitation for the destination layer-2 ID which the UE is configured to respond for, with applying a discovery query filter to a received PROSE PC5 DISCOVERY message for the above-mentioned bitwise AND operation, the UE shall use the associated DUCK, if received from the 5G DDNMF and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF, the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G DDNMF, the UE shall use the DUK and UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for direct discovery solicitation.

NOTE 2: The UE can look for a match on the unencrypted bits first before applying DUCK, to minimise the amount of processing performed before finding a match.

NOTE 3: The UE needs to verify the MIC field because the match report procedure is not used for checking the MIC of a PROSE PC5 DISCOVERY message containing a ProSe query code by the 5G DDNMF.

NOTE 4: The UE can determine the received PROSE PC5 DISCOVERY message for direct discovery solicitation is for 5G ProSe direct discovery based on an indication from the lower layer.

If the discoveree user info is included in the PROSE PC5 DISCOVERY message, the discoveree user info shall match the application layer ID of the UE. Once the match of the discovery query filter(s) occurs, the UE process this match event and requests the lower layers to announce the corresponding ProSe response code in the PC5 interface as a response, as specified in 3GPP TS 38.331 [13]. If the UE in 5GMM-IDLE mode has to request resources for 5G ProSe direct discovery announcing as specified in 3GPP TS 38.331 [13], the UE shall perform a service request procedure or registration procedure as specified in 3GPP TS 24.501 [11]. The UE shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time. If the resulting UTC-based counter is within max offset of the time shown by the clock used for ProSe by the UE, the UE shall use the ProSe response code received in the DISCOVERY_RESPONSE message from the 5G DDNMF. The UE shall generate a PROSE PC5 DISCOVERY message for 5G ProSe direct discovery response. In the PROSE PC5 DISCOVERY message for 5G ProSe direct discovery response, the UE:

- a) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.4;
- b) shall include ProSe response code;
- c) shall include the MIC field computed as described in 3GPP TS 33.503 [34] by using the UTC-based counter and the DUK contained in the <restricted-discoveree-response> element of the DISCOVERY_RESPONSE message;
- d) may include the Metadata IE to provide the application layer metadata information; and
- e) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter.

After generating the PROSE PC5 DISCOVERY message for 5G ProSe direct discovery response, the UE:

- a) shall set the destination layer-2 ID to the source layer-2 ID of the received message and self-assign a source layer-2 ID for sending the direct discovery response message;

NOTE 5: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

- b) shall apply the DUK, DUCK, or DUCK with the associated encrypted bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34]; and
- c) shall pass the resulting PROSE PC5 DISCOVERY message along with the source layer-2 ID and destination layer-2 ID for 5G ProSe direct discovery response, the PLMN ID of the intended announcing PLMN and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

NOTE 6: If the UE is processing a PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the same source layer-2 ID of the received PROSE PC5 DISCOVERY message for direct discovery solicitation, it depends on UE implementation to avoid the conflict of destination layer-2 ID (e.g. send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #3 "conflict of layer-2 ID for unicast communication is detected", or ignore the PROSE DIRECT DISCOVERY message for direct discovery solicitation).

For each match event with the discovery query filter(s), the UE shall at least pass PROSE PC5 DISCOVERY message once to the lower layers for transmission. The UE shall ensure that it keeps on passing PROSE PC5 DISCOVERY messages to the lower layers for transmission as response(s) to the match event(s) of the corresponding discovery query filter(s) until the validity timer T5068 expires. How this is achieved is left up to UE implementation.

6.2.14.2.2.5 Discoveree UE procedure for 5G ProSe direct discovery completion

During the discoveree operation, if

- a) the validity timer T5068 for the ProSe response code and corresponding discovery query filter(s) has expired; and
- b) the request from upper layers to perform discoveree operation for the RPAUID associated with an authorized ProSe identifier is not in place, then

the UE may instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the lower layers indicate that the UE is required to send a discovery indication to the NG-RAN and the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

6.2.15 Group member discovery over PC5 interface

6.2.15.1 General

This clause describes the procedures for group member discovery over PC5 interface for both public safety use and commercial services. The purpose of the group member discovery procedure over PC5 interface is to enable a ProSe-enabled UE to detect and identify another ProSe-enabled UE that belongs to the same application layer group (e.g., sharing the same application layer group ID) over PC5 interface.

To perform group member discovery over PC5 interface, the UE is configured with the related information as described in clause 5.2.3. The following models for group member discovery procedure over PC5 interface as specified in 3GPP TS 23.304 [2] are supported:

- a) Model A uses a single discovery protocol message (Announcement); and
- b) Model B uses two discovery protocol messages (Solicitation and Response).

NOTE: If the UE is authorized to perform both group member discovery over PC5 interface with Model A and group member discovery over PC5 interface with Model B, it is up to UE implementation to select which model to perform or perform both models simultaneously.

The following procedures are defined for group member discovery procedure over PC5 interface:

- a) Group member discovery over PC5 interface with Model A:
 - 1) Announcing UE procedure for group member discovery initiation;
 - 2) Announcing UE procedure for group member discovery completion;
 - 3) Monitoring UE procedure for group member discovery initiation; and
 - 4) Monitoring UE procedure for group member discovery completion; and
- b) Group member discovery over PC5 interface with Model B:
 - 1) Discoverer UE procedure for group member discovery initiation;

- 2) Discoverer UE procedure for group member discovery completion;
- 3) Discoveree UE procedure for group member discovery initiation; and
- 4) Discoveree UE procedure for group member discovery completion.

The group member discovery over PC5 interface with Model A can only discover the targeted group members that are identified by the configured application layer group ID. The group member discovery over PC5 interface with Model B can either discover a specific group member of the application layer group identified by the configured application layer group ID or the targeted group members that are identified by the configured application layer group ID.

6.2.15.2 Procedures

6.2.15.2.1 Group member discovery over PC5 interface with model A

6.2.15.2.1.1 General

In this procedure, the UE sending the PROSE PC5 DISCOVERY message is called the "announcing UE" and the other UE is called the "monitoring UE".

6.2.15.2.1.2 Announcing UE procedure for group member discovery initiation

The UE is authorised to perform the announcing UE procedure for group member discovery if:

a) the following is true:

- 1) the UE is not served by NG-RAN, is authorised to perform 5G ProSe direct discovery using announcing procedure when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;
- 2) the UE is served by NG-RAN and is authorised to perform 5G ProSe direct discovery using announcing in the PLMN or the subscribed SNPN indicated by the serving cell; or
- 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to perform 5G ProSe direct discovery using announcing when the UE is not served by NG-RAN and:
 - A) configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN; or
 - B) the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure; and

NOTE 1: When the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure, the serving cell broadcasts a common radio resources pool for 5G ProSe discovery transmission and the UE can use this common radio resources pool while in limited service state.

- b) the UE is configured with the application layer group ID identifying the application layer group to be announced and with the User info ID for the group member discovery parameter;

otherwise, the UE is not authorised to perform the announcing UE procedure for group member discovery procedure.

Figure 6.2.15.2.1.2.1 illustrates the interaction of the UEs in the announcing UE procedure for group member discovery.

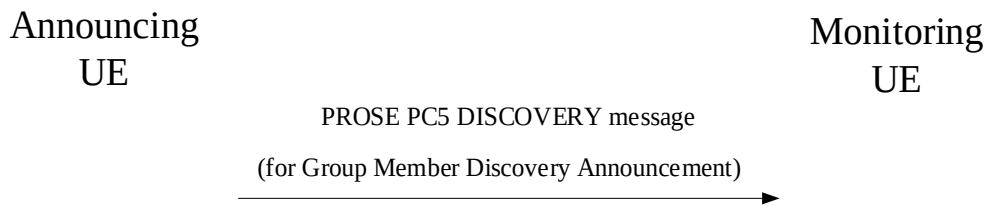


Figure 6.2.15.2.1.2.1: Announcing UE procedure for group member discovery

When the UE is triggered by an upper layer application to announce availability in a discovery group, if the UE is authorised to perform the announcing UE procedure for group member discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- c) shall generate a PROSE PC5 DISCOVERY message for group member discovery announcement. In the PROSE PC5 DISCOVERY message for group member discovery announcement, the UE:
 - 1) shall set the announcer info parameter to the User info ID for the group member discovery parameter; and
 - 2) shall set the application layer group ID parameter to the application layer group ID parameter identifying the discovery group to be announced;
 - 3) shall include the MIC field computed as described in 3GPP TS 33.503 [34], by using the UTC-based counter and the DUIK contained in the <restricted-announce-response> element of the DISCOVERY_RESPONSE message;
 - 4) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 5) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.5; and
 - 6) may include the Metadata IE to provide the application layer discovery message;
- d) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.303[36];
- e) shall apply one of the following to determine the destination layer-2 ID:
 - 1) if the application layer group ID has a configured layer-2 group ID as specified in clause 5.2.3, set the destination layer-2 ID to the layer-2 group ID; or
 - 2) otherwise, convert the application layer group ID into a destination layer-2 ID as following:
 - i) to use the group identifier as the input to the SHA-256 hashing algorithm as specified in ISO/IEC 10118-3:2018 [28]; and
 - ii) to use the 24 least significant bits of the 256 bits of the output as destination layer-2 ID;

NOTE 2: SHA-256 hashing algorithm is implemented in the ME.

- f) shall self-assign a source layer-2 ID for sending the group member discovery announcement message; and

NOTE 3: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.2.2, clause 6.2.15.2.2.2 and clause 8.2.1.3.1.2.

- g) shall pass the resulting PROSE PC5 DISCOVERY message for group member discovery announcement along with the source layer-2 ID and the destination layer-2 ID to the lower layers for transmission over the PC5 interface.

The announcing UE shall ensure that it keeps on passing the same PROSE PC5 DISCOVERY message to the lower layers for transmission until the announcing UE is triggered by an upper layer application to stop announcing availability in a discovery group, or until the UE stops being authorised to perform the announcing UE procedure for group member discovery.

NOTE 4: The announcing UE can stop announcing UE procedure for group member discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

6.2.15.2.1.3 Announcing UE procedure for group member discovery completion

When the announcing UE is triggered by an upper layer application to stop announcing availability in a discovery group, or when the announcing UE stops being authorised to perform the announcing UE procedure for group member discovery, the UE shall instruct the lower layers to stop announcing.

NOTE: The announcing UE can stop announcing UE procedure for group member discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops announcing, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

6.2.15.2.1.4 Monitoring UE procedure for group member discovery initiation

The UE is authorised to perform the monitoring UE procedure for group member discovery if:

- a) the following is true:

- 1) the UE is not served by NG-RAN, is authorised to perform 5G ProSe direct discovery using monitoring when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;
- 2) the UE is served by NG-RAN and is authorised to perform 5G ProSe direct discovery monitoring in at least one PLMN or the subscribed SNPN; or
- 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to perform 5G ProSe direct discovery using monitoring when the UE is not served by NG-RAN; and:
 - A) configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN; or

- B) the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure; and

NOTE 1: When the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure, the serving cell broadcasts a common radio resources pool for 5G ProSe discovery transmission and the UE can use this common radio resources pool while in limited service state.

- b) the UE is configured with the application layer group ID parameter identifying the discovery group to be monitored;

otherwise, the UE is not authorised to perform the monitoring UE procedure for group member discovery.

Figure 6.2.15.2.1.4.1 illustrates the interaction of the UEs in the monitoring UE procedure for group member discovery.

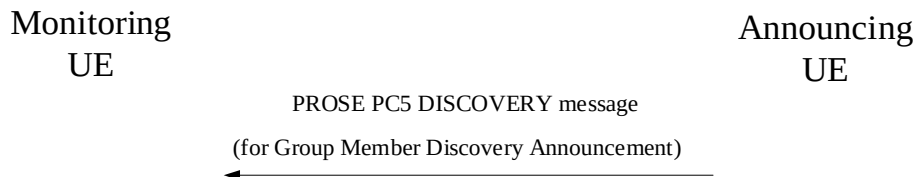


Figure 6.2.15.2.1.4.1: Monitoring UE procedure for group member discovery

When the UE is triggered by an upper layer application to monitor proximity of other UEs in a discovery group and if the UE is authorised to perform the monitoring UE procedure for group member discovery, then the UE shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY message as following:

- a) if the application layer group ID has a configured layer-2 group ID as specified in clause 5.2.3, the UE shall monitor for PROSE PC5 DISCOVERY message with the layer-2 group ID as specified in clause 5.2.3; or
- b) otherwise, the UE shall convert the application layer group ID into a destination layer-2 ID and shall monitor for PROSE PC5 DISCOVERY message with the converted destination layer-2 ID. The UE shall convert the application layer group ID into a destination layer-2 ID as following:
 - 1) to use the group identifier as the input to the SHA-256 hashing algorithm as specified in ISO/IEC 10118-3:2018 [28]; and
 - 2) to use the 24 least significant bits of the 256 bits of the output as destination layer-2 ID.

NOTE 2: SHA-256 hashing algorithm is implemented in the ME.

Upon reception of a PROSE PC5 DISCOVERY message for group member discovery announcement, for the target application layer group ID of the discovery group to be monitored, the UE shall use the associated DUSK, if configured or calculated using the PSDK and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.303 [36]. Then, if a DUCK is configured or calculated using the PSDK, the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.303 [36]. Finally, if a DUIK is configured or calculated using the PSDK, the UE shall use the DUIK and UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for group member discovery announcement.

NOTE 3: The use of an erroneous UTC-based counter for processing received PROSE PC5 DISCOVERY messages at the ProSe-enabled UE can cause MIC check failure after DUIK is used for integrity check and malformed contents after DUSK is used for unscrambling or DUCK is used for deciphering. How a ProSe-enabled UE ensures the accuracy of the UTC-based counter is left to UE implementation.

Then if the application layer group ID parameter of the PROSE PC5 DISCOVERY message for group member discovery announcement is the same as the configured application layer group ID parameter as specified in clause 5, the UE shall consider that other UE in the discovery group the UE seeks to monitor has been discovered.

6.2.15.2.1.5 Monitoring UE procedure for group member discovery completion

When the UE is triggered by an upper layer application to stop monitoring proximity of other UEs in a discovery group, or when the UE stops being authorised to perform the monitoring UE procedure for group member discovery, the UE shall instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

6.2.15.2.2 Group member discovery over PC5 interface with model B

6.2.15.2.2.1 General

In this procedure, the UE sending the PROSE PC5 DISCOVERY message is called the "discoverer UE" and the other UE is called the "discoveree UE".

6.2.15.2.2.2 Discoverer UE procedure for group member discovery initiation

The UE is authorised to perform the discoverer UE procedure for group member discovery if:

- a) the following is true:
 - 1) the UE is not served by NG-RAN, is authorised to perform 5G ProSe direct discovery discoverer operation when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;
 - 2) the UE is served by NG-RAN and is authorised to perform 5G ProSe direct discovery discoverer operation in the PLMN or the subscribed SNPN indicated by the serving cell; or
 - 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to perform 5G ProSe direct discovery discoverer operation when the UE is not served by NG-RAN and:
 - A) configured with the radio parameters to be used for 5G ProSe direct discovery use when not served by NG-RAN; or
 - B) the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure; and

NOTE 1: When the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure, the serving cell broadcasts a common radio resources pool for 5G ProSe discovery transmission and the UE can use this common radio resources pool while in limited service state.

- b) the UE is configured with the application layer group ID parameter identifying the discovery group to be solicited and with the User info ID for the group member discovery parameter;

otherwise, the UE is not authorised to perform the discoverer UE procedure for group member discovery.

Figure 6.2.15.2.2.1 illustrates the interaction of the UEs in the discoverer UE procedure for group member discovery.

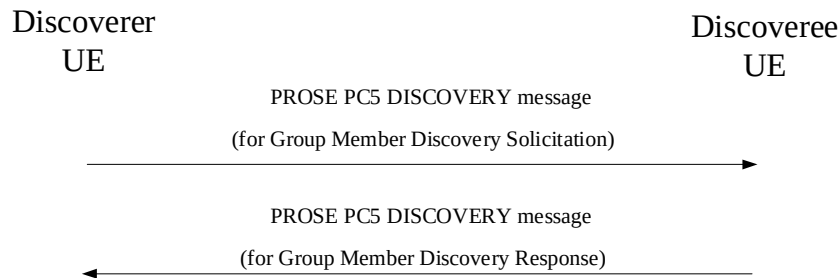


Figure 6.2.15.2.2.2.1: Discoverer UE procedure for group member discovery

When the UE is triggered by an upper layer application to solicit proximity of other UEs in a discovery group and if the UE is authorised to perform the discoverer UE procedure for group member discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- c) shall generate a PROSE PC5 DISCOVERY message for group member discovery solicitation. In the PROSE PC5 DISCOVERY message for group member discovery solicitation, the UE:
 - 1) shall set the discoverer info parameter to the user info ID for the group member discovery parameter;
 - 2) shall set the application layer group ID parameter to the application layer group ID parameter identifying the discovery group to be solicited;
 - 3) shall set the target user info parameter to the target info, if the target information is provided by the upper layers to identify a specific group member of the application layer group identified by the configured application layer group ID;

NOTE 2: If the PROSE PC5 DISCOVERY message for group member discovery solicitation does not indicate any specific target UE (i.e., target user info is not included in the PROSE PC5 DISCOVERY message), the PROSE PC5 DISCOVERY message for group member discovery solicitation is only used to discover the targeted group members that are identified by the configured application layer group ID.

- 4) shall include the MIC field computed as described in 3GPP TS 33.503 [34] by using the UTC-based counter and the DUIK contained in the <restricted-discoverer-response> element of the DISCOVERY_RESPONSE message;
- 5) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter; and
- 6) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.6;
- d) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.303 [36];
- e) shall apply one of the following to determine the destination layer-2 ID:
 - 1) if the application layer group ID has a configured layer-2 group ID as specified in clause 5.2.3, set the destination layer-2 ID to the layer-2 group ID; or
 - 2) otherwise, convert the application layer group ID into a destination layer-2 ID as following:
 - i) to use the group identifier as the input to the SHA-256 hashing algorithm as specified in ISO/IEC 10118-3:2018 [28]; and
 - ii) to use the 24 least significant bits of the 256 bits of the output as destination layer-2 ID;

NOTE 3: SHA-256 hashing algorithm is implemented in the ME.

- f) shall self-assign a source layer-2 ID for sending the group member discovery solicitation message; and

NOTE 4: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2, and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.1.2, clause 6.2.15.2.1.2, clause 8.2.1.2.2.2 and clause 8.2.1.2.4.2.

- g) shall pass the resulting PROSE PC5 DISCOVERY message for group member discovery solicitation along with the source layer-2 ID and destination layer-2 ID to the lower layers for transmission over the PC5 interface.

The UE shall ensure that it keeps on passing the same PROSE PC5 DISCOVERY message to the lower layers for transmission with an indication that the message until the UE is triggered by an upper layer application to stop soliciting proximity of other UEs in a discovery group, or until the UE stops being authorised to perform the discoverer UE procedure for group member discovery. How this is achieved is left up to UE implementation.

NOTE 5: The discoverer UE can stop discoverer UE procedure for group member discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

Upon reception of a PROSE PC5 DISCOVERY message for group member discovery response, for the target application layer group ID of the discovery group to be discovered, the UE shall use the associated DUSK, if configured or calculated using the PSDK and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.303 [36]. Then, if a DUCK is configured or calculated using the PSDK, the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.303 [36]. Finally, if a DUIK is configured or calculated using the PSDK, the UE shall use the DUIK and UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for group member discovery response.

Then if:

- a) the application layer group ID parameter of the PROSE PC5 DISCOVERY message for group member discovery response is the same as the application layer group ID parameter of the PROSE PC5 DISCOVERY message for group member discovery solicitation, and
- b) the target information is not provided by the upper layers to identify a specific group member of the application layer group, or the discoveree info in the PROSE PC5 DISCOVERY message for group member discovery response is the same as the target information if the target information is provided by the upper layers,

the UE shall consider that other UE in the discovery group the UE seeks to discover has been discovered.

6.2.15.2.2.3 Discoverer UE procedure for group member discovery completion

When the UE is triggered by an upper layer application to stop soliciting proximity of other UEs in a discovery group, or when the UE stops being authorised to perform the discoverer UE procedure for group member discovery, the UE shall instruct the lower layers to stop discoverer operation.

NOTE: The discoverer UE can stop discoverer UE procedure for group member discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops discoverer operation, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

6.2.15.2.2.4 Discoveree UE procedure for group member discovery initiation

The UE is authorised to perform the discoveree UE procedure for group member discovery if:

- a) the following is true:
 - 1) the UE is not served by NG-RAN, is authorised to perform 5G ProSe direct discovery discoveree operation when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;

- 2) the UE is served by NG-RAN and is authorised to perform 5G ProSe direct discovery discoveree operation in the PLMN(s) or the subscribed SNPN indicated by the serving cell; or
- 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to perform 5G ProSe direct discovery discoveree operation when the UE is not served by NG-RAN; and:
 - A) configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN; or
 - B) the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure; and

NOTE 1: When the lower layers indicate that the UE does not need to request resources for 5G ProSe direct discovery procedure, the serving cell broadcasts a common radio resources pool for 5G ProSe discovery transmission and the UE can use this common radio resources pool while in limited service state.

- b) the UE is configured with the application layer group ID parameter identifying the discovery group to be responded to and with the User info ID for the group member discovery parameter;

otherwise, the UE is not authorised to perform the discoveree UE procedure for group member discovery.

Figure 6.2.15.2.2.4.1 illustrates the interaction of the UEs in the discoveree UE procedure for group member discovery.

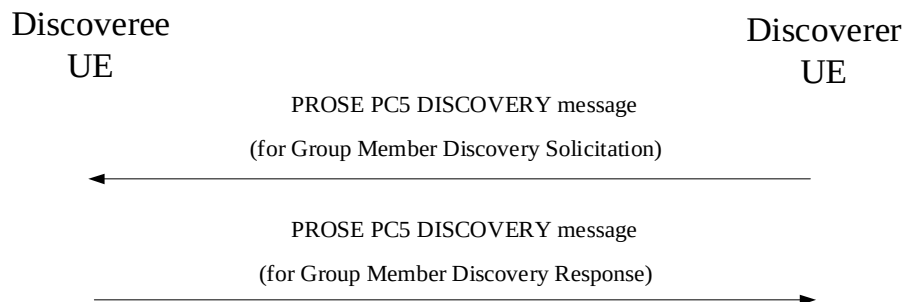


Figure 6.2.15.2.2.4.1: Discoveree UE procedure for group member discovery

When the UE is triggered by an upper layer application to start responding to solicitation on proximity of a UE in a discovery group and if the UE is authorised to perform the discoveree UE procedure for group member discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11]; and
- b) shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages.

Upon reception of a PROSE PC5 DISCOVERY message for group member discovery solicitation, for the application layer group ID of the discovery group which the UE is configured to respond for, the UE shall use the associated DUSK, if configured or calculated using the PSDK and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.303 [36]. Then, if a DUCK is configured or calculated using the PSDK, the UE shall use the DUCK and the UTC-based counter to decrypt

the configured message-specific confidentiality protected portion, as described in 3GPP TS 33.303 [36]. Finally, if a DUIK is configured or calculated using the PSDK, the UE shall use the DUIK and UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for group member discovery solicitation.

Then, if:

- a) the application layer group ID parameter of the received PROSE PC5 DISCOVERY message is the same as the application layer group ID parameter for the discovery group; and
- b) the target user info parameter is not included in the received PROSE PC5 DISCOVERY message or the target user info parameter in the received PROSE PC5 DISCOVERY message is the same as the user info ID for the group member discovery provided by the upper layers or same as the configured user info ID for the group member discovery as specified in clause 5.2.3;

the UE:

- a) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- b) shall generate a PROSE PC5 DISCOVERY message for group member discovery response. In the PROSE PC5 DISCOVERY message for group member discovery response, the UE:
 - 1) shall set the discoveree info parameter to the user info ID for the group member discovery parameter;
 - 2) shall set the application layer group ID parameter to the application layer group ID parameter of the PROSE PC5 DISCOVERY message for group member discovery solicitation;
 - 3) shall include the MIC field computed as described in 3GPP TS 33.503 [34] by using the UTC-based counter and the DUIK contained in the <restricted-discoveree-response> element of the DISCOVERY_RESPONSE message;
 - 4) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 5) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.7; and
 - 6) may include the Metadata IE to provide the application layer discovery message;
- c) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.303 [36];
- d) shall set the destination layer-2 ID to the source layer-2 ID from the discoverer UE used in the transportation of the PROSE PC5 DISCOVERY message for group member discovery solicitation and self-assign a source layer-2 ID for sending the group member discovery response message; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

- e) shall pass the resulting PROSE PC5 DISCOVERY message for group member discovery response along with the source layer-2 ID and the destination layer-2 ID to the lower layers for transmission over the PC5 interface.

NOTE 3: If the UE is processing a PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the same source layer-2 ID of the received PROSE PC5 DISCOVERY message for group member discovery solicitation, it depends on UE implementation to avoid the conflict of destination layer-2 ID (e.g. send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #3 "conflict of layer-2 ID for unicast communication is detected", or ignore the PROSE DIRECT DISCOVERY message for group member discovery solicitation).

6.2.15.2.2.5 Discoveree UE procedure for group member discovery completion

When the UE is triggered by an upper layer application to stop responding to solicitation on proximity of other UEs in a discovery group, or when the UE stops being authorised to perform the discoveree UE procedure for group member discovery, the UE shall instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

6.2.16 Procedure for UE to use provisioned radio resources for 5G ProSe direct discovery

When the UE is not served by NG-RAN for 5G ProSe direct discovery and is authorized to use 5G ProSe direct discovery, the UE shall select the corresponding radio parameters to be used for 5G ProSe direct discovery as follows:

- a) if the UE can determine itself located in a geographical area and the UE is provisioned with radio parameters for the geographical area, the UE shall select the radio parameters associated with that geographical area; or
- b) in all other cases, the UE shall not initiate 5G ProSe direct discovery over PC5.

If the UE intends to use "non-operator managed" radio parameters as specified in clause 5.2.3, the UE shall initiate 5G ProSe direct discovery with the selected radio parameters.

If the UE intends to use "operator managed" radio parameters as specified in clause 5.2.3, before initiating 5G ProSe direct discovery, the UE shall check with lower layers whether the selected radio parameters can be used in the current location without causing interference to other cells as specified in 3GPP TS 38.331 [13]; and:

- a) if the lower layers indicate that the usage would not cause any interference, the UE shall initiate 5G ProSe direct discovery; or

NOTE: If the lower layers find that there exists a cell operating the provisioned radio resources (i.e., carrier frequency) and the cell belongs to the registered PLMN or a PLMN equivalent to the registered PLMN, or for SNPN, to the RSNPN and the RSNPN is the subscribed SNPN, and the UE is authorized for 5G ProSe direct discovery in this PLMN or this RSNPN, the UE can use the radio parameters indicated by the cell as specified in 3GPP TS 38.331 [13].

- b) else if the lower layers report that one or more PLMNs or SNPNS operate in the provisioned radio resources (i.e., carrier frequency) then:

1) if the following conditions are met:

- i) none of the PLMNs reported by the lower layers is the registered PLMN or equivalent to the registered PLMN, or for SNPN none of the SNPNS reported by the lower layers is the RSNPN and the RSNPN is not the subscribed SNPN;
- ii) at least one of the PLMNs reported by the lower layers is in the list of authorized PLMNs for 5G ProSe direct discovery and provides radio resources for 5G ProSe direct discovery as specified in 3GPP TS 38.331 [13], or for SNPN one of the SNPNS reported by the lower layer is the subscribed SNPN and the UE is authorized to use 5G ProSe direct communication over PC5 interface in the subscribed SNPN; and

iii) the UE does not have an emergency PDU session;

then the UE shall:

- i) if in 5GMM-IDLE mode, perform PLMN selection triggered by 5G ProSe direct discovery, or SNPN selection triggered by ProSe direct discovery, as specified in 3GPP TS 23.122 [14]; or

ii) else if in 5GMM-CONNECTED mode, either:

A) perform a De-registration procedure as specified in 3GPP TS 24.501 [11] and then perform PLMN selection triggered by 5G ProSe direct discovery, or SNPN selection triggered by ProSe direct discovery, as specified in 3GPP TS 23.122 [14]; or

B) not initiate 5G ProSe direct discovery.

Whether the UE performs A) or B) above is left up to UE implementation; or

- 2) else the UE shall not initiate 5G ProSe direct discovery.

If the registration to the selected PLMN or the selected SNPN is successful, the UE shall proceed with the procedure to initiate 5G ProSe direct discovery as specified in clause 6.2.14 and clause 6.2.15.

If the UE is performing 5G ProSe direct discovery using radio parameters associated with a geographical area and moves out of that geographical area, the UE shall stop performing 5G ProSe direct discovery and then if the UE is not served by NG-RAN for 5G ProSe direct discovery, the UE shall select appropriate radio parameters for the new geographical area as specified above.

6.2.17 5G PKMF address request procedure

6.2.17.1 General

The purpose of the 5G PKMF address request procedure is to allow a UE to obtain a 5G PKMF address from the 5G DDNMF in HPLMN or subscribed SNPN over PC3a interface as specified in 3GPP TS 33.503 [34] for the security procedure over user plane. A UE may initiate a 5G PKMF address request procedure:

- a) when the UE needs to obtain a 5G PKMF address from the 5G DDNMF in HPLMN or subscribed SNPN on demand; or
- b) when the UE can not access the 5G PKMF using the 5G PKMF address provisioned by the network as specified in clause 5.2.5.

To initiate a 5G PKMF address request procedure, the UE shall be configured with the authorized parameters for 5G ProSe UE-to-network relay as specified in clause 5.2.5, the authorized parameters for 5G ProSe UE-to-UE relay as specified in clause 5.2.7, the authorized parameters for 5G ProSe multi-hop UE-to-network relay as specified in clause 5.2.8, or the authorized parameters for 5G ProSe multi-hop layer-3 UE-to-UE relay as specified in clause 5.2.9. Both the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE are allowed to initiate the 5G PKMF address request procedure for 5G ProSe UE-to-network relay. Both the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE are allowed to initiate the 5G PKMF address request procedure for 5G ProSe UE-to-UE relay. Both the 5G ProSe multi-hop remote UE and the 5G ProSe multi-hop UE-to-network relay UE are allowed to initiate the 5G PKMF address request procedure for 5G ProSe multi-hop UE-to-network relay. Both the 5G ProSe end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE are allowed to initiate the 5G PKMF address request procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay.

NOTE: The UE is allowed to access the 5G PKMF directly without initiating a 5G PKMF address request procedure if it is pre-configured with the 5G PKMF address as specified in clause 5.2.5, clause 5.2.7, clause 5.2.8 and clause 5.2.9.

6.2.17.2 5G PKMF address request procedure initiation by the UE

The UE shall initiate the 5G PKMF address request procedure by sending a PROSE_5GPKMF_ADDRESS_REQUEST message with the <PKMF-address-request> element. In the <PKMF-address-request> element, the UE:

- a) shall include a new transaction ID not used in any other direct discovery procedures in PC3a interface.

Figure 6.2.17.2.1 illustrates the interaction of the UE and the 5G DDNMF in the 5G PKMF address request procedure.

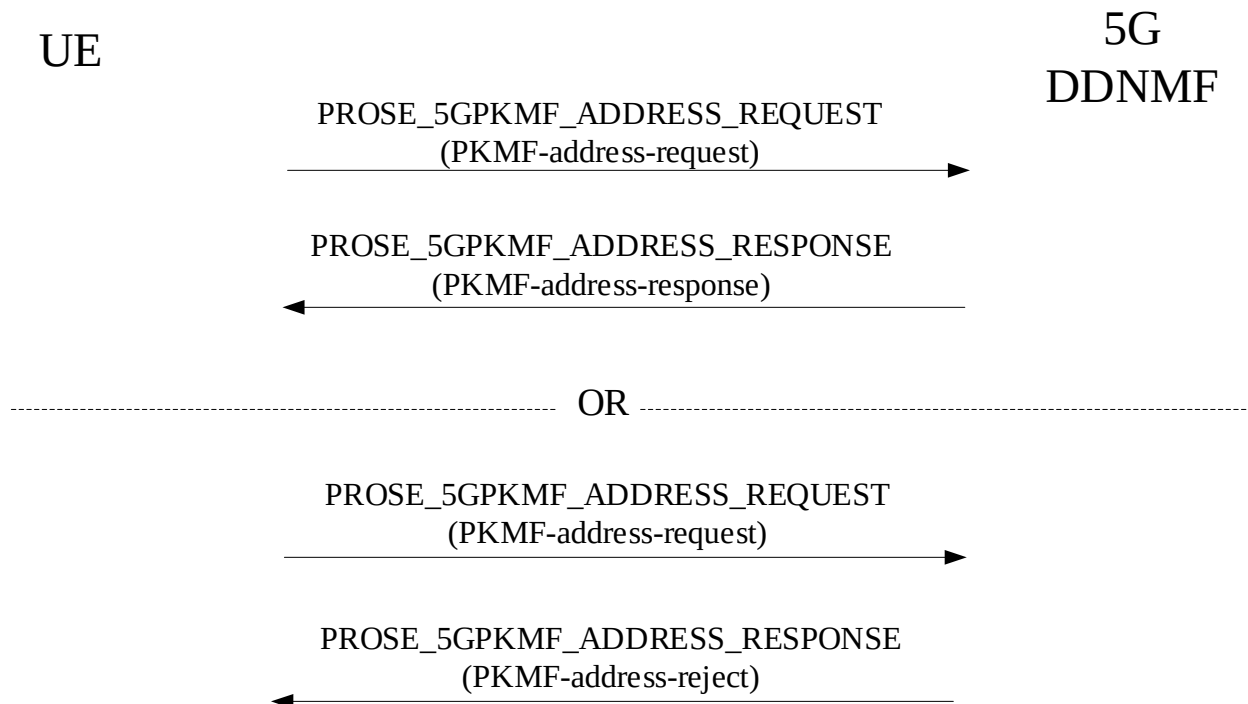


Figure 6.2.17.2.1: 5G PKMF address request procedure

6.2.17.3 5G PKMF address request procedure accepted by the 5G DDNMF

Upon receiving a PROSE_5GPKMF_ADDRESS_REQUEST message, the 5G DDNMF shall check whether the UE is authorized for 5G ProSe UE-to-network relay, 5G ProSe UE-to-UE relay, 5G ProSe multi-hop UE-to-network relay, or 5G ProSe multi-hop layer-3 UE-to-UE relay. If authorized, the 5G DDNMF shall then send a PROSE_5GPKMF_ADDRESS_RESPONSE message with the <PKMF-address-response> element. In the <PKMF-address-response> element, the 5G DDNMF shall include:

- the transaction ID set to the value of the transaction ID received in the PROSE_5GPKMF_ADDRESS_REQUEST message from the UE; and
- the PKMF address set to the value of the 5G PMKF address in the HPLMN or subscribed SNPN of the UE.

6.2.17.4 5G PKMF address request procedure completed by the UE

Upon receiving the PROSE_5GPKMF_ADDRESS_RESPONSE message with the <PKMF-address-response> element, if the transaction ID matches the value sent by the UE in a PROSE_5GPKMF_ADDRESS_REQUEST message, the UE shall store the received 5G PKMF address.

6.2.17.5 5G PKMF address request procedure not accepted by the 5G DDNMF

If the PROSE_5GPKMF_ADDRESS_REQUEST message cannot be accepted by the 5G DDNMF, the 5G DDNMF sends a PROSE_5GPKMF_ADDRESS_RESPONSE message containing a <PKMF-address-reject> element to the UE including an appropriate PC3a control protocol cause value and including the transaction ID set to the value of the transaction ID received in the PROSE_5GPKMF_ADDRESS_REQUEST message.

Upon receipt of the PROSE_5GPKMF_ADDRESS_RESPONSE message with the <PKMF-address-reject> element, if the transaction ID matches the value sent by the UE in a PROSE_5GPKMF_ADDRESS_REQUEST message, the UE shall consider the 5G PKMF address request procedure as rejected.

If the UE is not authorized for 5G ProSe UE-to-network relay, 5G ProSe UE-to-UE relay, 5G ProSe multi-hop UE-to-network relay, or 5G ProSe multi-hop layer-3 UE-to-UE relay, the 5G DDNMF shall send the PROSE_5GPKMF_ADDRESS_RESPONSE message containing a <PKMF-address-reject> element with PC3a control protocol cause value #3 "UE authorization failure".

6.2.17.6 Abnormal cases

6.2.17.6.1 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of PROSE_5GPKMF_ADDRESS_REQUEST message (e.g., after TCP retransmission timeout).

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the 5G PKMF address request procedure.

- b) No response from the 5G DDNMF after the PROSE_5GPKMF_ADDRESS_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the PROSE_5GPKMF_ADDRESS_REQUEST message).

The UE shall retransmit the PROSE_5GPKMF_ADDRESS_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

- c) Change of PLMN.

If a PLMN change occurs before the 5G PKMF address request procedure is completed, the procedure shall be aborted. If the UE is authorized to initiate the 5G PKMF address request procedure in the new PLMN, the procedure shall be restarted once the UE is registered on the new PLMN.

6.2.17.6.2 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of PROSE_5GPKMF_ADDRESS_REQUEST message.

After receiving an indication from lower layer that the PROSE_5GPKMF_ADDRESS_REQUEST message has not been successfully acknowledged (e.g., TCP ACK is not received), the 5G DDNMF shall abort the procedure.

7 5G ProSe direct communications

7.1 Overview

This clause describes the procedures at the UE and between UEs, for 5G ProSe direct communication over PC5.

The UE shall support requirements for securing 5G ProSe direct communication over PC5.

To perform the 5G ProSe direct communication over PC5, the UE shall be configured with the corresponding configurations as specified in clause 5.2.4. If a UE cannot derive any of the necessary configurations (e.g. NR Tx profile, ProSe NR frequencies, PC5 QoS parameters) according to the mapping rules for the ProSe identifier of a ProSe service (see 3GPP TS 24.555 [17]), then the UE is not allowed to perform any operation as specified in clause 7 for the ProSe service.

The PC5 interface is selected based on the ProSe application to path preference mapping rules as specified in clause 5.2.4 before 5G ProSe direct communication.

For unicast mode 5G ProSe direct communication, the following data unit types are supported: IPv4, IPv6, Ethernet and Unstructured.

For broadcast and groupcast mode 5G ProSe communication, the following data unit types are supported: IPv4, IPv6, Ethernet, Unstructured and Address Resolution Protocol (see RFC 826 [32]).

5G ProSe direct communication over NR-PC5 supports broadcast mode, groupcast mode and unicast mode. If the upper layer of the UE indicates the mode of communication, the UE shall set the mode of communication based on the request

of the upper layer. Otherwise, the UE shall set the mode of communication based on the mapping rules between the 5G ProSe identifiers and the default mode of communication defined in clause 5.2.4.

NOTE: Further details about whether broadcast, unicast or groupcast can be used over PC5 are described in 3GPP TS 23.304 [2] clause 5.3.

The UE may use the PC5 DRX mechanism to perform 5G ProSe direct communication over PC5 interface for broadcast mode and groupcast mode when the UE is not served by NG-RAN as specified in clause 5.2.4. For transmitting and receiving direct communication request messages (i.e. the PROSE DIRECT LINK ESTABLISHMENT REQUEST message), the default PC5 DRX configuration is used (see 3GPP TS 38.300 [21]).

7.2 Unicast mode 5G ProSe direct communication over PC5

7.2.1 Overview

This clause describes the PC5 signalling protocol procedures between two UEs for one-to-one (i.e., unicast) mode of 5G ProSe direct communication. The following PC5 signalling protocol procedures are defined:

- a) 5G ProSe direct link establishment;
- b) 5G ProSe direct link modification;
- c) 5G ProSe direct link release;
- d) 5G ProSe direct link identifier update;
- e) 5G ProSe direct link keep-alive;
- f) 5G ProSe direct link security mode control;
- g) 5G ProSe direct link re-keying;
- h) 5G ProSe direct link authentication;
- i) 5G ProSe direct link UE-to-UE relay update; and
- j) 5G ProSe direct link identification.

Each 5G ProSe direct link is associated with a 5G ProSe direct link context. For 5G ProSe UE-to-network relay, the 5G ProSe direct link context includes:

- a) user info ID and layer-2 ID of 5G ProSe remote UE;
- b) user info ID and layer-2 ID of 5G ProSe UE-to-network relay UE;
- c) relay service code; and
- d) in the case of 5G ProSe Layer-3 UE-to-network relay, the network layer protocol and the information about PC5 QoS flow(s).

For 5G ProSe layer-2 UE-to-UE relay over end-to-end 5G ProSe direct link, the 5G ProSe direct link context includes:

- a) user info (i.e. application layer ID) and layer-2 ID of source 5G ProSe end UE;
- b) user info (i.e. application layer ID) and layer-2 ID of target 5G ProSe end UE;
- c) relay service code; and
- d) the information about PC5 QoS flow(s).

For 5G ProSe UE-to-UE relay over each hop, the 5G ProSe direct link context includes:

- a) user info (i.e. application layer ID) and layer-2 ID of 5G ProSe end UE;
- b) user info ID (see clause 5.2.7) and layer-2 ID of 5G ProSe UE-to-UE relay UE;

- c) relay service code; and
- d) in the case of 5G ProSe layer-3 UE-to-UE relay, the network layer protocol and the information about PC5 QoS flow(s), also the IP address(es) of the 5G ProSe end UE(s) at the 5G ProSe layer-3 UE-to-UE relay UE.

The 5G ProSe direct link context shall be created during a 5G ProSe direct link establishment procedure, be updated accordingly after a 5G ProSe direct link modification procedure or 5G ProSe direct link identifier update procedure and be deleted during the 5G ProSe direct link release procedure or during a local release of 5G ProSe direct link as specified in clause 7.2.

7.2.2 5G ProSe direct link establishment procedure

7.2.2.1 General

Depending on the type of the 5G ProSe direct link establishment procedure (i.e., UE oriented layer-2 link establishment or ProSe service oriented layer-2 link establishment in 3GPP TS 23.304 [2]), the 5G ProSe direct link establishment procedure is used to establish a 5G ProSe direct link between two UEs or to establish multiple 5G ProSe direct links between the UE and multiple target UEs. The UE sending the request message is called the "initiating UE" and the other UE is called the "target UE". If the request message does not indicate the specific target UE (i.e., target user info is not included in the request message) and multiple target UEs are interested in the ProSe application(s) indicated in the request message, then the initiating UE shall handle corresponding response messages received from those target UEs. The maximum number of 5G ProSe direct links established in a UE at a time shall not exceed an implementation-specific maximum number of established 5G ProSe direct links.

NOTE 1: The recommended maximum number of established 5G ProSe direct links is 8.

When the 5G ProSe direct link establishment procedure for a 5G ProSe layer-3 remote UE completes successfully and if there is a PDU session established for relaying the traffic of the 5G ProSe remote UE, the 5G ProSe layer-3 UE-to-network relay UE shall perform the remote UE report procedure as specified in 3GPP TS 24.501 [11].

When the 5G ProSe direct link establishment procedure for a 5G ProSe multi-hop layer-3 remote UE completes successfully and if there is a PDU session established for relaying the traffic of the 5G ProSe multi-hop layer-3 remote UE, the 5G ProSe multi-hop layer-3 UE-to-network relay UE shall perform the remote UE report procedure as specified in 3GPP TS 24.501 [11].

NOTE 2: A single PC5 unicast link is established between a 5G ProSe layer-2 UE-to-network relay UE and a 5G ProSe layer-2 remote UE for supporting PDU sessions of the 5G ProSe layer-2 remote UE, as specified in 3GPP TS 38.300 [21].

7.2.2.2 5G ProSe direct link establishment procedure initiation by initiating UE

The initiating UE shall meet the following pre-conditions before initiating this procedure:

- a) the UE receives
 - 1) a request from upper layers to transmit the packet for ProSe application over PC5;
 - 2) a request from lower layers to trigger 5G ProSe direct link establishment;
 - 3) a PROSE DIRECT LINK ESTABLISHMENT REQUEST message in case of 5G ProSe UE-to-UE relay, to trigger 5G ProSe direct link establishment; or
 - 4) a PROSE DIRECT LINK MODIFICATION REQUEST message in case of 5G ProSe UE-to-UE relay, to trigger 5G ProSe direct link establishment;
- b) the communication mode is unicast mode (e.g., pre-configured as specified in clause 5.2.4 or indicated by upper layers);
- c) the link layer identifier for the initiating UE (i.e., layer-2 ID used for unicast communication) is available (e.g., pre-configured or self-assigned) and is not being used by other existing 5G ProSe direct links within the initiating UE;

- d) the link layer identifier for the destination UE (i.e., the unicast layer-2 ID of the target UE or the broadcast layer-2 ID) is available to the initiating UE (e.g., pre-configured, obtained as specified in clause 5.2, known via prior ProSe direct communication or indicated by lower layers);

NOTE 1A: In the case where different ProSe applications are mapped to distinct default destination layer-2 IDs, when the initiating UE intends to establish a single unicast link that can be used for more than one ProSe identifiers, the UE can select any of the default destination layer-2 ID for unicast initial signalling.

- e) the initiating UE is either authorised for 5G ProSe direct communication over PC5 in NR-PC5 in the serving PLMN or in the serving SNPN, has a valid authorization for 5G ProSe direct communication over PC5 in NR-PC5 when not served by NG-RAN, is authorized to use a 5G ProSe UE-to-network relay UE, is authorized to use a 5G ProSe UE-to-UE relay UE or a 5G ProSe multi-hop UE-to-UE relay UE, or is authorized to act as a 5G ProSe UE-to-UE relay UE or a 5G ProSe multi-hop UE-to-UE relay UE. The UE considers that it is not served by NG-RAN if the following conditions are met:
 - 1) not served by NG-RAN for ProSe direct communication over PC5;
 - 2) in limited service state as specified in 3GPP TS 23.122 [14], if the reason for the UE being in limited service state is one of the following:
 - i) the UE is unable to find a suitable cell in the selected PLMN or the selected SNPN as specified in 3GPP TS 38.304 [15];
 - ii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" or, in case of SNPN, cause #74 "Temporarily not authorized for this SNPN" or cause #75 "Permanently not authorized for this SNPN", as specified in 3GPP TS 24.501 [11];
 - iii) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; or
 - iv) the UE does not have a valid USIM, the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, and the RSC is specific for emergency services; or
 - 3) in limited service state as specified in 3GPP TS 23.122 [14] for reasons other than i), ii), iii) or iv) above and located in a geographical area for which the UE is provisioned with "non-operator managed" radio parameters as specified in clause 5.2;
- f) there is no existing 5G ProSe direct link between the initiating UE and the target UE, or there is an existing 5G ProSe direct link between the initiating UE and the target UE and:
 - 1) the network layer protocol of the existing 5G ProSe direct link is not identical to the network layer protocol required by the upper layer in the initiating UE for this ProSe application;
 - 2) the security policy (either signalling security policy or user plane security policy) corresponding to the ProSe identifier is not compatible with the security policy of the existing 5G ProSe direct link; or
 - 3) if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe layer-3 remote UE and the 5G ProSe layer-3 UE-to-network relay UE, the existing 5G ProSe direct link is established with a different RSC or established not for direct communication between the 5G ProSe layer-3 remote UE and the 5G ProSe layer-3 UE-to-network relay UE;
 - 4) if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe layer-2 remote UE and the 5G ProSe layer-2 UE-to-network relay UE, the existing 5G ProSe direct link is established not for direct communication between the 5G ProSe layer-2 remote UE and the 5G ProSe layer-2 UE-to-network relay UE;
 - 5) if the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, the initiating UE acts as the source 5G ProSe end UE, the existing 5G ProSe direct link is established with a different RSC or established not for direct communication between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE;
 - 6) if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE without integrated discovery, the initiating UE acts as the 5G ProSe UE-to-UE relay UE, the 5G ProSe direct link security mode control procedure between the source

5G ProSe end UE and the initiating UE has been successfully completed, and there is no 5G ProSe direct link established between the initiating UE and the target 5G ProSe end UE with the RSC received in PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the source 5G ProSe end UE for 5G ProSe UE-to-UE relay;

- 7) if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE, the initiating UE acting as the 5G ProSe layer-3 UE-to-UE relay UE receives a PROSE DIRECT LINK ESTABLISHMENT REQUEST message including the relay indication set to 1, and there is no 5G ProSe direct link established between the initiating UE and the target 5G ProSe end UE with the RSC received in PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the source 5G ProSe end UE for 5G ProSe UE-to-UE relay;
- 8) if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE, the initiating UE acting as the 5G ProSe layer-3 UE-to-UE relay UE receives a PROSE DIRECT LINK MODIFICATION REQUEST message to establish 5G ProSe UE-to-UE relay communication with an additional 5G ProSe layer-3 end UE as specified in clause 7.2.3.2, and there is no 5G ProSe direct link established between the initiating UE and the additional target 5G ProSe end UE with the RSC received in PROSE DIRECT LINK MODIFICATION REQUEST message from the source 5G ProSe end UE for 5G ProSe UE-to-UE relay;
- 9) if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE, the initiating UE acts as the 5G ProSe multi-hop layer-3 end UE, the existing 5G ProSe direct link is established with a different RSC or established not for direct communication between the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE;
- fa) if the initiating UE acts as the source 5G ProSe end UE and the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and the 5G ProSe layer-2 UE-to-UE relay UE for communication with a new target 5G ProSe end UE, there is no ongoing 5G ProSe direct link establishment or modification procedure between the initiating UE and the same 5G ProSe layer-2 UE-to-UE relay UE for establishing 5G ProSe UE-to-UE relay communication with a target 5G ProSe end UE;

NOTE 1B: The source 5G ProSe end UE does not initiate any 5G ProSe direct link establishment procedure towards the same 5G ProSe layer-2 UE-to-UE relay UE for communication with a different target 5G ProSe layer-2 end UE, unless any current 5G ProSe direct link establishment or 5G ProSe direct link modification procedure has been completed including reception of the layer-2 ID of the target 5G ProSe end UE from the 5G ProSe layer-2 UE-to-UE relay UE as specified in TS 38.300 [12].

- g) the number of established 5G ProSe direct links is less than the implementation-specific maximum number of established 5G ProSe direct links allowed in the UE at a time; and
- h) timer T5088 is not associated with the link layer identifier for the destination UE or timer T5088 associated with the link layer identifier for the destination UE has already expired or stopped.

If the initiating UE is not acting as a 5G ProSe UE-to-network relay UE or 5G ProSe UE-to-UE relay UE for the existing 5G ProSe direct link, after receiving the service data or request from the upper layers, the initiating UE shall derive the PC5 QoS parameters and assign the PQFI(s) for the PC5 QoS flows(s) to be established as specified in clause 7.2.7.

If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, then the UE shall apply the DUCK or DUSK used for UE-to-network relay discovery along with the UTC-based counter for encrypting:

- a) the relay service code; and
- b) the UP-PRUK ID or CP-PRUK ID, if available,

as specified in clause 6.3.5.2 of 3GPP TS 33.503 [34], and the UE shall use the security protected relay service code and the security protected UP-PRUK ID or security protected CP-PRUK ID for creating a PROSE DIRECT LINK ESTABLISHMENT REQUEST message.

NOTE 2: If the UE is neither configured with DUCK nor DUSK, the relay service code and the UP-PRUK ID or CP-PRUK ID are not encrypted.

If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, then the UE shall apply the DUCK or DUSK associated with the relay service code along with the UTC-based counter for encrypting:

- a) the relay service code; and
- b) the UP-PRUK ID or CP-PRUK ID, if available and the UE does not act as a 5G ProSe UE-to-UE relay UE,

as specified in clause 6.3.5.2 of 3GPP TS 33.503 [34], and the UE shall use the security protected relay service code and, if available and the UE does not act as a 5G ProSe UE-to-UE relay UE, the security protected UP-PRUK ID or security protected CP-PRUK ID for creating a PROSE DIRECT LINK ESTABLISHMENT REQUEST message.

NOTE 2A: If the UE is neither configured with DUCK nor DUSK, the relay service code and the UP-PRUK ID or CP-PRUK ID are not encrypted.

If the 5G ProSe direct link establishment procedure is for ProSe identifier of ranging and sidelink positioning, then the UE shall apply the DUCK or DUSK used for ranging and sidelink positioning UE discovery along with the UTC-based counter for encrypting:

- a) the ProSe identifier of ranging and sidelink positioning; and
- b) the SLPK ID, if available,

as specified in 3GPP TS 33.533 [55], and the UE shall use the security protected ProSe identifier of ranging and sidelink positioning and the security protected SLPK ID for creating a PROSE DIRECT LINK ESTABLISHMENT REQUEST message.

NOTE 2B: If the UE is neither configured with DUCK nor DUSK, the ProSe identifier of ranging and sidelink positioning and the SLPK ID are not encrypted.

In order to initiate the 5G ProSe direct link establishment procedure, the initiating UE shall create a PROSE DIRECT LINK ESTABLISHMENT REQUEST message. The initiating UE:

- a) shall include the source user info set to the initiating UE's application layer ID received from upper layers, or set to the application layer ID of the source 5G ProSe end UE if the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE or between the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE;
- b) shall include the ProSe identifier(s) received from upper layer if the 5G ProSe direct link establishment procedure is not for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE;
- c) shall include the target user info set to the target UE's application layer ID if received from upper layers or if known based on the unicast layer-2 ID of target UE (i.e. destination layer-2 ID) as described in clause 5.8.2.4 of 3GPP TS 23.304 [2], to the user info ID of the 5G ProSe UE-to-network relay UE obtained during the 5G ProSe UE-to-network relay discovery procedure if the initiating UE is acting as a 5G ProSe remote UE, or to the application layer ID of the target 5G ProSe end UE if:
 - 1) the initiating UE is acting as the source 5G ProSe end UE and the application layer ID of the target 5G ProSe end UE is obtained during the 5G ProSe UE-to-UE relay discovery procedure or received from upper layers in case of 5G ProSe direct link establishment with integrated discovery; or
 - 2) the initiating UE is acting as the 5G ProSe UE-to-UE relay UE and the application layer ID of the target 5G ProSe end UE is received in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message or PROSE DIRECT LINK MODIFICATION REQUEST message from the source 5G ProSe end UE;
- ca) shall include the UE-to-UE relay UE user info set to the user info ID of the 5G ProSe UE-to-UE relay UE:
 - 1) if obtained during the 5G ProSe UE-to-UE relay discovery procedure and the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE; or
 - 2) if the initiating UE is acting as the 5G ProSe UE-to-UE relay UE and user info ID is configured at configuration parameters for 5G ProSe UE-to-UE relay as specified in clause 5.2.7;

- cb) shall include the target end UE layer-2 ID set to the layer-2 ID of the target 5G ProSe end UE, if the initiating UE is acting as the source 5G ProSe end UE and the layer-2 ID of the target 5G ProSe end UE is available in the source 5G ProSe end UE via the previous direct communication;
- cc) shall include the UE-to-UE relay UE user info set to the user info ID of the 5G ProSe multi-hop layer-3 UE-to-UE relay UE:
 - 1) if obtained during the 5G ProSe multi-hop UE-to-UE relay discovery procedure and the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE; or
 - 2) if the initiating UE is acting as the 5G ProSe multi-hop layer-3 UE-to-UE relay UE and user info ID is configured at configuration parameters for 5G ProSe multi-hop layer-3 UE-to-UE relay as specified in clause 5.2.9;
- d) if the 5G ProSe direct link is neither for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, nor for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance:
 - 1) shall include the key establishment information container if the UE PC5 unicast signalling integrity protection policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred" and may include the key establishment information container if the UE PC5 unicast signalling integrity protection policy is set to "Signalling integrity protection not needed";

NOTE 3: The key establishment information container is provided by upper layers.

e) shall include:

- 1) a Nonce_1, if the direct communication is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE nor between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE and the direct communication is not for ProSe identifier of ranging and sidelink positioning, or if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE and the security procedure over control plane is used as specified in 3GPP TS 33.503 [34];
- 2) a K_{NRP} freshness parameter 1, if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE and the security procedure over user plane is used as specified in 3GPP TS 33.503 [34]; or
- 3) a K_{SLP} freshness parameter 1, if the direct communication is for ProSe identifier of ranging and sidelink positioning as specified in 3GPP TS 33.533 [55];

set to the 128-bit nonce value generated by the initiating UE for the purpose of session key establishment over this 5G ProSe direct link if the UE PC5 unicast signalling integrity protection policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred";

NOTE 4: The Nonce_1 IE in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message is used to hold the value of Nonce_1 or K_{NRP} freshness parameter 1.

- f) shall include its UE security capabilities indicating the list of algorithms that the initiating UE supports for the security establishment of this 5G ProSe direct link;
- g) shall include the MSB of $K_{NRP-session}$ ID chosen by the initiating UE as specified in 3GPP TS 33.503 [34] if:
 - 1) the direct communication is not for ProSe identifier of ranging and sidelink positioning;
 - 2) the direct communication is not between the target 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance; and
 - 3) the UE PC5 unicast signalling integrity protection policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred";

NOTE 5: If the direct communication is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, nor between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance, the K_{NR}P-sess ID holds the ID that corresponds to K_{NR}P-sess. If the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance, the K_{NR}P-sess ID holds the ID that corresponds to K_{NR}P-sess (if security procedure over user plane is used) or K_{relay}-sess (if security procedure over control plane is used).

g1) shall include the MSB of K_{SLP-sess} ID chosen by the initiating UE as specified in 3GPP TS 33.533 [55] if:

- 1) the direct communication is for ProSe identifier of ranging and sidelink positioning;
 - 2) the direct communication is not between the target 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance; and
 - 3) the UE PC5 unicast signalling integrity protection policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred";
- h) may include a K_{NR}P ID if the initiating UE has an existing K_{NR}P for the target UE and the direct communication is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE nor between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance;
- i) shall include its UE PC5 unicast signalling security policy. In the case where the different ProSe applications are mapped to the different PC5 unicast signalling security policies, when the initiating UE intends to establish a single unicast link that can be used for more than one ProSe application, each of the signalling security policies of those ProSe applications shall be compatible, e.g., "Signalling integrity protection not needed" and "Signalling integrity protection required" are not compatible. If the 5G ProSe direct link establishment procedure is for direct communication between 5G ProSe remote UE and 5G ProSe UE-to-network relay UE, and the RSC is not specific for emergency services, the Signalling integrity protection policy shall be set to "Signalling integrity protection required". If the 5G ProSe direct link establishment procedure is for direct communication between 5G ProSe remote UE and 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, and the initiating UE has a valid USIM, the Signalling integrity protection policy shall be set to "Signalling integrity protection preferred". If the 5G ProSe direct link establishment procedure is for direct communication between 5G ProSe remote UE and 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, and the initiating UE does not have a valid USIM, the Signalling integrity protection policy shall be set to "Signalling integrity protection not needed";
- j) shall include the Relay service code IE set to:
- 1) the relay service code of the target relay UE if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE; or
 - 2) the relay service code indicating the connectivity service requested by the source 5G ProSe end UE if the 5G ProSe direct link establishment procedure is for direct communication between the (source or target) 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;
- k) shall include the UTC-based counter LSB set to the four least significant bits of the UTC-based counter if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;
- l) shall include the UE identity IE set to the SUCI of the initiating UE if:
- 1) the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;
 - 2) the RSC is not specific for emergency services or the initiating UE has a valid USIM; and
 - 3) the security for 5G ProSe UE-to-network relay or 5G ProSe UE-to-UE relay uses the security procedure over control plane and the initiating UE does not have a valid CP-PRUK as specified in 3GPP TS 33.503 [34], or, the security for 5G ProSe UE-to-network relay or 5G ProSe UE-to-UE relay uses the security procedure over user plane and the initiating UE does not have a valid UP-PRUK as specified in 3GPP TS 33.503 [34];
- la) shall include the UE identity IE set to the IMEI or IMEISV of the initiating UE if:

- 1) the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE;
 - 2) the RSC is specific for emergency services; and
 - 3) the initiating UE does not have a valid USIM;
- m) shall include the User security key ID IE set to:
- 1) UP-PRUK ID of the initiating UE if:
 - i) the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;
 - ii) the initiating UE has a valid UP-PRUK; and
 - iii) the security for 5G ProSe UE-to-network relay or 5G ProSe UE-to-UE relay uses the security procedure over user plane as specified in 3GPP TS 33.503 [34];
 - 2) CP-PRUK ID of the initiating UE that is associated with the relay service code of the target UE if:
 - i) the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;
 - ii) the initiating UE has a valid CP-PRUK is associated with the relay service code of the target UE; and
 - iii) the security for 5G ProSe UE-to-network relay or 5G ProSe UE-to-UE relay uses the security procedure over control plane as specified in 3GPP TS 33.503 [34]; or
 - 3) SLPK ID of the initiating UE that is associated with the ProSe identifier of ranging and sidelink positioning if:
 - i) the 5G ProSe direct link establishment procedure is for direct communication for ProSe identifier of ranging and sidelink positioning; and
 - ii) the initiating UE has a valid SLPK is associated with the ProSe identifier of ranging and sidelink positioning;
- n) shall include the HPLMN ID of the initiating UE, if the UP-PRUK ID of the initiating UE is included and is not in NAI format (see 3GPP TS 33.503 [34]);

NOTE 5A: In case of SNPN, the HPLMN ID includes the PLMN ID of the subscribed SNPN.

- o) shall include the MIC IE set to the calculated MIC value as specified in clause 6.3.5.3 of 3GPP TS 33.503 [34] if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE and the UE has the DUIK;
- o1) shall include the MIC IE set to the calculated MIC value as specified in 3GPP TS 33.533 [55] if the 5G ProSe direct link establishment procedure is for ProSe identifier of ranging and sidelink positioning and the UE has the DUIK;
- p) shall include the relay indication which indicates that the PROSE DIRECT LINK ESTABLISHMENT REQUEST message can be forwarded with required changes by a 5G ProSe UE-to-UE relay UE, if the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and 5G ProSe UE-to-UE relay UE with integrated discovery; and
- q) optionally include the hop limit if
 - 1) the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE; and

- 2) the required hop limit by the 5G ProSe multi-hop layer-3 end UE for the 5G ProSe multi-hop layer-3 UE-to-UE relay service is less than the maximum number of hops for the relay service code as configured in clause 5.2.9.

After the PROSE DIRECT LINK ESTABLISHMENT REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the source layer-2 ID and destination layer-2 ID as follows:

- a) if the 5G ProSe direct communication is in a consequence of 5G ProSe direct discovery as defined in clause 6.2.14, clause 6.2.15, clause 8.2.1, clause 8a.2.1, or clause 6.2 in 3GPP TS 24.514 [56]:
self-assign a source layer-2 ID, and
 - 1) the destination layer-2 ID set to the target end UE layer-2 ID if received in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message or PROSE DIRECT LINK MODIFICATION REQUEST message from the source 5G ProSe end UE and if the initiating UE is acting as the 5G ProSe UE-to-UE relay UE; or
 - 2) otherwise, the destination layer-2 ID set to the source layer-2 ID in the received PROSE PC5 DISCOVERY message for discovery announcement or discovery response;
- b) if the initiating UE is acting as the source 5G ProSe end UE and the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and 5G ProSe UE-to-UE relay UE with integrated discovery:
self-assign a source layer-2 ID, and set the destination layer-2 ID to the broadcast destination layer-2 ID configured as specified in clause 5.2.4;
- c) if the initiating UE is acting as the 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe UE-to-UE relay UE and target 5G ProSe end UE with integrated discovery:
self-assign a source layer-2 ID, and set the destination layer-2 ID to:
 - 1) the target end UE layer-2 ID, if received in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the source 5G ProSe end UE; otherwise
 - 2) the broadcast destination layer-2 ID configured as specified in clause 5.2.4; or
- d) otherwise:
self-assign a source layer-2 ID, and the destination layer-2 ID set to the destination layer-2 ID used for unicast initial signalling as specified in clause 5.2.4,

NOTE 6: The UE implementation ensures that any value of the self-assigned source layer-2 ID in a), b), c) and d) is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct discovery as specified in clause 6.2.14, clause 6.2.15, clause 8.2.1 and clause 8a.2.1, and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

NOTE 6A: The UE implementation ensures that any value of the self-assigned source layer-2 ID in a), b) and c) is different from any self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication of a data unit type different from the data unit type of the 5G ProSe direct link being established, if the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE.

NOTE 6B: The UE implementation ensures that any value of the self-assigned source layer-2 ID in a), b) and c) is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication for Unstructured traffic and a different pair of the user info of the source 5G ProSe end UE and the user info of the target 5G ProSe end UE, if the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE and for Unstructured traffic.

NOTE 7: It is possible for the initiating UE to reuse the initiating UE's layer-2 ID used in previous 5G ProSe direct link with the same peer UE, except when the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE for Unstructured traffic and a different pair of the user info of the source 5G ProSe end UE and the user info of the target 5G ProSe end UE, and except when the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE for a data unit type different than the data unit type of the previous 5G ProSe direct link.

and start timer T5080.

NOTE 8: A default PC5 DRX configuration is used for transmitting the PROSE DIRECT LINK ESTABLISHMENT REQUEST message as specified in 3GPP TS 38.300 [21].

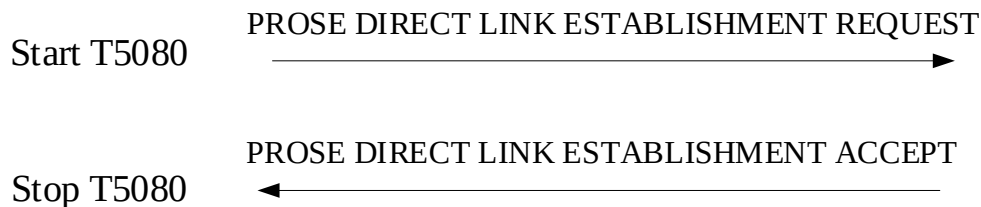
The initiating UE shall not send a new PROSE DIRECT LINK ESTABLISHMENT REQUEST message to the same target UE identified by the same application layer ID while timer T5080 is running. If the target user info IE is not included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message (i.e., ProSe application oriented 5G ProSe direct link establishment procedure), the initiating UE shall handle multiple PROSE DIRECT LINK ESTABLISHMENT ACCEPT messages, if any, received from different target UEs for the establishment of multiple 5G ProSe direct links before the expiry of timer T5080.

The initiating UE, if acting as the source 5G ProSe end UE, shall not send a new PROSE DIRECT LINK ESTABLISHMENT REQUEST message to the same 5G ProSe UE-to-UE relay UE identified by the same user info ID while timer T5080 is running.

NOTE 9: In order to ensure successful 5G ProSe direct link establishment, T5080 should be set to a value larger than the sum of T5089 and T5092.

Initiating UE

Target UE



OR

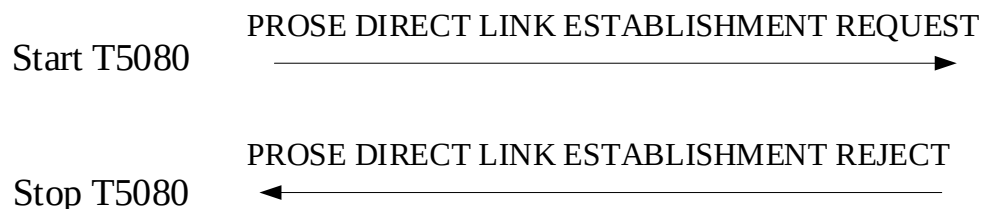


Figure 7.2.2.2.1: UE oriented 5G ProSe direct link establishment procedure

Initiating UE

Target UE

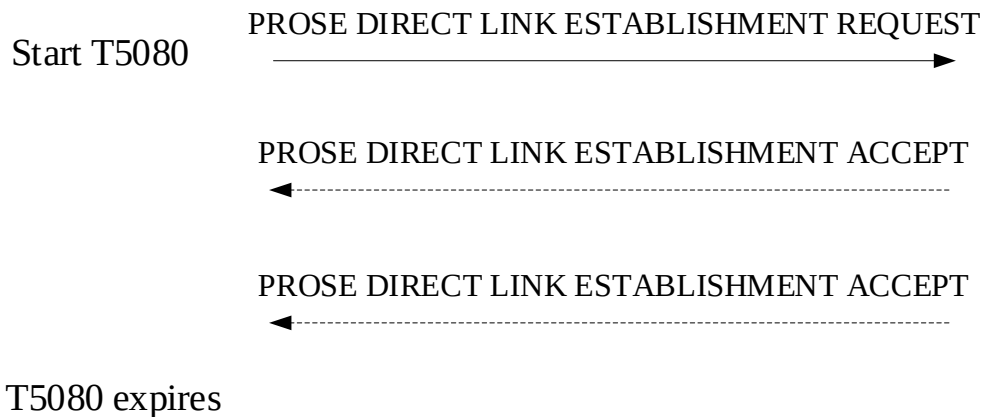


Figure 7.2.2.2.2: ProSe service oriented 5G ProSe direct link establishment procedure

7.2.2.3 5G ProSe direct link establishment procedure accepted by the target UE

Upon receipt of a PROSE DIRECT LINK ESTABLISHMENT REQUEST message, if the target UE accepts this request, the target UE shall uniquely assign a PC5 link identifier, create a 5G ProSe direct link context.

NOTE 1: A default PC5 DRX configuration is used for receiving the PROSE DIRECT LINK ESTABLISHMENT REQUEST message as specified in 3GPP TS 38.300 [21].

If the PROSE DIRECT LINK ESTABLISHMENT REQUEST message is for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the target UE shall verify the MIC field in the received PROSE DIRECT LINK ESTABLISHMENT REQUEST with the DUK, if any, and decrypts the encrypted:

- a) relay service code; and
- b) UP-PRUK ID or CP-PRUK ID, if received,

using the DUCK or DUSK used for 5G ProSe UE-to-network relay discovery (see clause 6.3.5.2 of 3GPP TS 33.503 [34]), and verifies if the relay service code matches with the one that the target UE has sent during 5G ProSe UE-to-network relay discovery procedure. To retrieve the DUK for integrity verification and retrieve the DUCK or DUSK for decryption, the target UE shall use the Destination Layer-2 ID of the received PROSE DIRECT LINK ESTABLISHMENT REQUEST message. The target UE shall match the destination layer-2 ID with the source layer-2 ID stored in the maintained association for the UE-to-network relay discovery procedure as described in clause 8.2.1.2.2.2 and clause 8.2.1.3.2.2. For the matched source layer-2 ID, the target UE shall use the associated relay service code to identify the provisioned DUK, DUCK or DUSK.

NOTE 2: If the UE is neither configured with DUCK nor DUSK, the relay service code and the UP-PRUK ID or CP-PRUK ID are not encrypted.

If the PROSE DIRECT LINK ESTABLISHMENT REQUEST message is for 5G ProSe direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, the target UE shall verify the MIC field in the received PROSE DIRECT LINK ESTABLISHMENT REQUEST with the DUK, if any, and decrypts the encrypted:

- a) relay service code; and
- b) UP-PRUK ID or CP-PRUK ID, if received,

using the DUCK or DUSK used for 5G ProSe UE-to-UE relay discovery (see clause 6.3.5.2 of 3GPP TS 33.503 [34]), and verifies if the relay service code matches with the one that the target UE has sent during 5G ProSe UE-to-UE relay discovery procedure.

NOTE 2A: If the UE is neither configured with DUCK nor DUSK, the relay service code and the UP-PRUK ID or CP-PRUK ID are not encrypted.

If the PROSE DIRECT LINK ESTABLISHMENT REQUEST message is for ProSe identifier of ranging and sidelink positioning, the target UE shall verify the MIC field in the received PROSE DIRECT LINK ESTABLISHMENT REQUEST with the DUIK, if any, and decrypts the encrypted:

- a) the ProSe identifier of ranging and sidelink positioning; and
- b) the SLPK ID, if available,

using the DUCK or DUSK used for ranging and sidelink positioning UE discovery, and verifies if the ProSe identifier of ranging and sidelink positioning matches with the one that the target UE has sent during ranging and sidelink positioning UE discovery.

NOTE 2B: If the UE is neither configured with DUCK nor DUSK, the ProSe identifier of ranging and sidelink positioning and the SLPK ID are not encrypted.

If the target UE is acting as the target 5G ProSe end UE and the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe UE-to-UE relay UE and target 5G ProSe end UE with integrated discovery, the target UE upon reception of the PROSE DIRECT LINK ESTABLISHMENT REQUEST messages which contain the same source user info, ProSe identifier(s) and relay service code as received from multiple 5G ProSe UE-to-UE relay UEs, selects one of the 5G ProSe UE-to-UE relay UEs via which to communicate with the source 5G ProSe end UE as specified in TS 23.304, clause 6.7.3.2.

If the 5G ProSe direct link establishment procedure is neither for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, nor for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance, and the 5G ProSe direct link establishment procedure is not for direct communication for ProSe identifier of ranging and sidelink positioning, the target UE may initiate 5G ProSe direct link authentication procedure as specified in clause 7.2.12 and shall initiate 5G ProSe direct link security mode control procedure as specified in clause 7.2.10.

If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, or for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance, upon reception of the PROSE DIRECT LINK ESTABLISHMENT REQUEST messages, and the initiating UE is identified by a SUCI, a CP-PRUK ID or a UP-PRUK ID, the target UE shall proceed with either:

- a) the authentication and key agreement procedure as specified in clause 5.5.4 of 3GPP TS 24.501 [11] if the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used; or
- b) the key request procedure as specified in clause 8.2.10.2.4 if the security procedure over user plane as specified in 3GPP TS 33.503 [34] is used;

and if:

- a) the security procedure over control plane or the security procedure over user plane as specified in 3GPP TS 33.503 [34] is completed successfully; or
- b) the security procedure over control plane or the security procedure over user plane as specified in 3GPP TS 33.503 [34] fails, the RSC is specific for emergency services, and providing 5G ProSe direct link for emergency services without 5G ProSe direct link security is required by the target UE's configuration;

shall initiate 5G ProSe direct link security mode control procedure as specified in clause 7.2.10.

NOTE 3: The target UE's configuration that indicates whether providing 5G ProSe direct link for emergency services without 5G ProSe direct link security is required or not is set based on the regulation and the operator policy. It is up to implementation how this information is known in the target UE.

If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE using the security procedure with network assistance, upon reception of the PROSE

DIRECT LINK ESTABLISHMENT REQUEST messages, the target UE shall proceed with 5G ProSe direct link security request procedure as specified in clause 8a.2.10.

If the 5G ProSe direct link establishment procedure is for direct communication for ProSe identifier of ranging and sidelink positioning, the target UE shall proceed with the SLP key request procedure as specified in clause 8.3.1.1.2 in 3GPP TS 24.514 [56], and shall initiate 5G ProSe direct link security mode control procedure as specified in clause 7.2.10.

If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, the initiating UE is identified by a PEI, and providing 5G ProSe direct link for emergency services without 5G ProSe direct link security is required by the target UE's configuration, the target UE shall initiate 5G ProSe direct link security mode control procedure as specified in clause 7.2.10.

The target UE shall set the source layer-2 ID and the destination layer-2 ID as specified in clause 7.2.12 and clause 7.2.10, and store the corresponding source layer-2 ID for unicast communication and the destination layer-2 ID for unicast communication in the 5G ProSe direct link context.

If:

- a) the target user info IE is included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message and this IE includes the target UE's application layer ID; or
- b) the target user info IE is not included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message and the target UE is interested in the ProSe application(s) identified by the ProSe identifier IE in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message;

then the target UE shall:

- a) if the direct communication is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, nor for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance, nor for direct communication for ProSe identifier of ranging and sidelink positioning:
 - 1) identify an existing K_{NRP} based on the K_{NRP} ID included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message; or
 - 2) if K_{NRP} ID is not included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, the target UE does not have an existing K_{NRP} for the K_{NRP} ID included in PROSE DIRECT LINK ESTABLISHMENT REQUEST message or the target UE wishes to derive a new K_{NRP} , derive a new K_{NRP} . This may require performing one or more 5G ProSe direct link authentication procedures as specified in clause 7.2.12;
- b) if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, the initiating UE is identified by a SUCI or a CP-PRUK ID, and the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, request a new $K_{\text{NR-ProSe}}$ according to the security procedure over user plane as specified in 3GPP TS 33.503 [34];
- c) if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, the initiating UE is identified by a SUCI or a UP-PRUK ID, and the security procedure over user plane as specified in 3GPP TS 33.503 [34] is used, request a new K_{NRP} according to the security procedure over user plane; and

NOTE 4: How many times the 5G ProSe direct link authentication procedure needs to be performed to derive a new K_{NRP} depends on the authentication method used.

- d) if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, the initiating UE is identified by a PEI, and providing 5G ProSe direct link for emergency services without 5G ProSe direct link security is required by the target UE's configuration, generate a new K_{NRP} in an implementation defined way.
- e) if the 5G ProSe direct link establishment procedure is for direct communication for ProSe identifier of ranging and sidelink positioning, request a new K_{SLP} according to the security procedure as specified in 3GPP TS 33.533 [55].

If the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, the security procedure over control plane or the security procedure over user plane as specified in 3GPP TS 33.503 [34] fails, and providing 5G ProSe direct link for emergency services without 5G ProSe direct link security is required by the target UE's configuration, the target UE shall generate a new K_{NR_ProSe} or K_{NRP} in an implementation defined way.

After an existing K_{NRP} or K_{SLP} was identified or a new K_{NRP} or K_{SLP} was derived, or after a new K_{NRP} or K_{NR_ProSe} or K_{SLP} is received or a new K_{NR_ProSe} or K_{NRP} were generated, the target UE shall initiate a 5G ProSe direct link security mode control procedure as specified in clause 7.2.10.

Upon successful completion of the 5G ProSe direct link security mode control procedure, in order to determine whether the PROSE DIRECT LINK ESTABLISHMENT REQUEST message can be accepted or not, in case of IP communication, the target UE checks whether there is at least one common IP address configuration option supported by both the initiating UE and the target UE.

If the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, the security procedure over control plane or the security procedure over user plane as specified in 3GPP TS 33.503 [34] fails, and providing 5G ProSe direct link for emergency services without 5G ProSe direct link security is required by the target UE's configuration, before sending the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message to the 5G ProSe remote UE, the target UE shall perform the 5G ProSe direct link identification procedure to fetch the PEI of the 5G ProSe remote UE.

Before sending the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message to the 5G ProSe remote UE, the target UE acting as a 5G ProSe layer-3 UE-to-network relay UE initiates the UE requested PDU session establishment procedure as specified in 3GPP TS 24.501 [11] if:

- 1) the PDU session for relaying the service associated with the RSC has not been established yet; or
- 2) the PDU session for relaying the service associated with the RSC has been established but the PDU session type is Unstructured.

If the target UE accepts the 5G ProSe direct link establishment procedure, the target UE shall create a PROSE DIRECT LINK ESTABLISHMENT ACCEPT message. The target UE:

- a) shall include the source user info set to the target UE's application layer ID received from upper layers, or set to the application layer ID of the target 5G ProSe end UE if the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;
- aa) shall include the UE-to-UE relay UE user info set to the user info ID of the 5G ProSe UE-to-UE relay UE if the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;
- ab) shall include the UE-to-UE relay UE user info set to the user info ID of the 5G ProSe multi-hop layer-3 UE-to-UE relay UE if the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE;
- b) shall include PQFI(s), the corresponding PC5 QoS parameters and optionally the ProSe identifier(s) that the target UE accepts, if the target UE is not acting as a 5G ProSe layer-2 UE-to-network relay UE and the 5G ProSe direct link establishment procedure is not with integrated discovery;
- c) may include the PC5 QoS rule(s) if the target UE is not acting as a 5G ProSe layer-2 UE-to-network relay UE and the 5G ProSe direct link establishment procedure is not with integrated discovery;
- d) shall include an IP address configuration IE set to one of the following values if IP communication is used and the target UE is not acting as a 5G ProSe layer-2 UE-to-network relay UE, 5G ProSe layer-2 UE-to-UE relay UE or 5G ProSe layer-3 UE-to-UE relay UE using the security procedure with network assistance:
 - 1) "DHCPv4 server" if only IPv4 address allocation mechanism is supported by the target UE, i.e., acting as a DHCPv4 server;
 - 2) "IPv6 router" if only IPv6 address allocation mechanism is supported by the target UE, i.e., acting as an IPv6 router;
 - 3) "DHCPv4 server & IPv6 Router" if both IPv4 and IPv6 address allocation mechanism are supported by the target UE; or

- 4) "address allocation not supported" if neither IPv4 nor IPv6 address allocation mechanism is supported by the target UE and the target UE is not acting as a 5G ProSe layer-3 UE-to-network relay UE;

NOTE 5: The UE doesn't include an IP address configuration IE nor a link local IPv6 address IE if Ethernet or Unstructured data unit type is used for communication.

- e) shall include a link local IPv6 address IE formed locally based on IETF RFC 4862 [25] if IP address configuration IE is set to "address allocation not supported", the received PROSE DIRECT LINK SECURITY MODE COMPLETE message included a link local IPv6 address IE and the target UE is not acting as a 5G ProSe layer-2 UE-to-network relay UE, 5G ProSe layer-3 UE-to-network relay UE, or 5G ProSe layer-2 UE-to-UE relay UE or 5G ProSe layer-3 UE-to-UE relay UE using the security procedure with network assistance;
- f) shall include the configuration of UE PC5 unicast user plane security protection based on the agreed user plane security policy, as specified in 3GPP TS 33.503 [34]. If the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, and:
- 1) the security procedure over control plane or the security procedure over user plane as specified in 3GPP TS 33.503 [34] fails; or
 - 2) the initiating UE is identified by a PEI;
- the target UE shall include the user plane integrity protection configuration set to "off" and the user plane ciphering configuration set to "off";
- g) if the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source or target 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, and for Ethernet traffic, shall include the MAC address of the target 5G ProSe layer-3 end UE;
- ga) if the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source or target 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE, and for Ethernet traffic, shall include the MAC address of the target 5G ProSe multi-hop layer-3 end UE; and
- h) may include a target 5G ProSe layer-3 end UE IP address IE set to the IP address of the target 5G ProSe layer-3 end UE, if the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, and the data unit type for the communication is IP.

After the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message is generated, the target UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication and shall start timer T5090 if:

- a) at least one of ProSe identifiers for the 5G ProSe direct links satisfies the privacy requirements as specified in clause 5.2.4; or
- b) T5090 is configured as specified in clause 5.2.5.

NOTE 6: Two UEs negotiate the PC5 DRX configuration in the AS layer, and the PC5 DRX parameter values are configured per pair of source and destination Layer-2 IDs in the AS layer, as specified in 3GPP TS 38.300 [21].

After sending the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message, the target UE shall provide the following information along with the layer-2 IDs to the lower layer, which enables the lower layer to handle the coming PC5 signalling or traffic data:

- a) the PC5 link identifier self-assigned for this 5G ProSe direct link;
- b) PQFI(s) and its corresponding PC5 QoS parameters, if available;
- c) an indication of activation of the PC5 unicast user plane security protection for the 5G ProSe direct link, if applicable; and
- d) an indication of emergency services for the 5G ProSe direct link if the 5G ProSe direct link is established with the RSC specific for emergency services between the 5G ProSe layer-2 remote UE and the 5G ProSe layer-2 UE-to-network relay UE.

If the target UE accepts the 5G ProSe direct link establishment request and the 5G ProSe direct link is established not for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE and not for 5G ProSe direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, then the target UE may perform the PC5 QoS flow establishment over 5G ProSe direct link as specified in clause 7.2.7. If the 5G ProSe direct link is established for 5G ProSe direct communication between the 5G ProSe layer-3 remote UE and the 5G ProSe layer-3 UE-to-network relay UE, then the target UE may perform the PC5 QoS flow establishment over 5G ProSe direct link as specified in clause 8.2.6. If the 5G ProSe direct link is established for 5G ProSe direct communication between the 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, then the target UE may perform the PC5 QoS flow establishment over 5G ProSe direct link as specified in clause 8a.2.7.

7.2.2.4 5G ProSe direct link establishment procedure completion by the initiating UE

If the 5G ProSe direct link establishment procedure is not for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and:

- if the Target user info IE is included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, upon receipt of the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message, the initiating UE shall stop timer T5080; or
- if the Target user info IE is not included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, the initiating UE may keep the timer T5080 running and continue to handle multiple response messages (i.e., the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message) from multiple target UEs.

If the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and 5G ProSe UE-to-UE relay UE, and:

- if the UE-to-UE relay UE user info IE is included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, upon receipt of the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message, the initiating UE shall stop timer T5080; or
- if the UE-to-UE relay UE user info IE is not included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message (i.e. the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and 5G ProSe UE-to-UE relay UE with integrated discovery), the initiating UE may keep the timer T5080 running and continue to handle multiple response messages (i.e., the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message) from multiple target UEs.

If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe multi-hop layer-3 end UE and 5G ProSe multi-hop layer-3 UE-to-UE relay UE, and:

- if the UE-to-UE relay UE user info IE is included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, upon receipt of the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message, the initiating UE shall stop timer T5080.

For each of the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message received, the initiating UE shall uniquely assign a PC5 link identifier and create a 5G ProSe direct link context for each of the 5G ProSe direct link(s). Then the initiating UE shall store the source layer-2 ID and the destination layer-2 ID used in the transport of this message provided by the lower layers in the 5G ProSe direct link context(s) to complete the establishment of the 5G ProSe direct link with the target UE(s). From this time onward the initiating UE shall use the established link(s) for ProSe direct communication over PC5 and additional PC5 signalling messages to the target UE(s).

If the initiating UE is acting as the 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe UE-to-UE relay UE and target 5G ProSe end UE with integrated discovery, the initiating UE upon receipt of the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message from the target 5G ProSe end UE, shall initiate the 5G ProSe direct link security mode control procedure with the source 5G ProSe end UE, and the initiating UE upon successful completion of the 5G ProSe direct link security mode control procedure with the source 5G ProSe end UE, shall create a PROSE DIRECT LINK ESTABLISHMENT ACCEPT message as specified in clause 7.2.2.3 to send to the source 5G ProSe end UE. If the target user info IE is not included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, the initiating UE acting as the 5G ProSe UE-to-UE relay UE may initiate the 5G ProSe direct link security mode control procedure with the source 5G ProSe end UE after handling multiple response messages (i.e., the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message) from multiple target end UEs. If the target user info IE is not included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, the initiating UE acting as the 5G ProSe UE-to-UE relay UE may initiate the 5G ProSe direct link modification procedure to add additional target 5G ProSe end UE to the source 5G ProSe end UE

after handling multiple response messages (i.e., the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message) from multiple target end UEs.

After receiving the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message, the initiating UE shall provide the following information along with the layer-2 IDs to the lower layer, which enables the lower layer to handle the coming PC5 signalling or traffic data:

- a) the PC5 link identifier self-assigned for this 5G ProSe direct link;
- b) PQFI(s) and its corresponding PC5 QoS parameters, if available; and
- c) an indication of activation of the PC5 unicast user plane security protection for the 5G ProSe direct link, if applicable.

The initiating UE shall start timer T5090 if:

- a) at least one of ProSe identifiers for the 5G ProSe direct links satisfies the privacy requirements as specified in clause 5.2.4; or
- b) T5090 is configured as specified in clause 5.2.5.

In addition, the initiating UE may perform the PC5 QoS flow establishment over 5G ProSe direct link as specified in clause 7.2.7.

Upon expiry of the timer T5080, if:

- the 5G ProSe direct link establishment procedure is not for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the PROSE DIRECT LINK ESTABLISHMENT REQUEST message did not include the Target user info IE; or
- the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the PROSE DIRECT LINK ESTABLISHMENT REQUEST message did not include the UE-to-UE relay UE user info IE;

and the initiating UE received at least one PROSE DIRECT LINK ESTABLISHMENT ACCEPT message, it is up to the UE implementation to consider the 5G ProSe direct link establishment procedure as complete or to restart the timer T5080.

If the 5G ProSe direct link establishment procedure is triggered by a PROSE DIRECT LINK MODIFICATION REQUEST message from the source 5G ProSe layer-3 end UE as specified in clause 7.2.3.2, upon receipt of the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message, the initiating UE shall send a PROSE DIRECT LINK MODIFICATION ACCEPT message to the source 5G ProSe layer-3 end UE as specified in clause 7.2.3.3, if the initiating UE acts as the 5G ProSe layer-3 UE-to-UE relay UE.

If the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE, for Ethernet traffic, and the initiating UE acting as the 5G ProSe layer-3 UE-to-UE relay UE detects that the MAC address of the target 5G ProSe layer-3 end UE in the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message is not unique, i.e., the MAC address of the target 5G ProSe layer-3 end UE was also provided by another 5G ProSe layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe layer-3 UE-to-UE relay UE shall perform 5G ProSe direct link release procedure as specified in clause 7.2.6.

If the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe multi-hop layer-3 UE-to-UE relay UE and the target 5G ProSe multi-hop layer-3 end UE or between any two 5G ProSe multi-hop layer-3 UE-to-UE relay UE, for Ethernet traffic, and the initiating UE acting as the 5G ProSe layer-3 UE-to-UE relay UE detects that the MAC address of the target 5G ProSe layer-3 end UE in the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message is not unique, i.e., the MAC address of the target 5G ProSe layer-3 end UE was also provided by another 5G ProSe layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe layer-3 UE-to-UE relay UE shall perform 5G ProSe direct link release procedure as specified in clause 7.2.6.

7.2.2.5 5G ProSe direct link establishment procedure not accepted by the target UE

If the PROSE DIRECT LINK ESTABLISHMENT REQUEST message cannot be accepted, the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message. The PROSE DIRECT LINK ESTABLISHMENT REJECT message contains a PC5 signalling protocol cause IE set to one of the following cause values:

- #1 direct communication to the target UE not allowed;
- #3 conflict of layer-2 ID for unicast communication is detected;
- #5 lack of resources for 5G ProSe direct link;
- #13 congestion situation;
- #15 security procedure failure of 5G ProSe UE-to-network relay;
- #22 security procedure failure of 5G ProSe UE-to-UE relay;
- #20 Failure from 5G ProSe end UE;
- #21 5G ProSe direct link already exists;
- #23 MAC address not unique;
- #25 triggering security procedure not possible; or
- #111 protocol error, unspecified.

If the target UE is not allowed to accept the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, e.g., based on operator policy or configuration parameters for ProSe direct communication over PC5 as specified in clause 5.2, or the target UE is acting as a 5G ProSe layer-3 UE-to-network relay UE, is in non-allowed area of its serving PLMN or serving SNPN, and the corresponding relay service code is not associated with high priority access as defined in clause 5.3.5 of 3GPP TS 24.501 [11], the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #1 "direct communication to the target UE not allowed".

NOTE 1: When the target UE acting as a 5G ProSe layer-3 UE-to-network relay UE is involved into its own emergency services as specified in 3GPP TS 24.501 [11] or is handling an emergency services of another 5G ProSe layer-3 remote UE, and receives PROSE DIRECT LINK ESTABLISHMENT REQUEST message with an RSC that is specific for emergency services, the target UE is allowed to ignore the PROSE DIRECT LINK ESTABLISHMENT REQUEST message if the target UE decides to prioritize its own ongoing emergency services or prioritize the handling of the emergency services of the other 5G ProSe layer-3 remote UE, due to local regulations or implementation specific requirements.

For a received PROSE DIRECT LINK ESTABLISHMENT REQUEST message from a layer-2 ID (for unicast communication), if the target UE already has an existing link established to a UE using this layer-2 ID or is currently processing a PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the same layer-2 ID and with one of following parameters different from the existing link or the link for which the link establishment is in progress:

- a) the source user info;
- b) type of data (e.g., IP, Ethernet or Unstructured); or
- c) security policy,

the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #3 "conflict of layer-2 ID for unicast communication is detected".

NOTE 2: If the UE is processing a PROSE DIRECT DISCOVERY message from the same source layer-2 ID of the received PROSE DIRECT LINK ESTABLISHMENT REQUEST message, it depends on UE implementation to avoid the conflict of destination layer-2 ID (e.g. send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #3 "conflict of layer-2 ID for unicast communication is detected", or ignore the PROSE DIRECT DISCOVERY message).

NOTE 3: The type of data (e.g., IP, Ethernet or Unstructured) is indicated by the optional IP address configuration IE included in the corresponding DIRECT LINK SECURITY MODE COMPLETE message, i.e., the type of data for the requested link is IP type if this IE is included and the type of data for the requested link is Ethernet or Unstructured if this IE is not included.

If the 5G ProSe direct link establishment fails due to the implementation-specific maximum number of established 5G ProSe direct links has been reached, or other temporary lower layer problems causing resource constraints, the target

UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #5 "lack of resources for 5G ProSe direct link".

If the target UE receives a DIRECT LINK ESTABLISHMENT REQUEST message from a source UE, and the target UE does not have valid long-term credentials (see 3GPP TS 33.536[37]) to establish a secure link, the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #25 "triggering security procedure not possible".

If the 5G ProSe direct link establishment request is for 5G ProSe UE-to-network relaying and:

- a) the NAS level mobility management congestion control as specified in clause 5.3.9 of TS 24.501 [11] is activated at the target UE acting as the 5G ProSe UE-to-network relay UE; or
- b) the target UE acting as the 5G ProSe UE-to-network relay UE is under congestion;

the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #13 "congestion situation". The target UE may provide a back-off timer value to the initiating UE in the PROSE DIRECT LINK ESTABLISHMENT REJECT message. The target UE shall not accept any 5G ProSe direct link establishment request for relaying if the back-off timer for NAS level mobility management congestion control is running.

If the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, for Ethernet traffic, and the target UE acting as the 5G ProSe layer-3 UE-to-UE relay UE detects that the MAC address of the source 5G ProSe layer-3 end UE in the PROSE DIRECT LINK SECURITY MODE COMPLETE message is not unique, i.e., the MAC address of the source 5G ProSe layer-3 end UE was also provided by another 5G ProSe layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe layer-3 UE-to-UE relay UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #23 "MAC address not unique" to the source 5G ProSe layer-3 end UE.

If the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE or between any two 5G ProSe multi-hop layer-3 UE-to-UE relay UE, for Ethernet traffic, and the target UE acting as the 5G ProSe multi-hop layer-3 UE-to-UE relay UE detects that the MAC address of the source 5G ProSe multi-hop layer-3 end UE in the PROSE DIRECT LINK SECURITY MODE COMPLETE message is not unique, i.e., the MAC address of the source 5G ProSe multi-hop layer-3 end UE was also provided by another 5G ProSe multi-hop layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #23 "MAC address not unique" to the source 5G ProSe multi-hop layer-3 end UE or the 5G ProSe multi-hop layer-3 UE-to-UE relay UE.

If the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE with integrated discovery, for Ethernet traffic, and the target UE acting as the 5G ProSe layer-3 UE-to-UE relay UE detects that the MAC address of the source 5G ProSe layer-3 end UE in the PROSE DIRECT LINK SECURITY MODE COMPLETE message is not unique, i.e., the MAC address of the source 5G ProSe layer-3 end UE was also provided by another 5G ProSe layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe layer-3 UE-to-UE relay UE may perform 5G ProSe direct link release procedure with PC5 signalling protocol cause value #111 "protocol error, unspecified" toward the target 5G ProSe layer-3 end UE as specified in clause 7.2.6.

If the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, for Ethernet traffic, and the target UE acting as the 5G ProSe layer-3 UE-to-UE relay UE releases the 5G ProSe direct link between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE with PC5 signalling protocol cause value #23 "MAC address not unique", the 5G ProSe layer-3 UE-to-UE relay UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #111 "protocol error, unspecified" to the source 5G ProSe layer-3 end UE.

If the 5G ProSe direct link establishment request is for 5G ProSe UE-to-network relaying, the NAS level session management congestion as specified in clause 6.2.7 and in clause 6.2.8 of TS 24.501 [11] is activated at the target UE which is acting as a 5G ProSe layer-3 UE-to-network relay UE, and the relay service code used in the 5G ProSe direct link establishment corresponds to a DNN and/or S-NSSAI for which the NAS level session management congestion is activated, and the target UE needs to perform the PDU session establishment procedure for the DNN and/or S-NSSAI or the PDU session modification procedure for the DNN and/or S-NSSAI, then the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #13 "congestion

situation". The target UE may provide a back-off timer value to the initiating UE in the PROSE DIRECT LINK ESTABLISHMENT REJECT message.

NOTE 4: How the target UE determines that it is under congestion is implementation specific (e.g., any relaying related operational overhead, etc).

NOTE 5: In case the target UE is under the NAS level mobility management congestion control, it is an implementation option that the provided back-off timer value to the initiating UE is set to the remaining time of the mobility management back-off timer T3346 or with an additional offset value.

If the 5G ProSe direct link establishment request is for 5G ProSe layer-3 UE-to-network relaying, the PDU session for relaying the service is an LADN PDU session, and the target UE acting as a 5G ProSe layer-3 UE-to-network relay UE is outside the LADN service area, the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #111 "protocol error, unspecified".

If the 5G ProSe direct link establishment request is for 5G ProSe layer-3 UE-to-network relaying, the request required the establishment of a PDU session by the 5G ProSe layer-3 UE-to-network relay UE which is a target UE, and the PDU session establishment was unsuccessful due to the reception of 5GSM cause #8 "maximum number of PDU sessions reached", #27 "Missing or unknown DNN", #28 "Unknown PDU session type", #29 "user authentication or authorization failed", #31 "request rejected, unspecified", #32 "service option not supported", #33 "requested service option not subscribed", #46 "out of LADN service area", or #65 "maximum number of PDU sessions reached" as specified in 3GPP TS 24.501 [11], the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #111 "protocol error, unspecified".

If the 5G ProSe direct link establishment request is for 5G ProSe UE-to-UE relay and:

- a) the target UE acting as a target 5G ProSe end UE is under congestion;

the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #13 "congestion situation". The target UE may provide a back-off timer value to the initiating UE in the PROSE DIRECT LINK ESTABLISHMENT REJECT message.

The initiating UE, acting as a 5G ProSe UE-to-UE relay UE, upon reception of PROSE DIRECT LINK ESTABLISHMENT REJECT message from the target 5G ProSe end UE, and the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, the target 5G ProSe end UE has rejected the 5G ProSe direct link establishment procedure or the 5G ProSe direct link modification procedure, the reject message contains a backoff value, and the initiating UE has not reached the maximum number of allowed retransmissions, the initiating UE shall send PROSE DIRECT LINK ESTABLISHMENT REJECT message to the source 5G ProSe end UE including a PC5 signalling cause value set to #20 "Failure from 5G ProSe end UE" and the backoff timer received from the target 5G ProSe end UE and the cause value from the target 5G ProSe end UE.

The UE acting as a source 5G ProSe end UE, upon reception of the PROSE DIRECT LINK ESTABLISHMENT REJECT message from the initiating UE acting as a 5G ProSe UE-to-UE relay UE, shall not re-attempt for the 5G ProSe direct link establishment procedure to the same target 5G ProSe end UE until the backoff timer has expired.

The initiating UE, acting as a 5G ProSe UE-to-UE relay UE, upon reception of PROSE DIRECT LINK ESTABLISHMENT REJECT message from the target 5G ProSe end UE, the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, the target 5G ProSe end UE has rejected the 5G ProSe direct link establishment procedure or the 5G ProSe direct link modification procedure, the reject message contains a backoff value, and the initiating UE has reached the maximum number of allowed retransmissions, the initiating UE may send a PROSE DIRECT LINK ESTABLISHMENT REJECT message with the appropriate PC5 signalling protocol cause value to the source 5G ProSe end UE. The initiating UE shall include in the PROSE DIRECT LINK ESTABLISHMENT REJECT message PC5 protocol cause value #20 "Failure from 5G ProSe end UE" and include the PC5 end UE failure cause IE set to #13 "congestion situation" received from the target 5G ProSe end UE that has rejected the 5G ProSe direct link establishment or 5G ProSe direct link modification procedure. The initiating UE may include the target end UE info IE set to the user info of the target 5G ProSe end UE in the PROSE DIRECT LINK ESTABLISHMENT REJECT message.

The UE acting as a source 5G ProSe end UE, upon reception of PROSE DIRECT LINK ESTABLISHMENT REJECT message from the initiating UE acting as a 5G ProSe UE-to-UE relay UE, may abort the 5G ProSe direct link establishment procedure and may notify the upper layer that the target 5G ProSe end UE is unreachable, if the PC5 signalling protocol cause value in the PROSE DIRECT LINK ESTABLISHMENT REJECT message is #20 "Failure from 5G ProSe end UE" and the PC5 end UE failure cause IE is set to #13 "congestion situation".

If the 5G ProSe direct link establishment request is for 5G ProSe UE-to-UE relay and:

- a) the target UE acting as a 5G ProSe UE-to-UE relay UE is under congestion;

the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #13 "congestion situation". The target UE may provide a back-off timer value to the initiating UE in the PROSE DIRECT LINK ESTABLISHMENT REJECT message.

The initiating UE acting as a source 5G ProSe end UE, upon reception of PROSE DIRECT LINK ESTABLISHMENT REJECT message from the target UE acting as a 5G ProSe UE-to-UE relay UE, may abort the 5G ProSe direct link establishment procedure and may select another 5G ProSe UE-to-UE Relay to establish a PC5 link with the same target 5G ProSe end UE, if the PC5 signalling protocol cause value in the PROSE DIRECT LINK ESTABLISHMENT REJECT message is #13 "congestion situation".

If the target UE is acting as the 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link security establishment procedure is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE and:

- a) the indicated security procedure is without network assistance; and
- b) the 5G ProSe UE-to-UE relay UE does not have valid long-term credentials, as specified in 3GPP TS 33.536 [37];

the 5G ProSe UE-to-UE relay UE shall send PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #25 "triggering security procedure not possible" to the source 5G ProSe end UE.

If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE and it fails due to a failure in the security procedure over control plane or security procedure over user plane as specified in 3GPP TS 33.503 [34], the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #15 "security procedure failure of 5G ProSe UE-to-network relay". The target UE shall provide the EAP message if received from the network according to the security procedure over control plane as specified in 3GPP TS 33.503 [34].

NOTE 6: The cause value #15 "security procedure failure of 5G ProSe UE-to-network relay" is also used when the CP-PRUK or the UP-PRUK is not found in the network.

If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE and it fails due to a failure in the security procedure over control plane or security procedure over user plane as specified in 3GPP TS 33.503 [34], the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #22 "security procedure failure of 5G ProSe UE-to-UE relay". The target UE shall provide the EAP message if received from the network according to the security procedure over control plane as specified in 3GPP TS 33.503 [34].

NOTE 7: The cause value #22 "security procedure failure of 5G ProSe UE-to-UE relay" is also used when the CP-PRUK or the UP-PRUK is not found in the network.

If the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and is using the security procedure with network assistance, and the target UE acting as the 5G ProSe UE-to-UE relay UE is not in NG-RAN coverage; the 5G ProSe UE-to-UE relay UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #25 "triggering security procedure not possible" to the source 5G ProSe end UE.

If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe UE-to-UE relay UE and target 5G ProSe end UE with integrated discovery and a 5G ProSe direct link for the pair of initiating UE user info and target UE user info already exists and the data type unit is IP or Ethernet, the target UE acting as a target 5G ProSe end UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message to the 5G ProSe UE-to-UE relay UE containing PC5 signalling protocol cause value #21 "5G ProSe direct link already exists".

If the target UE is acting as a target 5G ProSe end UE and the 5G ProSe direct link establishment procedure is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE, the target 5G ProSe end UE may include in the PROSE DIRECT LINK ESTABLISHMENT REJECT message:

- a) the source end UE info IE set to the user info of the source 5G ProSe end UE;
- b) the target end UE info IE set to the user info of the target 5G ProSe end UE; and

- c) the UE-to-UE relay UE info IE set to the user info ID of the 5G ProSe UE-to-UE relay UE.

If the target UE is acting as a 5G ProSe UE-to-UE relay UE, the 5G ProSe direct link establishment procedure is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the target 5G ProSe end UE has rejected the 5G ProSe direct link establishment procedure or the 5G ProSe direct link modification procedure, then the 5G ProSe UE-to-UE relay UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message with PC5 signalling protocol cause value #20 "Failure from 5G ProSe end UE" to the source 5G ProSe end UE. The 5G ProSe UE-to-UE relay UE may include in the PROSE DIRECT LINK ESTABLISHMENT REJECT message the PC5 end UE failure cause IE set to the PC5 signalling protocol cause received from the target 5G ProSe end UE that has rejected the 5G ProSe direct link establishment procedure. The 5G ProSe UE-to-UE relay UE may include in the PROSE DIRECT LINK ESTABLISHMENT REJECT message:

- a) the source end UE info IE set to the user info of the source 5G ProSe end UE;
- b) the target end UE info IE set to the user info of the target 5G ProSe end UE; and
- c) the UE-to-UE relay UE info IE set to the user info ID of the 5G ProSe UE-to-UE relay UE.

If the 5G ProSe direct link establishment fails due to other reasons, the target UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #111 "protocol error, unspecified".

After sending the PROSE DIRECT LINK ESTABLISHMENT REJECT message, the target UE shall provide the following information along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication to the lower layer:

- a) an indication of deactivation of the PC5 unicast security protection and deletion of security context for the 5G ProSe direct link, if applicable.

Upon receipt of the PROSE DIRECT LINK ESTABLISHMENT REJECT message, the initiating UE shall stop timer T5080 and abort the 5G ProSe direct link establishment procedure.

If the PC5 signalling protocol cause value in the PROSE DIRECT LINK ESTABLISHMENT REJECT message is #1 "direct communication to the target UE not allowed" or #5 "lack of resources for 5G ProSe direct link", then the initiating UE shall not attempt to start the 5G ProSe direct link establishment procedure with the same target UE at least for a time period T.

NOTE 8: The length of time period T is UE implementation specific and can be different for the case when the UE receives PC5 signalling protocol cause value #1 "direct communication to the target UE not allowed" or when the UE receives PC5 signalling protocol cause value #5 "lack of resources for 5G ProSe direct link".

If the PC5 signalling protocol cause value in the PROSE DIRECT LINK ESTABLISHMENT REJECT message is #13 "congestion situation" and a back-off timer value is provided in the PROSE DIRECT LINK ESTABLISHMENT REJECT message, the initiating UE shall start timer T5088 associated with the layer-2 ID of the target UE and set its value to the provided timer value.

If the PC5 signalling protocol cause value in the PROSE DIRECT LINK ESTABLISHMENT REJECT message is #15 "security procedure failure of 5G ProSe UE-to-network relay", and initiating UE, acting as the 5G ProSe remote UE, has included the UE identity IE set to SUCI in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, then the initiating UE shall initiate the UE-to-network relay reselection procedure as specified in clause 8.2.3. If the PC5 signalling protocol cause value in the PROSE DIRECT LINK ESTABLISHMENT REJECT message is #15 "security procedure failure of 5G ProSe UE-to-network relay" and the initiating UE, acting as the 5G ProSe remote UE, has included the User security key ID IE set to UP-PRUK ID or CP-PRUK ID in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, then the initiating UE may initiate the UE-to-network relay reselection procedure as specified in clause 8.2.3 and the UE shall further:

- a) if the same 5G ProSe UE-to-network relay UE is selected, discard the previously used CP-PRUK and associated CP-PRUK ID, or the UP-PRUK and associated UP-PRUK ID, if any, and include the UE identity IE set to SUCI in the PROSE DIRECT LINK ESTABLISHMENT REQUEST when initiating the subsequent 5G ProSe direct link establishment procedure as specified in clause 7.2.2.2; or
- b) if a different 5G ProSe UE-to-network relay UE is selected, include the User security key ID IE set to the previously used UP-PRUK ID or CP-PRUK ID in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message.

If the PC5 signalling protocol cause value in the PROSE DIRECT LINK ESTABLISHMENT REJECT message is #22 "security procedure failure of 5G ProSe UE-to-UE relay", and initiating UE, acting as the 5G ProSe end UE, has included the UE identity IE set to SUCI in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, then the initiating UE shall initiate the UE-to-UE relay reselection procedure as specified in clause 8a.2.3. If the PC5 signalling protocol cause value in the PROSE DIRECT LINK ESTABLISHMENT REJECT message is #22 "security procedure failure of 5G ProSe UE-to-UE relay" and the initiating UE, acting as the 5G ProSe end UE, has included the User security key ID IE set to UP-PRUK ID or CP-PRUK ID in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, then the initiating UE may initiate the UE-to-UE relay reselection procedure as specified in clause 8a.2.3 and the UE shall further:

- a) if the same 5G ProSe UE-to-UE relay UE is selected, discard the previously used CP-PRUK and associated CP-PRUK ID, or the UP-PRUK and associated UP-PRUK ID, if any, and include the UE identity IE set to SUCI in the PROSE DIRECT LINK ESTABLISHMENT REQUEST when initiating the subsequent 5G ProSe direct link establishment procedure as specified in clause 7.2.2.2; or
- b) if a different 5G ProSe UE-to-UE relay UE is selected, include the User security key ID IE set to the previously used UP-PRUK ID or CP-PRUK ID in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message.

If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe UE-to-UE relay UE and target 5G ProSe end UE and the PC5 signalling protocol cause value in the PROSE DIRECT LINK ESTABLISHMENT REJECT message is #21 "5G ProSe direct link already exists", then the initiating UE acting as the 5G ProSe UE-to-UE relay UE may initiate the 5G ProSe direct link modification procedure with the target UE to associate the source 5G ProSe end UE user info and the ProSe identifiers, as specified in the rejected PROSE DIRECT LINK ESTABLISHMENT REQUEST message, to the existing 5G ProSe direct link.

After receiving the PROSE DIRECT LINK ESTABLISHMENT REJECT message, the initiating UE shall provide the following information along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication to the lower layer:

- a) an indication of deactivation of the PC5 unicast security protection and deletion of security context for the 5G ProSe direct link, if applicable.

7.2.2.6 Abnormal cases

7.2.2.6.1 Abnormal cases at the initiating UE

If timer T5080 expires, and if:

- the 5G ProSe direct link establishment procedure is not for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the Target user info IE was included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message; or
- the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the UE-to-UE relay UE user info IE was included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message;

the initiating UE shall retransmit the PROSE DIRECT LINK ESTABLISHMENT REQUEST message and restart timer T5080. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct link establishment procedure and may notify the upper layer that the target UE is unreachable. If the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE, and the initiating UE is acting as a 5G ProSe UE-to-UE relay UE, the initiating UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message to the source 5G ProSe end UE.

Upon expiry of the timer T5080, if:

- the 5G ProSe direct link establishment procedure is not for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the PROSE DIRECT LINK ESTABLISHMENT REQUEST message did not include the Target user info IE; or
- the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the PROSE DIRECT LINK ESTABLISHMENT REQUEST message did not include the UE-to-UE relay UE user info IE;

the PROSE DIRECT LINK ESTABLISHMENT REQUEST message did not include the Target user info IE and the initiating UE did not receive any PROSE DIRECT LINK ESTABLISHMENT ACCEPT message, the initiating UE may retransmit the PROSE DIRECT LINK ESTABLISHMENT REQUEST message and restart timer T5080. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct link establishment procedure and may notify the upper layer that no target UE is available.

NOTE: The maximum number of allowed retransmissions is UE implementation specific.

If the need to establish a link no longer exists before the procedure is completed, the initiating UE shall abort the procedure.

When the initiating UE aborts the 5G ProSe direct link establishment procedure, the initiating UE shall provide the following information along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication to the lower layer:

- a) an indication of deactivation of the PC5 unicast security protection and deletion of security context for the 5G ProSe direct link, if applicable.

7.2.2.6.2 Abnormal cases at the target UE

For a received PROSE DIRECT LINK ESTABLISHMENT REQUEST message from a source layer-2 ID (for unicast communication), if the target UE already has an existing link established to the UE known to use the same source layer-2 ID, the same source user info, the same type of data (IP, Ethernet or Unstructured) and the same security policy, the UE shall process the new request. However, the target UE shall only delete the existing 5G ProSe direct link context after the new link establishment procedure succeeds.

NOTE: The type of data (e.g., IP, Ethernet or Unstructured) is indicated by the optional IP address configuration IE included in the corresponding PROSE DIRECT LINK SECURITY MODE COMPLETE message, i.e., the type of data for the requested link is IP type if this IE is included and the type of data for the requested link is Ethernet or Unstructured if this IE is not included.

If the PROSE DIRECT LINK ESTABLISHMENT REQUEST message is for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, after the target UE decrypts the encrypted relay service code using the DUSK or DUCK used for 5G ProSe UE-to-network relay discovery, if the relay service code does not match with the one that the target UE has sent during 5G ProSe UE-to-network relay discovery procedure, then the target UE shall abort the 5G ProSe direct link establishment procedure.

If the PROSE DIRECT LINK ESTABLISHMENT REQUEST message is for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the message is integrity protected and the integrity verification of the message fails at the target UE, then the target UE shall abort the 5G ProSe direct link establishment procedure.

7.2.3 5G ProSe direct link modification procedure

7.2.3.1 General

The purpose of the 5G ProSe direct link modification procedure is to modify the existing ProSe direct link to:

- a) add new PC5 QoS flow(s) to the existing 5G ProSe direct link;
- b) modify existing PC5 QoS flow(s) for updating PC5 QoS parameters of the existing PC5 QoS flow(s);
- c) modify existing PC5 QoS flow(s) for associating new ProSe application(s) with the existing PC5 QoS flow(s);
- d) modify existing PC5 QoS flow(s) for removing the associated ProSe application(s) from the existing PC5 QoS flow(s);
- e) remove existing PC5 QoS flow(s) from the existing 5G ProSe direct link;
- f) negotiate a new 5G ProSe UE-to-UE relay UE over the existing 5G ProSe direct link;
- g) establish 5G ProSe UE-to-UE relay communication with additional 5G ProSe layer-3 end UE(s) using the existing 5G ProSe direct link between the 5G ProSe layer-3 end UE and 5G ProSe layer-3 UE-to-UE relay UE;

- h) release 5G ProSe UE-to-UE relay communication with one of the peer 5G ProSe layer-3 end UEs using the shared 5G ProSe direct link between the 5G ProSe layer-3 end UE and 5G ProSe layer-3 UE-to-UE relay UE;
- i) establish 5G ProSe UE-to-UE relay communication with additional 5G ProSe layer-2 end UE(s) using the existing 5G ProSe direct link between the 5G ProSe layer-2 end UE and 5G ProSe layer-2 UE-to-UE relay UE; or
- j) for 5G ProSe layer-2 UE-to-UE relay, remove existing PC5 QoS flow(s) from the existing 5G ProSe direct link between the 5G ProSe layer-2 end UE and the 5G ProSe layer-2 UE-to-UE relay UE, when the end-to-end 5G ProSe direct link is released.

In this procedure, the UE sending the PROSE DIRECT LINK MODIFICATION REQUEST message is called the "initiating UE" and the other UE is called the "target UE".

NOTE: The 5G ProSe direct link modification procedure is not applicable for 5G ProSe layer-2 UE-to-network relay case.

7.2.3.2 5G ProSe direct link modification procedure initiated by initiating UE

The initiating UE shall meet the following pre-conditions before initiating this procedure for adding a new ProSe application to the existing 5G ProSe direct link:

- a) there is a 5G ProSe direct link between the initiating UE and the target UE;
- b) the pair of application layer IDs and the network layer protocol of this 5G ProSe direct link are identical to those required by the application layer in the initiating UE for this ProSe application, if the initiating UE is not acting as a 5G ProSe UE-to-network relay UE or 5G ProSe UE-to-UE relay UE for the existing 5G ProSe direct link;
- c) the security policy corresponding to the ProSe identifier is aligned with the security policy of the existing 5G ProSe direct link;
- d) the timer T5091 is not running; and
- e) the initiating UE is not performing the 5G ProSe direct link re-keying procedure initiated by the target UE.

The initiating UE shall meet the following pre-conditions before initiating this procedure for negotiating a new 5G ProSe UE-to-UE relay UE over the existing 5G ProSe direct link:

- a) there is a 5G ProSe direct link between the initiating UE and the target UE;
- b) the initiating UE is a source 5G ProSe end UE communicating with the target 5G ProSe end UE via a 5G ProSe UE-to-UE relay UE;
- c) the initiating UE determines, e.g., based on PC5 signal strength, to perform UE-to-UE relay reselection; and
- d) the initiating UE obtains a list of candidate UE-to-UE relays via UE-to-UE discovery procedure.

The initiating UE shall meet the following pre-conditions before initiating this procedure for establishing 5G ProSe UE-to-UE relay communication with an additional 5G ProSe layer-3 end UE over the existing 5G ProSe direct link:

- a) there is a 5G ProSe direct link between the initiating UE and the target UE;
- b) the initiating UE acts as a 5G ProSe layer-3 end UE and the target UE acts as a 5G ProSe layer-3 UE-to-UE relay UE, or vice versa;
- c) the initiating UE, if acting as a 5G ProSe layer-3 end UE, determines to communicate with an additional 5G ProSe layer-3 end UE using the same RSC as that of the existing 5G ProSe direct link; and
- d) the initiating UE, if acting as a 5G ProSe layer-3 UE-to-UE relay UE, receives a request from another 5G ProSe layer-3 end UE to communicate with the target UE using the same RSC as that of the existing 5G ProSe direct link.

If the initiating UE is not acting as a 5G ProSe UE-to-network relay UE or 5G ProSe UE-to-UE relay UE for the existing 5G ProSe direct link, after receiving the service data or request from the upper layers, the initiating UE shall perform the PC5 QoS flow match as specified in clause 7.2.8. If there is no matched PC5 QoS flow, the initiating UE

shall derive the PC5 QoS parameters and assign the PQFI(s) for the PC5 QoS flows(s) to be established as specified in clause 7.2.7.

If the 5G ProSe direct link modification procedure is to add new PC5 QoS flow(s) to the existing 5G ProSe direct link, the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message. In this message, initiating UE:

- a) shall include the PQFI(s), the corresponding PC5 QoS parameters and optionally the ProSe identifier(s);
- b) shall include the link modification operation code set to "Add new PC5 QoS flow(s) to the existing 5G ProSe direct link";
- c) may include the PC5 QoS rule(s) to indicate the packet filters of the PC5 QoS flow(s);
- d) shall include the source end UE info set to the user info of the source 5G ProSe layer-3 end UE, if the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE, the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE, and multiple source 5G ProSe layer-3 end UEs have established direct communication with the target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
- e) may include the source end UE info set to the user info of the source 5G ProSe end UE, if the UE acts as a 5G ProSe UE-to-UE relay UE, the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE, and only one source 5G ProSe end UE has established direct communication with the target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link;
- f) shall include the target end UE info set to the user info of the target 5G ProSe layer-3 end UE, if the UE acts as a source 5G ProSe layer-3 end UE, the 5G ProSe direct link is between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, and the source 5G ProSe layer-3 end UE has established direct communication with multiple target 5G ProSe layer-3 end UEs via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
- g) may include the target end UE info set to the user info of the target 5G ProSe end UE, if:
 - 1) the UE acts as a source 5G ProSe end UE, the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the source 5G ProSe end UE has established direct communication with only one target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link; or
 - 2) the UE acts as a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE;
- h) may include the target end UE layer-2 ID set to the layer-2 ID of the target 5G ProSe end UE, if the UE acts as a source 5G ProSe end UE and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE; and
- i) for Ethernet traffic, shall additionally include the MAC address of the source 5G ProSe layer-3 end UE, if the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE, the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE and the 5G ProSe direct link modification procedure is to provide the MAC address of the source 5G ProSe layer-3 end UE to the target 5G ProSe layer-3 end UE.

If the 5G ProSe direct link modification procedure is to modify the PC5 QoS parameters for existing PC5 QoS flow(s) in the existing 5G ProSe direct link, the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message. In this message, the initiating UE:

- a) shall include the PQFI(s) and the corresponding PC5 QoS parameters, including the ProSe identifier(s);
- b) shall include the link modification operation code set to "Modify PC5 QoS parameters of the existing PC5 QoS flow(s)";
- c) may include the PC5 QoS rule(s) to indicate the packet filters of the PC5 QoS flow(s);
- d) shall include the source end UE info set to the user info of the source 5G ProSe layer-3 end UE, if the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE, the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE, and multiple source 5G ProSe layer-3 end UEs have

established direct communication with the target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;

- e) may include the source end UE info set to the user info of the source 5G ProSe end UE, if the UE acts as a 5G ProSe UE-to-UE relay UE, the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE, and only one source 5G ProSe end UE has established direct communication with the target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link;
- f) shall include the target end UE info set to the user info of the target 5G ProSe layer-3 end UE, if the UE acts as a source 5G ProSe layer-3 end UE, the 5G ProSe direct link is between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, and the source 5G ProSe layer-3 end UE has established direct communication multiple target 5G ProSe layer-3 end UEs via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
- g) may include the target end UE info set to the user info of the target 5G ProSe end UE, if:
 - 1) the UE acts as a source 5G ProSe end UE, the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the source 5G ProSe end UE has established direct communication with only one target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link; or
 - 2) the UE acts as a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE; and
- h) may include the target end UE layer-2 ID set to the destination layer-2 ID of the target 5G ProSe end UE, if the UE acts as a source 5G ProSe end UE and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

If the 5G ProSe direct link modification procedure is to associate new ProSe application(s) with existing PC5 QoS flow(s), the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message. In this message, the initiating UE:

- a) shall include the PQFI(s) and the corresponding PC5 QoS parameters, including the ProSe identifier(s);
- b) shall include the link modification operation code set to "Associate new ProSe application(s) with existing PC5 QoS flow(s)";
- c) may include the PC5 QoS rule(s) to indicate the packet filters of the PC5 QoS flow(s);
- d) shall include the source end UE info set to the user info of the source 5G ProSe layer-3 end UE, if the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE, the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE, and multiple source 5G ProSe layer-3 end UEs have established direct communication with the target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
- e) may include the source end UE info set to the user info of the source 5G ProSe end UE, if the UE acts as a 5G ProSe UE-to-UE relay UE, the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE, and only one source 5G ProSe end UE has established direct communication with the target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link;
- f) shall include the target end UE info set to the user info of the target 5G ProSe layer-3 end UE, if the UE acts as a source 5G ProSe layer-3 end UE, the 5G ProSe direct link is between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, and the source 5G ProSe layer-3 end UE has established direct communication with multiple target 5G ProSe layer-3 end UEs via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
- g) may include the target end UE info set to the user info of the target 5G ProSe end UE, if:
 - 1) the UE acts as a source 5G ProSe end UE, the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the source 5G ProSe end UE has established direct communication with only one target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link; or
 - 2) the UE acts as a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE; and

- h) may include the target end UE layer-2 ID set to the layer-2 ID of the target 5G ProSe end UE, if the UE acts as a source 5G ProSe end UE and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

If the PC5 5G ProSe direct link modification procedure is to remove the associated ProSe application(s) from existing PC5 QoS flow(s), the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message. In this message, the initiating UE:

- a) shall include the PQFI(s) and the corresponding PC5 QoS parameters including the ProSe identifier(s); and
- b) shall include the link modification operation code set to "Remove ProSe application(s) from existing PC5 QoS flow(s)".

If the direct link modification procedure is to remove any PC5 QoS flow(s) from the existing 5G ProSe direct link, the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message. In this message, the initiating UE:

- a) shall include the PQFI(s); and
- b) shall include the link modification operation code set to "Remove existing PC5 QoS flow(s) from the existing 5G ProSe direct link".

If the 5G ProSe direct link modification procedure is to establish 5G ProSe UE-to-UE relay communication with additional 5G ProSe layer-3 end UE using the existing 5G ProSe direct link between the 5G ProSe layer-3 end UE and 5G ProSe layer-3 UE-to-UE relay UE, the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message. In this message, the initiating UE:

- a) shall include the source end UE info set to the user info of the source 5G ProSe layer-3 end UE and the target end UE info set to the user info of the target 5G ProSe layer-3 end UE received in PROSE DIRECT LINK ESTABLISHMENT REQUEST message, if the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE;
- b) for Ethernet traffic, shall include the MAC address of the source 5G ProSe layer-3 end UE, if the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE and shall include the MAC address of the source 5G ProSe layer-3 end UE, if:
 - 1) the UE acts as a source 5G ProSe layer-3 UE-to-UE end UE;
 - 2) the MAC address of the source 5G ProSe layer-3 end UE changed; and
 - 3) the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the source 5G ProSe layer-3 end UE;
- b1) for Ethernet traffic, shall include the MAC address of the target 5G ProSe layer-3 end UE, if:
 - 1) the UE acts as the 5G ProSe layer-3 UE-to-UE relay UE; and
 - 2) the 5G ProSe direct link is between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE;
- c) shall include the target end UE info set to the user info of the additional target 5G ProSe layer-3 end UE to which the 5G ProSe UE-to-UE relay communication is requested, if the UE acts as a source 5G ProSe layer-3 end UE or a 5G ProSe layer-3 UE-to-UE relay UE, and the 5G ProSe direct link is between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE;
- d) shall include the link modification operation code set to "Add new 5G ProSe layer-3 end UE to the existing 5G ProSe direct link";
- e) may include the PQFI(s) and the corresponding PC5 QoS parameters including the ProSe identifier(s);
- f) may include the PC5 QoS rule(s) to indicate the packet filters of the PC5 QoS flow(s); and
- g) may include the target end UE layer-2 ID set to the layer-2 ID of the target 5G ProSe layer-3 end UE, if the UE acts as a source 5G ProSe layer-3 end UE and the 5G ProSe direct link is between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE.

If the 5G ProSe direct link modification procedure is to establish 5G ProSe UE-to-UE relay communication with additional 5G ProSe layer-2 end UE using the existing 5G ProSe direct link between the 5G ProSe layer-2 end UE and 5G ProSe layer-2 UE-to-UE relay UE, the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message. In this message, the initiating UE:

- a) shall include the source end UE info set to the user info of the source 5G ProSe layer-2 end UE and the target end UE info set to the user info of the target 5G ProSe layer-2 end UE received in PROSE DIRECT LINK ESTABLISHMENT REQUEST message, if the UE acts as a 5G ProSe layer-2 UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe layer-2 UE-to-UE relay UE and the target 5G ProSe layer-2 end UE;
- b) shall include the target end UE info set to the user info of the additional target 5G ProSe layer-2 end UE to which the 5G ProSe UE-to-UE relay communication is requested, if the UE acts as a source 5G ProSe layer-2 end UE and the 5G ProSe direct link is between the source 5G ProSe layer-2 end UE and the 5G ProSe layer-2 UE-to-UE relay UE; and
- c) shall include the link modification operation code set to "Add new 5G ProSe layer-2 end UE to the existing 5G ProSe direct link".

The initiating UE, if acting as the source 5G ProSe end UE, shall meet the following pre-conditions before initiating this procedure for establishing 5G ProSe UE-to-UE relay communication with additional 5G ProSe end UE via the same 5G ProSe layer-2 UE-to-UE relay UE:

- a) there is no ongoing 5G ProSe direct link establishment or modification procedure between the initiating UE and the 5G ProSe layer-2 UE-to-UE relay UE for establishing 5G ProSe UE-to-UE relay communication with a target 5G ProSe end UE.

NOTE: The source 5G ProSe end UE does not initiate any 5G ProSe direct link modification procedure towards the same 5G ProSe layer-2 UE-to-UE relay UE for communication with a different target 5G ProSe layer-2 end UE, unless any current 5G ProSe direct link establishment or 5G ProSe direct link modification procedure has been completed including reception of the layer-2 ID of the target 5G ProSe end UE from the 5G ProSe layer-2 UE-to-UE relay UE as specified in TS 38.300 [12].

If the 5G ProSe direct link modification procedure is to release 5G ProSe UE-to-UE relay communication with one of the peer 5G ProSe layer-3 end UEs using the shared 5G ProSe direct link between the 5G ProSe layer-3 end UE and 5G ProSe layer-3 UE-to-UE relay UE, the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message. In this message, initiating UE:

- a) shall include the source end UE info set to the source user info of the 5G ProSe layer-3 end UE received in the PROSE DIRECT LINK RELEASE REQUEST message, if the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the 5G ProSe layer-3 end UE;
- b) shall include the target end UE info set to the user info of the peer 5G ProSe layer-3 end UE with which the 5G ProSe UE-to-UE relay communication is to be released, if the UE acts as a 5G ProSe layer-3 end UE and the 5G ProSe direct link is between the 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE; and
- c) shall include the link modification operation code set to "Remove 5G ProSe layer-3 end UE from the existing 5G ProSe direct link".

If the 5G ProSe direct link modification procedure is to trigger the negotiated 5G ProSe layer-3 UE-to-UE relay reselection, the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message. In this message:

- a) If the initiating UE acts as a source 5G ProSe layer-3 end UE and the 5G ProSe direct link is between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, the initiating UE:
 - 1) shall include the relay reselection indication;
 - 2) shall include the list of user info IDs of the candidates 5G ProSe UE-to-UE relay UEs supporting the same RSC used for the existing 5G ProSe direct link;
 - 3) shall include the list of target 5G ProSe end UEs IP address/prefix, if IP communication is used; and
 - 4) may include the list of layer-2 IDs of the candidates 5G ProSe UE-to-UE relay UEs supporting the same RSC used for the existing 5G ProSe direct link; or

- b) If the initiating UE acts as a 5G ProSe layer-3 UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe end UE, the initiating UE:
- 1) shall include the relay reselection indication;
 - 2) shall include the list of user info IDs of the candidates 5G ProSe UE-to-UE relay UEs supporting the same RSC used for the existing 5G ProSe direct link;
 - 3) shall include the initiating source 5G ProSe UE IP address/prefix, if IP communication is used; and
 - 4) may include list of layer-2 IDs of the candidates 5G ProSe UE-to-UE relay UEs supporting the same RSC used for the existing 5G ProSe direct link.

If the 5G ProSe direct link modification procedure is to trigger the negotiated 5G ProSe layer-3 UE-to-UE relay reselection and the initiating UE acts as a 5G ProSe layer-3 UE-to-UE relay UE, the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message for every IP address/prefix of the target 5G ProSe layer-3 end UEs received on the associated PROSE DIRECT LINK MODIFICATION REQUEST message from the source 5G ProSe layer-3 end UE.

If the 5G ProSe direct link modification procedure is to trigger the negotiated 5G ProSe layer-2 UE-to-UE relay reselection, the initiating UE shall create a PROSE DIRECT LINK MODIFICATION REQUEST message. In this message:

- a) shall include the relay reselection indication;
- b) shall include the list of candidates 5G ProSe UE-to-UE relay UE user info ID;
- c) shall include the new MSBs of K_{NRP} ID; and
- d) may include the list of candidates 5G ProSe UE-to-UE relay UE layer-2 ID.

If the 5G ProSe direct link modification procedure is to trigger the negotiated 5G ProSe UE-to-UE relay reselection, the initiating UE shall include the link modification operation code IE set to a value other than the reserved value as specified in clause 11.3.19 in the PROSE DIRECT LINK MODIFICATION REQUEST message.

After the PROSE DIRECT LINK MODIFICATION REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID for 5G ProSe direct communication and start timer T5081. The UE shall not send a new PROSE DIRECT LINK MODIFICATION REQUEST message to the same target UE while timer T5081 is running.

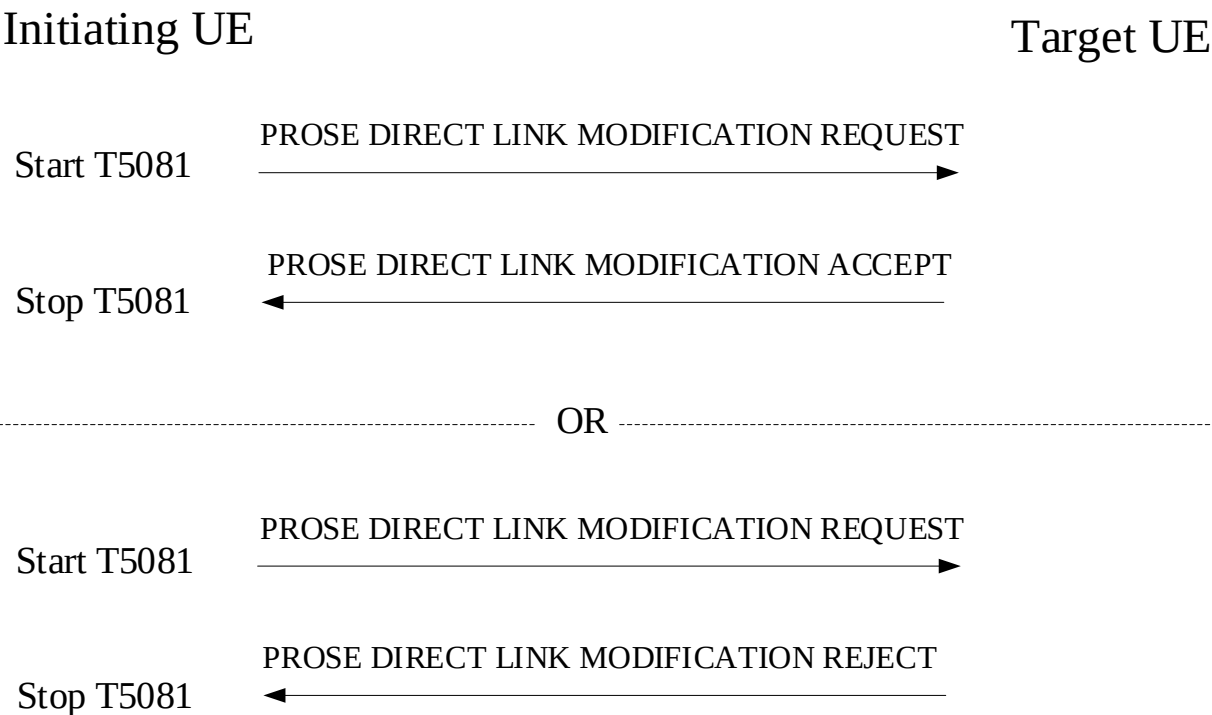


Figure 7.2.3.2.1: 5G ProSe direct link modification procedure

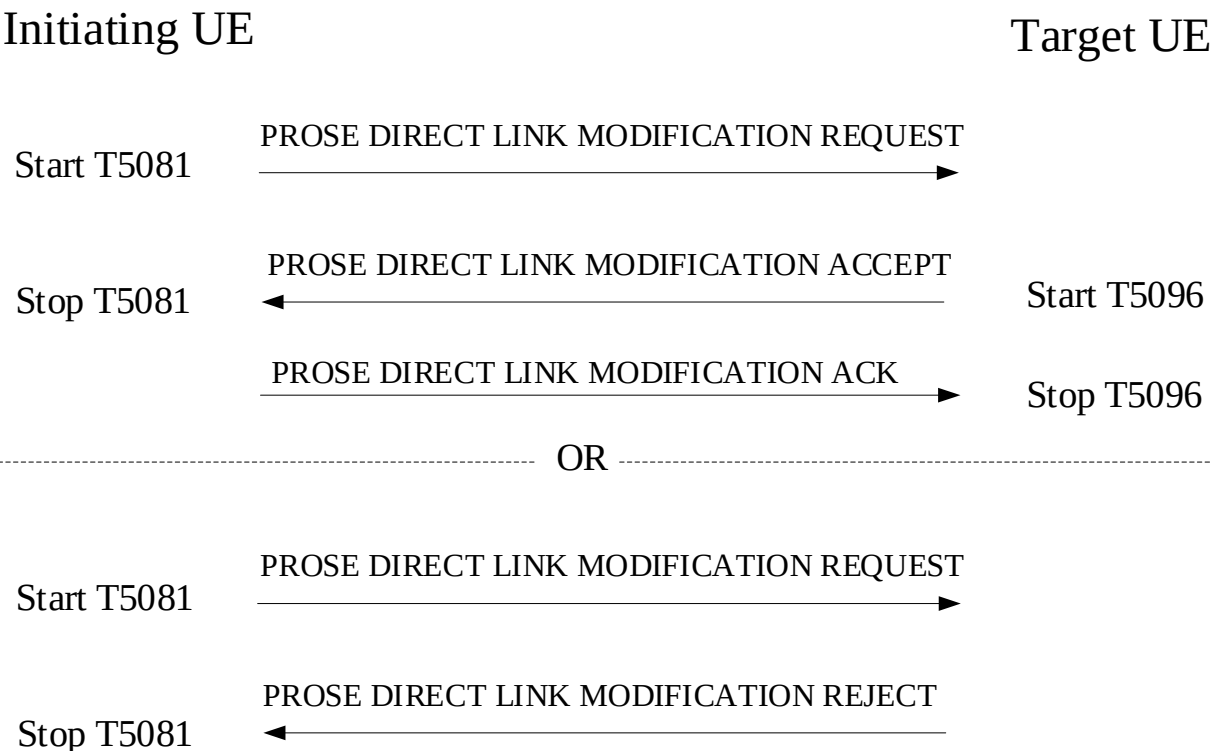


Figure 7.2.3.2.2: 5G ProSe direct link modification procedure for the negotiated 5G ProSe layer-3 UE-to-UE relay reselection

7.2.3.3 5G ProSe direct link modification procedure accepted by the target UE

If the PROSE DIRECT LINK MODIFICATION REQUEST message is accepted, the target UE shall respond with the PROSE DIRECT LINK MODIFICATION ACCEPT message.

If the PROSE DIRECT LINK MODIFICATION REQUEST message is to add a new ProSe application, add new PC5 QoS flow(s) or modify any existing PC5 QoS flow(s) in the 5G ProSe direct link, the target UE:

- a) shall include the PQFI(s), the corresponding PC5 QoS parameters and optionally the ProSe identifier(s) that the target UE accepts;
- b) may include the PC5 QoS rule(s) to indicate the packet filters of the PC5 QoS flow(s);
- c) shall include the source end UE info set to the user info of the source 5G ProSe layer-3 end UE, if the UE acts as a target 5G ProSe layer-3 end UE, the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE, and the target 5G ProSe layer-3 end UE has established direct communication with multiple source 5G ProSe layer-3 end UEs via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
- d) may include the source end UE info set to the user info of the source 5G ProSe end UE, if the UE acts as a target 5G ProSe end UE, the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE, and the target 5G ProSe end UE has established direct communication with only one source 5G ProSe end UEs via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link;
- e) shall include the target end UE info set to the user info of the target 5G ProSe end UE, if the UE acts as a 5G ProSe UE-to-UE relay UE and, the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the source 5G ProSe layer-3 end UE has established direct communication with multiple target 5G ProSe layer-3 end UEs via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link; and
- f) may include the target end UE info set to the user info of the target 5G ProSe end UE, if the UE acts as a 5G ProSe UE-to-UE relay UE, the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the source 5G ProSe end UE has established direct communication with only one target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link;

in the PROSE DIRECT LINK MODIFICATION ACCEPT message.

If the PROSE DIRECT LINK MODIFICATION REQUEST message is to remove an existing ProSe application from the 5G ProSe direct link, the target UE shall delete the ProSe identifier received in the PROSE DIRECT LINK MODIFICATION REQUEST message and the corresponding PQFI(s) and PC5 QoS parameters from the profile associated with the 5G ProSe direct link.

If the PROSE DIRECT LINK MODIFICATION REQUEST message is to remove existing PC5 QoS flow(s) from the PC5 5G ProSe direct link, the target UE shall delete the PQFI(s) and the corresponding PC5 QoS parameters from the profile associated with the 5G ProSe direct link.

If the PROSE DIRECT LINK MODIFICATION REQUEST message is to add a new ProSe application, add new PC5 QoS flow(s) or modify any existing PC5 QoS flow(s) in the 5G ProSe direct link, after sending the PROSE DIRECT LINK MODIFICATION ACCEPT message, the target UE shall provide the added or modified PQFI(s) and corresponding PC5 QoS parameters along with PC5 link identifier to the lower layer.

If the PROSE DIRECT LINK MODIFICATION REQUEST message is to remove an existing ProSe application or to remove the existing PC5 QoS flow(s) from the 5G ProSe direct link, after sending the PROSE DIRECT LINK MODIFICATION ACCEPT message, the target UE shall provide the removed PQFI(s) along with the PC5 link identifier to the lower layer.

If the PROSE DIRECT LINK MODIFICATION REQUEST message is to establish 5G ProSe UE-to-UE relay communication with additional 5G ProSe layer-3 end UE using the existing 5G ProSe direct link between the 5G ProSe layer-3 end UE and 5G ProSe layer-3 UE-to-UE relay UE, the target UE:

- a) if acting as the 5G ProSe layer-3 UE-to-UE relay UE, shall perform the 5G ProSe direct link establishment procedure towards the target 5G ProSe layer-3 end UE as specified in clause 7.2.2.2; and after receiving the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message from the target 5G ProSe layer-3 end UE, shall create a PROSE DIRECT LINK MODIFICATION ACCEPT message;
- b) if acting as the target 5G ProSe layer-3 end UE, shall create a PROSE DIRECT LINK MODIFICATION ACCEPT message; and
- c) in the PROSE DIRECT LINK MODIFICATION ACCEPT message, the target UE:

- 1) if the UE acts as the target 5G ProSe layer-3 end UE:
 - i) shall include the source end UE info set to the user info of the source 5G ProSe layer-3 end UE and the target end UE info set to the user info of the target 5G ProSe layer-3 end UE; and
 - ii) for Ethernet traffic, shall include the MAC address of the target 5G ProSe layer-3 end UE if the MAC address of the target 5G ProSe layer-3 end UE changed;
- 2) if the UE acts as the 5G ProSe layer-3 UE-to-UE relay UE:
 - i) shall include the target end UE info set to the user info of the target 5G ProSe layer-3 end UE;
 - ii) for IP traffic, may include the target 5G ProSe layer-3 end UE IP address IE set to the IP address of the additional target 5G ProSe layer-3 end UE; and
 - iii) for Ethernet traffic, shall include the MAC address of the target 5G ProSe layer-3 end UE.
- 3) may include the PQFI(s) and the corresponding PC5 QoS parameters optionally including the ProSe identifier(s) for the PC5 QoS flow(s) that the target 5G ProSe layer-3 end UE accepts; and
- 4) may include the PC5 QoS rule(s) to indicate the packet filters of the PC5 QoS flow(s).

If the PROSE DIRECT LINK MODIFICATION REQUEST message is to establish 5G ProSe UE-to-UE relay communication with additional 5G ProSe layer-2 end UE using the existing 5G ProSe direct link between the 5G ProSe layer-2 end UE and 5G ProSe layer-2 UE-to-UE relay UE, the target UE:

- a) if acting as the 5G ProSe layer-2 UE-to-UE relay UE, shall perform the 5G ProSe direct link establishment procedure towards the target 5G ProSe layer-2 end UE as specified in clause 7.2.2.2; and after receiving the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message from the target 5G ProSe layer-2 end UE, shall create a PROSE DIRECT LINK MODIFICATION ACCEPT message;
- b) if acting as the target 5G ProSe layer-2 end UE, shall create a PROSE DIRECT LINK MODIFICATION ACCEPT message; and
- c) in the PROSE DIRECT LINK MODIFICATION ACCEPT message, the target UE:
 - 1) if the UE acts as the target 5G ProSe layer-2 end UE:
 - i) shall include the source end UE info set to the user info of the source 5G ProSe layer-2 end UE and the target end UE info set to the user info of the target 5G ProSe layer-2 end UE; or
 - 2) if the UE acts as the 5G ProSe layer-2 UE-to-UE relay UE:
 - i) shall include the target end UE info set to the user info of the target 5G ProSe layer-2 end UE.

If the PROSE DIRECT LINK MODIFICATION REQUEST message is to release 5G ProSe UE-to-UE relay communication with one of the peer 5G ProSe layer-3 end UEs using the shared 5G ProSe direct link between the 5G ProSe layer-3 end UE and 5G ProSe layer-3 UE-to-UE relay UE, the target UE:

- a) if acting as the 5G ProSe layer-3 UE-to-UE relay UE, may initiate one of the following procedures towards the target 5G ProSe layer-3 end UE:
 - 1) 5G ProSe direct link release procedure as specified in clause 7.2.6.2 to release the 5G ProSe direct link with the peer 5G ProSe layer-3 end UE; or
 - 2) 5G ProSe direct link modification procedure as specified in clause 7.2.3.2 to remove the corresponding PC5 QoS flow(s), if the UE determines to keep the 5G ProSe direct link with the peer 5G ProSe layer-3 end UE; and
- b) shall create a PROSE DIRECT LINK MODIFICATION ACCEPT message, and in this message, the target UE:
 - 1) shall include the source end UE info set to the user info of the source 5G ProSe layer-3 end UE, if the UE acts as the target 5G ProSe layer-3 end UE; or
 - 2) shall include the target end UE info set to the user info of the target 5G ProSe layer-3 end UE, if the UE acts as the 5G ProSe layer-3 UE-to-UE relay UE.

If the 5G ProSe direct link is for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe layer-3 UE-to-network relay UE, and if the initiating UE is the 5G ProSe remote UE, then the target UE (as the 5G ProSe layer-3 UE-to-network relay UE) performs the QoS flows handling procedure as specified in clause 8.2.6.3.3 and clause 8.2.6.4.2.

The target UE shall ignore the value of the link modification operation code IE if the relay reselection indication is included in this message.

If the PROSE DIRECT LINK MODIFICATION REQUEST message is accepted by the target 5G ProSe end UE to trigger UE-to-UE relay reselection and the 5G PC5 direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE, the target UE acting as the target 5G ProSe end UE may perform the candidate 5G ProSe UE-to-UE relay discovery procedure as specified in clause 8a.2.3.3. The target UE shall set up a PC5 unicast link with the selected new 5G ProSe UE-to-UE relay UE, if no such PC5 unicast link already exists.

If the PROSE DIRECT LINK MODIFICATION REQUEST message is accepted to trigger the negotiated 5G ProSe layer-3 UE-to-UE relay reselection, the target UE shall respond with PROSE DIRECT LINK MODIFICATION ACCEPT message. In this message:

- a) if the target UE acts as a target 5G ProSe layer-3 end UE and the 5G ProSe direct link is between the target 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, the target UE:
 - 1) shall include the relay reselection indication;
 - 2) shall include the newly selected 5G ProSe UE-to-UE relay UE user info ID;
 - 3) shall include the initiating 5G ProSe end UE IP address; and
 - 4) shall include the target 5G ProSe end UE IP address to be used with the newly selected 5G ProSe UE-to-UE relay UE, if IP communication is used; and
- b) if the target UE acts as a 5G ProSe layer-3 UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the source 5G ProSe layer-3 end UE, after receiving the PROSE DIRECT LINK MODIFICATION ACCEPT message from the target 5G ProSe layer-3 end UE, the target UE.
 - 1) shall include the relay reselection indication;
 - 2) shall include the newly selected 5G ProSe UE-to-UE relay UE user info ID;
 - 3) shall include the target 5G ProSe end UE IP address; and
 - 4) shall include the target 5G ProSe end UE IP address to be used with the newly selected 5G ProSe UE-to-UE relay UE, if IP communication is used.

If the PROSE DIRECT LINK MODIFICATION REQUEST message is accepted to trigger the negotiated 5G ProSe layer-2 UE-to-UE relay reselection, the target UE acting as the target 5G ProSe layer-2 end UE shall respond with PROSE DIRECT LINK MODIFICATION ACCEPT message. In this message:

- a) shall include the relay reselection indication;
- b) shall include the new 5G ProSe UE-to-UE relay UE user info ID; and
- c) shall include the new LBSs of KNR ID.

After the PROSE DIRECT LINK MODIFICATION ACCEPT message is generated, the target UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID for 5G ProSe direct communication.

If this procedure is performed for the negotiated 5G ProSe layer-3 UE-to-UE relay reselection, the target UE shall start timer T5096. The target UE shall not send a new PROSE DIRECT LINK MODIFICATION ACCEPT message to the same initiating UE while timer T5096 is running.

If the target UE accepts the 5G ProSe direct link modification request, then the target UE may perform the PC5 QoS flow establishment over 5G ProSe direct link as specified in clause 7.2.7 and perform the PC5 QoS flow match over 5G ProSe direct link as specified in clause 7.2.8.

The target UE shall form the new K_{NRP} ID from the new MSBs of K_{NRP} ID received in the PROSE DIRECT LINK MODIFICATION REQUEST message and the new LSBs of K_{NRP} ID included in the PROSE DIRECT LINK MODIFICATION ACCEPT message. The target UE shall replace the existing K_{NRP} ID with the new K_{NRP} ID. The target UE may include the new K_{NRP} ID in DIRECT LINK ESTABLISHMENT REQUEST message with the initiating UE as specified in clause 7.2.2.2.

7.2.3.4 5G ProSe direct link modification procedure completion by the initiating UE

Upon receipt of the PROSE DIRECT LINK MODIFICATION ACCEPT message, the initiating UE shall stop timer T5081.

Upon receipt of the PROSE DIRECT LINK MODIFICATION ACCEPT message, if the PROSE DIRECT LINK MODIFICATION REQUEST message is to add a new ProSe application, add new PC5 QoS flow(s) or modify any existing PC5 QoS flow(s) in the 5G ProSe direct link, the initiating UE shall provide the added or modified PQFI(s) and corresponding PC5 QoS parameters along with PC5 link identifier to the lower layer.

Upon receipt of the PROSE DIRECT LINK MODIFICATION ACCEPT message, if the PROSE DIRECT LINK MODIFICATION REQUEST message is to remove an existing ProSe application or to remove the existing PC5 QoS flow(s) from the 5G ProSe direct link, the initiating UE shall provide the removed PQFI(s) along with the PC5 link identifier to the lower layer.

Upon receipt of the PROSE DIRECT LINK MODIFICATION ACCEPT message, if the initiating UE acts as the 5G ProSe layer-3 UE-to-UE relay UE and the PROSE DIRECT LINK MODIFICATION REQUEST message is to establish 5G ProSe UE-to-UE relay communication with additional 5G ProSe layer-3 end UE using the existing 5G ProSe direct link between the 5G ProSe layer-3 end UE and 5G ProSe layer-3 UE-to-UE relay UE, the initiating UE shall send a PROSE DIRECT LINK ESTABLISHMENT ACCEPT message to the source 5G ProSe layer-3 end UE as specified in clause 7.2.2.3.

Upon receipt of the PROSE DIRECT LINK MODIFICATION ACCEPT message, if the initiating UE acts as the 5G ProSe layer-3 UE-to-UE relay UE and the PROSE DIRECT LINK MODIFICATION REQUEST message is to add new PC5 QoS flow(s) or modify any existing PC5 QoS flow(s) in the existing 5G ProSe direct link or to remove any PC5 QoS flow(s) from the existing 5G ProSe direct link between the 5G ProSe layer-3 end UE and 5G ProSe layer-3 UE-to-UE relay UE, the initiating UE shall send a PROSE DIRECT LINK MODIFICATION ACCEPT message to the source 5G ProSe layer-3 end UE as specified in clause 7.2.3.3.

When the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, upon receiving PROSE DIRECT LINK MODIFICATION ACCEPT message, which includes relay reselection indication, and the PROSE DIRECT LINK MODIFICATION REQUEST message is for the negotiated 5G ProSe UE-to-UE relay reselection, the initiating UE, acting as the source 5G ProSe end UE, shall set up a PC5 unicast link with the newly selected 5G ProSe UE-to-UE relay UE whose user info ID is included in the PROSE DIRECT LINK MODIFICATION ACCEPT message, if no such PC5 unicast link already exists. If the initiating UE acts as a source 5G ProSe layer-3 end UE, the initiating UE shall create a PROSE DIRECT LINK MODIFICATION ACK message. In this message, the initiating UE:

- a) shall include the relay reselection indication, source end UE IP address for new relay IE set to IP address of the source 5G ProSe layer-3 end UE's IP address to be used with the newly selected 5G ProSe layer-3 UE-to-UE relay UE and target end UE IP address IE set to the IP address of the target 5G ProSe layer-3 end UE, if IP communication is used.

When the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE, and the 5G ProSe layer-3 UE-to-UE relay UE receives PROSE DIRECT LINK MODIFICATION ACK message from the source 5G ProSe end UE which includes relay reselection indication, the 5G ProSe layer-3 UE-to-UE relay UE shall create a PROSE DIRECT LINK MODIFICATION ACK message. In this message, the 5G ProSe layer-3 UE-to-UE relay UE:

- a) shall include the relay reselection indication, source end UE IP address for new relay IE set to the IP address of the source 5G ProSe layer-3 end UE to be used with the newly selected 5G ProSe layer-3 UE-to-UE relay UE, and source end UE IP address IE set to the IP address of the source 5G ProSe layer-3 end UE, if IP communication is used.

Upon receiving PROSE DIRECT LINK MODIFICATION ACCEPT message, that includes relay reselection indication, if the PROSE DIRECT LINK MODIFICATION REQUEST message is for relay reselection, the initiating UE shall form the new K_{NRP} ID from the MSBs of K_{NRP} ID included in the PROSE DIRECT LINK MODIFICATION

REQUEST message and the LSBs of K_{NRP} ID received in the PROSE DIRECT LINK MODIFICATION ACCEPT message. The initiating UE shall replace the existing K_{NRP} ID with the new K_{NRP} ID. The initiating UE may include the new K_{NRP} ID in PROSE DIRECT LINK ESTABLISHMENT REQUEST message with the target UE as specified in clause 7.2.2.2 when the initiating UE reconnects with the same target UE.

After the PROSE DIRECT LINK MODIFICATION ACK message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID for 5G ProSe direct communication.

If the source UE acknowledges the 5G ProSe direct link modification accept, then the source UE starts to receive and/or transmit traffic via the newly selected 5G ProSe UE-to-UE relay UE.

If the 5G ProSe direct link modification procedure is for 5G ProSe direct communication between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE, for Ethernet traffic, the PROSE DIRECT LINK MODIFICATION ACCEPT message contains target 5G ProSe layer-3 end UE MAC address, and the initiating UE acting as the 5G ProSe layer-3 UE-to-UE relay UE detects that the MAC address of the target 5G ProSe layer-3 end UE is not unique, i.e., the MAC address of the target 5G ProSe layer-3 end UE was also provided by another 5G ProSe layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe layer-3 UE-to-UE relay UE shall perform 5G ProSe direct link release procedure as specified in clause 7.2.6.

If the 5G ProSe direct link modification procedure is for 5G ProSe direct communication between the 5G ProSe multi-hop layer-3 UE-to-UE relay UE and the target 5G ProSe multi-hop layer-3 end UE or between any two 5G ProSe multi-hop layer-3 UE-to-UE relay UE, for Ethernet traffic, the PROSE DIRECT LINK MODIFICATION ACCEPT message contains target 5G ProSe multi-hop layer-3 end UE MAC address, and the initiating UE acting as the 5G ProSe multi-hop layer-3 UE-to-UE relay UE detects that the MAC address of the target 5G ProSe multi-hop layer-3 end UE is not unique, i.e., the MAC address of the target 5G ProSe multi-hop layer-3 end UE was also provided by another 5G ProSe multi-hop layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall perform 5G ProSe direct link release procedure as specified in clause 7.2.6.

7.2.3.4a 5G ProSe direct link modification procedure completion by the target UE

Upon receipt of the PROSE DIRECT LINK MODIFICATION ACK message, the target layer-3 5G ProSe end UE starts to receive traffic, transmit traffic, or both, via the newly selected 5G ProSe UE-to-UE relay UE and shall stop T5096.

Upon receipt of the PROSE DIRECT LINK MODIFICATION ACK message, the layer-3 5G ProSe UE-to-UE relay UE shall stop T5096.

7.2.3.5 5G ProSe direct link modification procedure not accepted by the target UE

If the 5G ProSe direct link modification request cannot be accepted, the target UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message. The PROSE DIRECT LINK MODIFICATION REJECT message contains a PC5 signalling protocol cause IE set to one of the following cause values:

- #5 lack of resources for 5G ProSe direct link;
- #6 required service not allowed;
- #12 security policy not aligned;
- #16 lack of local capabilities;
- #20 Failure from 5G ProSe end UE;
- #23 MAC address not unique;
- #24 relay UE is not selected for link setup with integrated discovery; or
- #111 protocol error, unspecified.

If the target UE is not allowed to accept this request, e.g., because the ProSe application to be added is not allowed per the operator policy or configuration parameters for ProSe communication over PC5 as specified in clause 5.2.4, the target UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message with PC5 signalling protocol cause value #6 "required service not allowed".

If the target UE is a 5G ProSe layer-3 UE-to-network relay UE, the PDU session for relaying the service is an LADN PDU session and:

- a) the target UE is outside the LADN service area; or
- b) the 5G ProSe direct link modification requires a PDU session modification procedure which fails due to reception of the 5GSM cause value #46 "out of LADN service area" in the PDU SESSION MODIFICATION REJECT message as specified in as specified in 3GPP TS 24.501 [11] clause 6.4.2.4.1;

the target UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message with PC5 signalling protocol cause value #111 "protocol error, unspecified".

If the 5G ProSe direct link modification fails due to the congestion problems or other temporary lower layer problems causing resource constraints, the target UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message with PC5 signalling protocol cause value #5 "lack of resources for 5G ProSe direct link".

If the target UE acting as a target 5G ProSe end UE, receives one or more direct link modification request or direct link establishment request for end-to-end connection setup with the source 5G ProSe end UE and integrated discovery is used, then the target UE shall select a 5G ProSe UE-to-UE relay UE and send a PROSE DIRECT LINK MODIFICATION REJECT message to the 5G ProSe UE-to-UE Relay which is not selected and which has sent the PROSE DIRECT LINK MODIFICATION REQUEST message, with PC5 signalling protocol cause value #24 "relay UE is not selected for link setup with integrated discovery".

If the link modification operation code is set to "Associate new ProSe application(s) with existing PC5 QoS flow(s)" and the security policy corresponding to the ProSe identifier(s) is not aligned with the security policy applied to the existing 5G ProSe direct link, then the target UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message with PC5 signalling protocol cause value #12 "security policy not aligned".

If the link modification operation requires the addition of new PC5 QoS flow(s) but the target UE cannot support additional packet filters which would be required on the existing PDU session of the target UE, then the target UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message with PC5 signalling protocol cause value #16 "lack of local capabilities".

If the target UE is acting as a target 5G ProSe end UE and the 5G ProSe direct link modification procedure is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE, the target 5G ProSe end UE may include in the PROSE DIRECT LINK MODIFICATION REJECT message the source end UE info IE set to the user info of the source 5G ProSe end UE that has initiated the 5G ProSe direct link establishment procedure.

If the target UE is acting as a 5G ProSe UE-to-UE relay UE, the 5G ProSe direct link modification procedure is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the target 5G ProSe end UE has rejected the 5G ProSe direct link establishment procedure or the 5G ProSe direct link modification procedure, then the 5G ProSe UE-to-UE relay UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message with PC5 signalling protocol cause value #20 "Failure from 5G ProSe end UE" to the source 5G ProSe end UE. The 5G ProSe UE-to-UE relay UE may include in the PROSE DIRECT LINK MODIFICATION REJECT message the PC5 end UE failure cause IE set to the PC5 signalling protocol cause received from the target 5G ProSe end UE that has rejected the 5G ProSe direct link establishment procedure as specified in clause 7.2.2.5. The 5G ProSe UE-to-UE relay UE may include in the PROSE DIRECT LINK MODIFICATION REJECT message the target end UE info IE set to the user info of the target 5G ProSe end UE that has rejected the 5G ProSe direct link establishment procedure.

For other reasons causing the failure of link modification, the target UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message with PC5 signalling protocol cause value #111 "protocol error, unspecified".

Upon receipt of the PROSE DIRECT LINK MODIFICATION REJECT message, the initiating UE shall stop timer T5081 and abort the 5G ProSe direct link modification procedure. If the PC5 signalling protocol cause value in the PROSE DIRECT LINK MODIFICATION REJECT message is #11 "required service not allowed" or #5 "lack of resources for 5G ProSe direct link" or #12 "security policy not aligned", then the initiating UE shall not attempt to start 5G ProSe direct link modification with the same target UE to add the same ProSe application, or to add or modify the same PC5 QoS flow(s) at least for a time period T.

NOTE: The length of time period T is UE implementation specific and can be different for the case when the UE receives PC5 signalling protocol cause value #11 "required service not allowed" or when the UE receives PC5 signalling protocol cause value #5 "lack of resources for 5G ProSe direct link" or when the UE receives PC5 signalling protocol cause value #12 "security policy not aligned". The length of time period T is not less than 30 minutes.

If the 5G ProSe direct link modification procedure is for 5G ProSe direct communication between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, for Ethernet traffic, the PROSE DIRECT LINK MODIFICATION REQUEST message contains source 5G ProSe layer-3 end UE MAC address, and the target UE acting as the 5G ProSe layer-3 UE-to-UE relay UE detects that the MAC address of the source 5G ProSe layer-3 end UE is not unique, i.e., the MAC address of the source 5G ProSe layer-3 end UE was also provided by another 5G ProSe layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe layer-3 UE-to-UE relay UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message containing PC5 signalling protocol cause value #23 "MAC address not unique" to the source 5G ProSe layer-3 end UE.

If the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, for Ethernet traffic, and the target UE acting as the 5G ProSe layer-3 UE-to-UE relay UE releases the 5G ProSe direct link between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE with PC5 signalling protocol cause value #23 "MAC address not unique", the 5G ProSe layer-3 UE-to-UE relay UE shall send a the PROSE DIRECT LINK MODIFICATION REJECT message containing PC5 signalling protocol cause value #111 "protocol error, unspecified" to the source 5G ProSe layer-3 end UE.

If the 5G ProSe direct link modification procedure is for 5G ProSe direct communication between the source 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE, for Ethernet traffic, the PROSE DIRECT LINK MODIFICATION REQUEST message contains source 5G ProSe multi-hop layer-3 end UE MAC address, and the target UE acting as the 5G ProSe multi-hop layer-3 UE-to-UE relay UE detects that the MAC address of the source 5G ProSe multi-hop layer-3 end UE is not unique, i.e., the MAC address of the source 5G ProSe multi-hop layer-3 end UE was also provided by another 5G ProSe multi-hop layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message containing PC5 signalling protocol cause value #23 "MAC address not unique" to the source 5G ProSe multi-hop layer-3 end UE.

If the 5G ProSe direct link modification procedure is for 5G ProSe direct communication between the one 5G ProSe multi-hop layer-3 UE-to-UE relay UE and the other 5G ProSe multi-hop layer-3 UE-to-UE relay UE, for Ethernet traffic, the PROSE DIRECT LINK MODIFICATION REQUEST message contains source 5G ProSe multi-hop layer-3 end UE MAC address, and the target UE acting as the 5G ProSe multi-hop layer-3 UE-to-UE relay UE detects that the MAC address of the source 5G ProSe multi-hop layer-3 end UE is not unique, i.e., the MAC address of the source 5G ProSe multi-hop layer-3 end UE was also provided by another 5G ProSe multi-hop layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall send a PROSE DIRECT LINK MODIFICATION REJECT message containing PC5 signalling protocol cause value #23 "MAC address not unique" to the source 5G ProSe multi-hop layer-3 end UE.

If the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE, for Ethernet traffic, and the target UE acting as the 5G ProSe multi-hop layer-3 UE-to-UE relay UE releases the 5G ProSe direct link between the 5G ProSe multi-hop layer-3 UE-to-UE relay UE and the target 5G ProSe multi-hop layer-3 end UE with PC5 signalling protocol cause value #23 "MAC address not unique", the 5G ProSe layer-3 UE-to-UE relay UE shall send a the PROSE DIRECT LINK MODIFICATION REJECT message containing PC5 signalling protocol cause value #111 "protocol error, unspecified" to the source 5G ProSe layer-3 end UE.

7.2.3.6 Abnormal cases

7.2.3.6.1 Abnormal cases at the initiating UE

The following abnormal cases can be identified:

- a) If timer T5081 expires, the initiating UE shall retransmit the PROSE DIRECT LINK MODIFICATION REQUEST message and restart timer T5081. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct link modification procedure and may notify the upper layer that the target UE is unreachable.

NOTE 1: The maximum number of allowed retransmissions is UE implementation specific.

NOTE 2: After reaching the maximum number of allowed retransmissions, whether the initiating UE releases this 5G ProSe direct link depends on its implementation.

- b) For the same 5G ProSe direct link, if the initiating UE receives a PROSE DIRECT LINK RELEASE REQUEST message after the initiation of UE-requested 5G ProSe direct link modification procedure, the initiating UE shall

stop the timer T5081 and abort the 5G ProSe direct link modification procedure and proceed with the 5G ProSe direct link release procedure.

- c) For the same 5G ProSe direct link, if the initiating UE receives a PROSE DIRECT LINK MODIFICATION REQUEST message during the 5G ProSe direct link modification procedure, the initiating UE shall stop the timer T5081 and abort the 5G ProSe direct link modification procedure. Following handling is implementation dependent, e.g., the initiating UE waits for an implementation dependent time for initiating a new 5G ProSe direct link modification procedure, if still needed.

NOTE 3: The implementation dependent timer value needs to be set to avoid further collisions (e.g., random timer value).

7.2.3.6.2 Abnormal cases at the target UE

The following abnormal cases can be identified:

- a) For the same 5G ProSe direct link, if the target UE receives a PROSE DIRECT LINK RELEASE REQUEST message during the 5G ProSe direct link modification procedure, the target UE shall stop all running timers for this 5G ProSe direct link, abort the 5G ProSe direct link modification procedure and proceed with the 5G ProSe direct link release procedure.

7.2.3.7 Void

7.2.4 5G ProSe direct link identifier update procedure

7.2.4.1 General

The 5G ProSe direct link identifier update procedure is used to update and exchange the new identifiers (e.g., application layer ID, layer-2 ID, security information and IP address/prefix) between two UEs for a 5G ProSe direct link before using the new identifiers. The UE sending the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message is called the “initiating UE” and the other UE is called the “target UE”.

In case of 5G ProSe layer-2 UE-to-UE relay, the source 5G ProSe end UE and the target 5G ProSe end UE shall not update the associated end-to-end 5G ProSe direct link context with the new layer-2 IDs included in the 5G ProSe direct link identifier update procedure initiated between the source 5G ProSe end UE and the target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE.

7.2.4.2 5G ProSe direct link identifier update procedure initiation by initiating UE

The initiating UE shall initiate the procedure if:

- a) the initiating UE receives a request from upper layers to change the application layer ID and there is an existing 5G ProSe direct link associated with this application layer ID;
- b) the privacy timer (see clause 5.2.4 and clause 5.2.5) of the initiating UE’s layer-2 ID expires for an existing 5G ProSe direct link;
- c) the initiating UE is the 5G ProSe multi-hop layer-3 end UE configured with a static IPv4 address, a static IPv6 prefix or both associated with the RSC (see clause 8c.2.4), after the 5G ProSe direct link establishment with the 5G ProSe multi-hop layer-3 UE-to-UE relay UE; or
- d) the initiating UE is the 5G ProSe multi-hop layer-3 end UE and the UE receives a request from upper layers to change the hop limit for the 5G ProSe multi-hop layer-3 UE-to-UE relay communication.

The initiating UE shall meet the following pre-conditions before initiating this procedure:

- a) the timer T5091 is not running; and
- b) the initiating UE is not performing the 5G ProSe direct link re-keying procedure initiated by the target UE.

If the 5G ProSe direct link identifier update procedure is triggered by a change of the initiating UE's application layer ID, the initiating UE shall create a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message. In this message, the initiating UE:

- a) shall include the initiating UE's new application layer ID received from upper layer;
- a1) may include the hop limit for the UE's new application layer ID, if the 5G ProSe direct link is for the 5G ProSe multi-hop layer-3 UE-to-UE relay communication and the hop limit is received from the upper layer;
- b) shall include the initiating UE's new layer-2 ID assigned by itself;
- c) shall include the new MSB of $K_{\text{NRP-session}}$ ID;
- d) shall include the initiating UE's new IP address/prefix, if IP communication is used, IP address/prefix of the initiating UE needs to be changed and is allocated by the initiating UE, the 5G ProSe direct link is not for 5G ProSe direct communication between 5G ProSe layer-2 remote UE and 5G ProSe layer-2 UE-to-network relay UE, and the target UE is not a 5G ProSe layer-3 UE-to-UE relay UE;
- e) shall include the initiating UE's new IP address/prefix, if IP communication is used, IP address/prefix of the initiating UE needs to be changed and is allocated by the initiating UE, and the target UE is a 5G ProSe layer-3 UE-to-UE relay UE;
- f) shall include the IP address/prefix needed indication if IP communication is used, the target UE is a 5G ProSe layer-3 UE-to-UE relay UE, and IP address/prefix of the initiating UE needs to be changed and is allocated by the 5G ProSe UE-to-UE relay UE; and
- g) shall include the list of target end UE IP address(es)/prefix(es), or the list of target end UE user info, or both, if IP communication is used, the initiating UE's IP address/prefix needs to be changed, and the target UE is a 5G ProSe layer-3 UE-to-UE relay UE.

If the 5G ProSe direct link identifier update procedure is triggered by the expiry of the initiating UE's privacy timer T5090 as specified in clause 5.2.4 and clause 5.2.5, the initiating UE shall create a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message. In this message, the initiating UE:

- a) shall include the initiating UE's new layer-2 ID assigned by itself;
- b) shall include the new MSB of $K_{\text{NRP-session}}$ ID;
- c) may include the initiating UE's new application layer ID if received from upper layer;
- c1) may include the hop limit for the UE's new application layer ID, if the 5G ProSe direct link is for the 5G ProSe multi-hop layer-3 UE-to-UE relay communication and the hop limit is received from the upper layer;
- d) shall include the initiating UE's new IP address/prefix, if IP communication is used, IP address/prefix of the initiating UE needs to be changed and is allocated by the initiating UE, the 5G ProSe direct link is not for 5G ProSe direct communication between 5G ProSe layer-2 remote UE and 5G ProSe layer-2 UE-to-network relay UE, and the target UE is not a 5G ProSe layer-3 UE-to-UE relay UE;
- e) shall include the initiating UE's new IP address/prefix if IP communication is used, IP address/prefix of the initiating UE needs to be changed and is allocated by the initiating UE, and the target UE is a 5G ProSe layer-3 UE-to-UE relay UE;
- f) shall include the IP address/prefix needed indication if IP communication is used, the target UE is a 5G ProSe layer-3 UE-to-UE relay UE, and IP address/prefix of the initiating UE needs to be changed and is allocated by the 5G ProSe layer-3 UE-to-UE relay UE; and
- g) shall include the list of target end UE IP address(es)/prefix(es), or the list of target end UE user info, or both, if IP communication is used, IP address/prefix of the initiating UE needs to be changed and the target UE is a 5G ProSe layer-3 UE-to-UE relay UE.

If the 5G ProSe direct link is for the 5G ProSe multi-hop layer-3 UE-to-UE relay communication and the 5G ProSe direct link identifier update procedure is triggered by the initiating UE after the IP address allocation based on the configuration with a static IPv4 address, a static IPv6 prefix or both associated with the RSC (see clause 8c.2.4), the initiating UE shall create a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message. In this message, the initiating UE:

- a) shall include the initiating UE's application layer ID;
- b) may include the hop limit for the UE's application layer ID if received from the upper layer;
- c) shall include the initiating UE's layer-2 ID;
- d) shall include the new MSB of $K_{\text{NRP-sess}}$ ID; and
- e) shall include the initiating UE's new IP address/prefix.

If the 5G ProSe direct link is for the 5G ProSe multi-hop layer-3 UE-to-UE relay communication and the 5G ProSe direct link identifier update procedure is triggered by a change of the hop limit for the initiating UE's application layer ID, the initiating UE shall create a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message. In this message, the initiating UE:

- a) shall include the initiating UE's application layer ID;
- b) shall include the updated hop limit for the UE's application layer ID as received from the upper layer;
- c) shall include the initiating UE's layer-2 ID; and
- d) shall include the new MSB of $K_{\text{NRP-sess}}$ ID.

After the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's old layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID for 5G ProSe direct communication and start timer T5082. The UE shall not send a new PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message to the same target UE while timer T5082 is running.

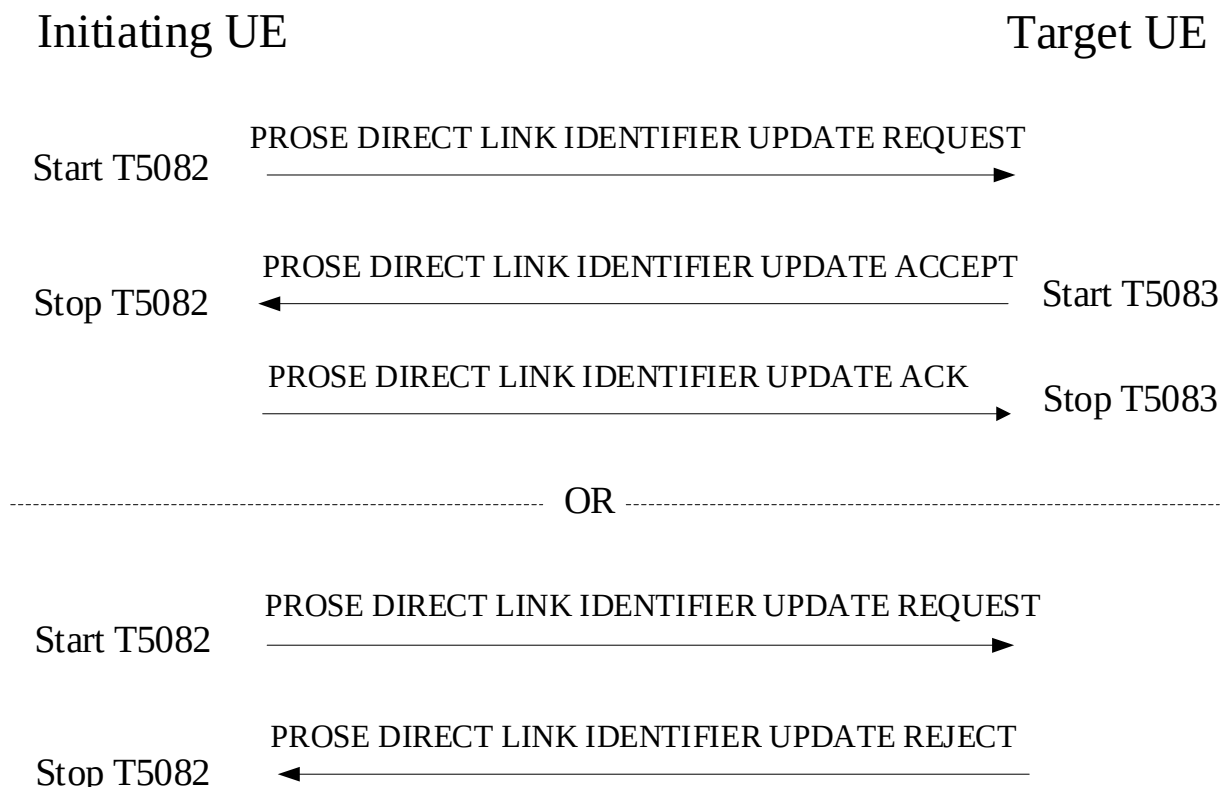


Figure 7.2.4.2.1: 5G ProSe direct link identifier update procedure

7.2.4.3 5G ProSe direct link identifier update procedure accepted by the target UE

Upon receipt of a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message, if the target UE determines:

- a) the 5G ProSe direct link associated with this request message is still valid; and
- b) the timer T5083 for the 5G ProSe direct link identified by this request message is not running,

then the target UE accepts this request and responds with a PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message.

If the target UE is a 5G ProSe layer-3 UE-to-UE relay UE and IP address/prefix needed indication is received in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message from the initiating UE, the target UE assigns a new IP address/prefix to the initiating UE.

If the target UE is a 5G ProSe layer-3 UE-to-UE relay UE, the 5G ProSe layer-3 UE-to-UE relay UE shall initiate the 5G ProSe UE to UE relay update procedure as specified in clause 7.2.13.

If the target UE is a 5G ProSe multi-hop layer-3 UE-to-UE relay UE, the 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall update the MANET routing table or the MANET discovery entry for the 5G ProSe multi-hop layer-3 end UE as specified in clause 8c.2.2.2.

The target UE shall create the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message. If the 5G ProSe direct link is not for the 5G ProSe multi-hop layer-3 UE-to-UE relay communication, in this message, the target UE:

- a) shall include the target UE's new layer-2 ID assigned by itself;
- b) shall include the new LSB of $K_{\text{NRP-session}}$ ID;
- c) shall include the initiating UE's new MSB of $K_{\text{NRP-session}}$ ID;
- d) shall include the initiating UE's new layer-2 ID;
- e) shall include the target UE's new application layer ID if received from upper layer if the target UE is not a 5G ProSe layer-3 UE-to-UE relay UE;
- f) shall include the initiating UE's new IP address/prefix if received from the initiating UE and IP communication is used or if IP address/prefix needed indication is received from the initiating UE and IP communication is used;
- g) shall include the initiating UE's new application layer ID if received from the initiating UE; and
- h) shall include the target UE's new IP address/prefix if IP communication is used, the target UE's IP address/prefix needs to be changed, and the 5G ProSe direct link is not for 5G ProSe direct communication between 5G ProSe layer-2 remote UE and 5G ProSe layer-2 UE-to-network relay UE.

If the 5G ProSe direct link is for the 5G ProSe multi-hop layer-3 UE-to-UE relay communication, in the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message, the target UE:

- a) shall include the target UE's layer-2 ID assigned by itself;
- b) shall include the LSB of $K_{\text{NRP-session}}$ ID;
- c) shall include the initiating UE's MSB of $K_{\text{NRP-session}}$ ID;
- d) shall include the initiating UE's layer-2 ID;
- e) shall include the initiating UE's new IP address/prefix if received from the initiating UE and IP communication is used or if IP address/prefix needed indication is received from the initiating UE and IP communication is used; and
- f) shall include the initiating UE's new application layer ID if received from the initiating UE.

After the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message is generated, the target UE shall pass this message to the lower layers for transmission along with the initiating UE's old layer-2 ID for 5G ProSe direct communication and the target UE's old layer-2 ID for 5G ProSe direct communication and start timer T5083. The UE shall not send a new PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message to the same initiating UE while timer T5083 is running.

Before target UE receives the traffic using the new layer-2 IDs, the target UE shall continue to receive the traffic with the old layer-2 IDs (i.e., initiating UE's old layer-2 ID and target UE's old layer-2 ID) from initiating UE.

Before target UE receives the PROSE DIRECT LINK IDENTIFIER UPDATE ACK message from initiating UE, the target UE shall keep sending traffic to the initiating UE using the old layer-2 IDs (i.e., initiating UE's old layer-2 ID for 5G ProSe direct communication and target UE's old layer-2 ID for 5G ProSe direct communication).

7.2.4.4 5G ProSe direct link identifier update procedure acknowledged by the initiating UE

Upon receipt of the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message, the initiating UE shall save its new IP address/prefix if received on the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message, shall stop timer T5082 and respond with a PROSE DIRECT LINK IDENTIFIER UPDATE ACK message. In this message, the initiating UE:

- a) shall include the target UE's new layer-2 ID;
- b) shall include the target UE's new LSB of $K_{\text{NRP-sess}}$ ID;
- c) shall include the target UE's new application layer ID, if received;
- d) shall include the target UE's new IP address/prefix, if received; and
- e) shall include the initiating UE's new IP address/prefix, if received on the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message.

After the PROSE DIRECT LINK IDENTIFIER UPDATE ACK message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's old layer-2 ID for 5G ProSe direct communication and the target UE's old layer-2 ID for 5G ProSe direct communication and shall stop timer T5090 if running and start a timer T5090 as configured if at least one of ProSe identifiers for the 5G ProSe direct link satisfying the privacy requirements as specified in clause 5.2.4 or if satisfying the privacy requirements as specified in clause 5.2.5.

Upon sending the PROSE DIRECT LINK IDENTIFIER UPDATE ACK message, the initiating UE shall update the associated 5G ProSe direct link context with the new identifiers and pass the new layer-2 IDs (i.e., initiating UE's new layer-2 ID for 5G ProSe direct communication and target UE's new layer-2 ID for 5G ProSe direct communication) along with the PC5 link identifier down to the lower layer. Then the initiating UE shall use the new layer-2 IDs (i.e., initiating UE's new layer-2 ID for 5G ProSe direct communication and target UE's new layer-2 ID for 5G ProSe direct communication) to transmit the PC5 signalling message and PC5 user plane data.

NOTE: For 5G ProSe layer-2 UE-to-UE relay, the new layer-2 IDs to be updated in the associated end-to-end 5G ProSe direct link context are received from the 5G ProSe layer-2 UE-to-UE relay UE as specified in TS 38.300 [12].

The initiating UE shall continue to receive traffic with the old layer-2 IDs (i.e., initiating UE's old layer-2 ID for 5G ProSe direct communication and target UE's old layer-2 ID for 5G ProSe direct communication) from the target UE until it receives traffic with the new layer-2 IDs (i.e., initiating UE's new layer-2 ID and target UE's new layer-2 ID) from the target UE.

7.2.4.5 5G ProSe direct link identifier update procedure completion by the target UE

Upon receipt of the PROSE DIRECT LINK IDENTIFIER UPDATE ACK message, the target UE shall update the associated 5G ProSe direct link context with the new identifiers, pass the new layer-2 IDs (i.e., initiating UE's new layer-2 ID and target UE's new layer-2 ID) down to the lower layer, stop timer T5083 and timer T5090 if running and start a timer T5090 as configured if at least one of ProSe identifiers for the 5G ProSe direct link satisfying the privacy requirements as specified in clause 5.2.4 or if satisfying the privacy requirements as specified in clause 5.2.5. Then the target UE shall use the new layer-2 IDs (i.e., initiating UE's new layer-2 ID for 5G ProSe direct communication and target UE's new layer-2 ID for 5G ProSe direct communication) to transmit the PC5 signalling message and PC5 user plane data.

NOTE: For 5G ProSe layer-2 UE-to-UE relay, the new layer-2 IDs to be updated in the associated end-to-end 5G ProSe direct link context are received from the 5G ProSe layer-2 UE-to-UE relay UE as specified in TS 38.300 [12].

7.2.4.6 5G ProSe direct link identifier update procedure not accepted by the target UE

If the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message cannot be accepted, the target UE shall send a PROSE DIRECT LINK IDENTIFIER UPDATE REJECT message. The PROSE DIRECT LINK IDENTIFIER UPDATE REJECT message contains a PC5 signalling protocol cause IE set to one of the following cause values:

- #3 conflict of layer-2 ID for 5G ProSe direct communication is detected;
- #16 unknown target UE's IP address/prefix or target UE's Application layer ID; or
- #111 protocol error, unspecified.

For a received PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message from a layer-2 ID (for 5G ProSe direct communication), if the target UE already has an existing link using this layer-2 ID or is currently processing a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message from the same layer-2 ID, but with user info different from the user info IE included in this new incoming message, the target UE shall send a PROSE DIRECT LINK IDENTIFIER UPDATE REJECT message with PC5 signalling protocol cause value #3 "conflict of layer-2 ID for 5G ProSe direct communication is detected".

NOTE: After receiving the PROSE DIRECT LINK IDENTIFIER UPDATE REJECT message, whether the initiating UE initiates the 5G ProSe direct link release procedure or initiates another 5G ProSe direct link identifier update procedure with a new layer-2 ID depends on UE implementation.

For a received PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message from a source 5G ProSe end UE, if the target UE is a 5G ProSe layer-3 UE-to-UE relay UE and receives the PC5 signalling protocol cause value #17 "unknown initiating end UE's IP address/prefix or initiating UE's Application layer ID" from the target 5G ProSe end UE in the PROSE UE TO UE RELAY UPDATE REJECT message as specified in clause 7.2.13.5, the target UE sends a PROSE DIRECT LINK IDENTIFIER UPDATE REJECT message with PC5 signalling protocol cause value #16 "unknown target UE's IP address/prefix or target UE's Application layer ID".

For other reasons causing the failure of link identifier update, the target UE shall send a PROSE DIRECT LINK IDENTIFIER UPDATE REJECT message with PC5 signalling protocol cause value #111 "protocol error, unspecified".

Upon receipt of the PROSE DIRECT LINK IDENTIFIER UPDATE REJECT message, the initiating UE shall stop timer T5082 and abort this 5G ProSe direct link identifier update procedure.

7.2.4.7 Abnormal cases

7.2.4.7.1 Abnormal cases at the initiating UE

The following abnormal cases can be identified:

- a) If timer T5082 expires, the initiating UE shall retransmit the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message and restart timer T5082. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct link identifier update procedure and may notify the upper layer that the target UE is unreachable.

NOTE 1: The maximum number of allowed retransmissions is UE implementation specific.

NOTE 2: After reaching the maximum number of allowed retransmissions, whether the initiating UE releases this 5G ProSe direct link depends on its implementation.

- b) For the same 5G ProSe direct link, if the initiating UE receives a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message during the 5G ProSe direct link identifier update procedure, the initiating UE shall stop the timer T5082 and abort the 5G ProSe direct link identifier update procedure. Following handling is implementation dependent, e.g., the initiating UE waits for an implementation dependent time for initiating a new 5G ProSe direct link identifier update procedure, if still needed.

NOTE 3: The implementation dependent timer value needs to be set to avoid further collisions (e.g., random timer value).

- c) For the same 5G ProSe direct link, if the initiating UE receives a PROSE DIRECT LINK REKEYING REQUEST message after initiating the 5G ProSe direct link identifier update procedure, the initiating UE shall

ignore the PROSE DIRECT LINK REKEYING REQUEST message and proceed with the 5G ProSe direct link identifier update procedure.

- d) For the same 5G ProSe direct link, if the initiating UE receives a PROSE DIRECT LINK RELEASE REQUEST message after the initiation of 5G ProSe direct link identifier update procedure, the initiating UE shall stop the timer T5082 and abort the 5G ProSe direct link identifier update procedure and proceed with the 5G ProSe direct link release procedure.
- e) After sending the PROSE DIRECT LINK IDENTIFIER UPDATE ACK message to the target UE, if another PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message from the target UE is received before the traffic from the target UE with the new layer-2 IDs is received, the initiating UE shall retransmit the PROSE DIRECT LINK IDENTIFIER UPDATE ACK message along with the initiating UE's old layer-2 ID and the target UE's old layer-2 ID.

NOTE 4: It is up to implementation to handle the failure of traffic delivery for new layer-2 IDs if such traffic has been sent before the initiating UE retransmits the PROSE DIRECT LINK IDENTIFIER UPDATE ACK message.

- f) After sending the PROSE DIRECT LINK IDENTIFIER UPDATE ACK message to the target UE, if the initiating UE keeps receiving traffic from the target UE with the old layer-2 IDs and traffic from the target UE with the new layer-2 IDs is not received during an implementation specific time which is greater than the value of timer T5083, the initiating UE shall abort the 5G ProSe direct link identifier update procedure and may release the 5G ProSe direct link.

7.2.4.7.2 Abnormal cases at the target UE

The following abnormal cases can be identified:

- a) If timer T5083 expires, the target UE shall retransmit the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message and restart timer T5083. After reaching the maximum number of allowed retransmissions, the target UE shall abort the 5G ProSe direct link identifier update procedure and may notify the upper layer that the initiating UE is unreachable.

NOTE 1: The maximum number of allowed retransmissions is UE implementation specific.

NOTE 2: After reaching the maximum number of allowed retransmissions, whether the target UE releases this 5G ProSe direct link depends on its implementation.

- b) If PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST is received when the timer T5083 is running, the target UE shall stop the timer T5083 and abort the ongoing 5G ProSe direct link identifier update procedure. The target UE shall handle the new PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST as specified in clause 7.2.4.3.
- c) For the same 5G ProSe direct link, if the target UE receives a PROSE DIRECT LINK RELEASE REQUEST message during the 5G ProSe direct link identifier update procedure, the target UE shall stop the timer T5083, abort the 5G ProSe direct link identifier update procedure and proceed with the 5G ProSe direct link release procedure.

7.2.5 5G ProSe direct link keep-alive procedure

7.2.5.1 General

The 5G ProSe direct link keep-alive procedure is used to maintain a 5G ProSe direct link between two UEs, i.e., check that the link between the two UEs is still valid. The UE sending the PROSE DIRECT LINK KEEPALIVE REQUEST message is called the "initiating UE" and the other UE is called the "target UE".

The 5G ProSe direct link keep-alive procedure can be initiated by only one UE or both UEs in the established 5G ProSe direct link.

NOTE: Whether the 5G ProSe direct link keep-alive procedure is initiated by only one UE or both UEs in the established 5G ProSe direct link is UE implementation specific.

7.2.5.2 5G ProSe direct link keep-alive procedure initiation by the initiating UE

The initiating UE shall meet the following pre-condition before initiating the 5G ProSe direct link keep-alive procedure:

- a) there is a 5G ProSe direct link between the initiating UE and the target UE.

The initiating UE shall manage a keep-alive timer T5084 and a keep-alive counter for the 5G ProSe direct link keep-alive procedure. Timer T5084 is used to trigger the periodic initiation of the 5G ProSe direct link keep-alive procedure. The UE shall start or restart timer T5084 whenever the UE receives a PC5 signalling message or PC5 user plane data from the target UE over this 5G ProSe direct link. The UE shall set the keep-alive counter to an initial value of zero after 5G ProSe direct link establishment.

The initiating UE shall initiate the 5G ProSe direct link keep-alive procedure when:

- a) timer T5084 for this link expires;
- b) optionally, a request from the lower layers to check the viability of the 5G ProSe direct link is received; or

NOTE 1: Whether the lower layers can request the initiation of the 5G ProSe direct link keep-alive procedure and what the triggers for the lower layers are to request the initiation of the 5G ProSe direct link keep-alive procedure, are UE implementation specific.

- c) optionally, a request from the upper layers to check the viability of the 5G ProSe direct link is received.

NOTE 2: Whether the upper layers can request the initiation of the 5G ProSe direct link keep-alive procedure and what the triggers for the upper layers are to request the initiation of the 5G ProSe direct link keep-alive procedure, are UE implementation specific.

In order to initiate the 5G ProSe direct link keep-alive procedure, the initiating UE shall stop timer T5084, if running and shall create a PROSE DIRECT LINK KEEPALIVE REQUEST message. In this message, the initiating UE:

- a) shall include the keep-alive counter for the 5G ProSe direct link; and
- b) may include a maximum inactivity period to indicate the maximum inactivity period of the initiating UE over this 5G ProSe direct link.

NOTE 3: The value chosen for the maximum inactivity period of the initiating UE is UE implementation specific with the objective to minimize the number of keep-alive procedures as much as possible. It is desirable to have the maximum inactivity period value to be slightly higher than the value of keep-alive timer T5084.

After the PROSE DIRECT LINK KEEPALIVE REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID for 5G ProSe direct communication and start timer T5085. The UE shall not send a new PROSE DIRECT LINK KEEPALIVE REQUEST message to the same target UE while timer T5085 is running.

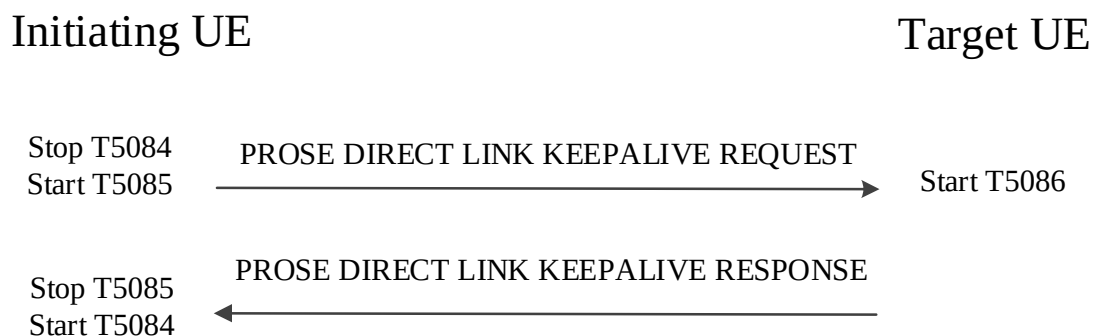


Figure 7.2.5.2.1: 5G ProSe direct link keep-alive procedure

7.2.5.3 5G ProSe direct link keep-alive procedure accepted by the target UE

Upon receipt of a PROSE DIRECT LINK KEEPALIVE REQUEST message, the target UE shall create a PROSE DIRECT LINK KEEPALIVE RESPONSE message. In this message, the target UE:

- a) shall include the keep-alive counter set to the same value as that received in the PROSE DIRECT LINK KEEPALIVE REQUEST message.

After the PROSE DIRECT LINK KEEPALIVE RESPONSE message is generated, the target UE shall pass this message to the lower layers for transmission along with the target UE's layer-2 ID for 5G ProSe direct communication and the initiating UE's layer-2 ID for 5G ProSe direct communication.

If a maximum inactivity period is included in the PROSE DIRECT LINK KEEPALIVE REQUEST message, the target UE shall stop T5086, if running and start T5086 with its value set to the maximum inactivity period. The target UE shall restart T5086 whenever the target UE receives a PC5 signalling message or PC5 user plane data from the initiating UE over this 5G ProSe direct link.

7.2.5.4 5G ProSe direct link keep-alive procedure completion by the initiating UE

Upon receipt of a PROSE DIRECT LINK KEEPALIVE RESPONSE message, the initiating UE shall stop timer T5085, start timer T5084 and increment the keep-alive counter for the 5G ProSe direct link.

7.2.5.5 Abnormal cases

7.2.5.5.1 Abnormal cases at the initiating UE

- a) Timer T5085 expires.

The initiating UE shall retransmit the PROSE DIRECT LINK KEEPALIVE REQUEST message with the last used value of the keep-alive counter and restart timer T5085. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct link keep-alive procedure and locally release the 5G ProSe direct link.

NOTE: The maximum number of allowed retransmissions is UE implementation specific.

- b) The need to use this 5G ProSe direct link no longer exists before the 5G ProSe direct link keep-alive procedure is completed.

The initiating UE shall abort the 5G ProSe direct link keep-alive procedure and initiate a 5G ProSe direct link release procedure.

- c) The initiating UE receives a PROSE DIRECT LINK KEEPALIVE RESPONSE message with a keep-alive counter value different from the value which the initiating UE had included in the last sent PROSE DIRECT LINK KEEPALIVE REQUEST message.

The initiating UE shall discard the PROSE DIRECT LINK KEEPALIVE RESPONSE message.

- d) The initiating UE receives a PC5 signalling message other than a PROSE DIRECT LINK KEEPALIVE RESPONSE message or PC5 user plane data from the target UE over this 5G ProSe direct link while timer T5085 is running.

The initiating UE shall stop timer T5085, abort the 5G ProSe direct link keep-alive procedure, start timer T5084 and increment the keep-alive counter for the 5G ProSe direct link.

- e) The initiating UE receives a PROSE DIRECT LINK KEEPALIVE RESPONSE message when T5085 is not running.

The initiating UE shall discard the PROSE DIRECT LINK KEEPALIVE RESPONSE message.

7.2.5.5.2 Abnormal cases at the target UE

- a) Timer T5086 expires.

The target UE shall:

- 1) initiate a 5G ProSe direct link keep-alive procedure to check the link; or
- 2) initiate the 5G ProSe direct link release procedure.

Whether the UE chooses 1) or 2) is left to UE implementation.

- b) The target UE receives a PROSE DIRECT LINK KEEPALIVE REQUEST message with a keep-alive counter value lower than the value which the target UE had included in the last sent PROSE DIRECT LINK KEEPALIVE RESPONSE message.

The target UE shall discard the PROSE DIRECT LINK KEEPALIVE REQUEST message.

- c) The target UE receives a PROSE DIRECT LINK KEEPALIVE REQUEST message if there is a pending PC5 signalling message or PC5 user plane data to be sent to the initiating UE over this 5G ProSe direct link.

The target UE:

- 1) shall pass this PC5 signalling message to the lower layers for transmission along with the target UE's layer-2 ID for 5G ProSe direct communication and the initiating UE's layer-2 ID for 5G ProSe direct communication, or perform the data transmission over 5G ProSe direct link as specified in clause 7.2.9; and
- 2) shall consider transmission of this PC5 signalling message or PC5 user plane data to be an implicit PROSE DIRECT LINK KEEPALIVE RESPONSE message and skip generating a PROSE DIRECT LINK KEEPALIVE RESPONSE message. If a maximum inactivity period is included in the PROSE DIRECT LINK KEEPALIVE REQUEST message, the target UE shall stop T5086, if running and start T5086 with its value set to the maximum inactivity period.

7.2.6 5G ProSe direct link release procedure

7.2.6.1 General

The 5G ProSe direct link release procedure is used to release a secure 5G ProSe direct link between two UEs. The link can be released from either end point. The UE sending the PROSE DIRECT LINK RELEASE REQUEST message is called the "initiating UE" and the other UE is called the "target UE".

If the UE receives an indication of radio link failure or an indication of PC5-RRC connection release from the lower layer, the UE shall release the 5G ProSe direct link locally and may delete the K_{NRP} ID associated with this link after an implementation specific time. If the UE acting as 5G ProSe layer-2 UE-to-network relay UE or 5G ProSe layer-2 remote UE receives a request of 5G ProSe direct link release from the lower layer as specified in 3GPP TS 38.331 [13], the UE shall initiate the 5G ProSe direct link release procedure.

When the direct link between a 5G ProSe remote UE and a 5G ProSe UE-to-network relay UE is released, the 5G ProSe layer-3 UE-to-network relay UE shall perform the remote UE report procedure as specified in 3GPP TS 24.501 [11].

When the link between a 5G ProSe multi-hop remote UE and a 5G ProSe multi-hop layer-3 UE-to-network relay UE via zero or more 5G ProSe intermediate UE-to-network relay UE is released, the 5G ProSe multi-hop layer-3 UE-to-network relay UE shall perform the remote UE report procedure as specified in 3GPP TS 24.501 [11].

7.2.6.2 5G ProSe direct link release procedure initiation by initiating UE

The initiating UE shall initiate the procedure if a request from upper layers to release a 5G ProSe direct link with the target UE which uses a known layer-2 ID (for unicast communication) is received and there is an existing 5G ProSe direct link between these two UEs.

The initiating UE may initiate the procedure if the target UE has been non-responsive, e.g., no response in the 5G ProSe direct link modification procedure, 5G ProSe direct link identifier update procedure, 5G ProSe direct link re-keying procedure or 5G ProSe direct link keep-alive procedure.

The initiating UE may initiate the procedure to release an established 5G ProSe direct link if the UE has reached the maximum number of established 5G ProSe direct links and there is a need to establish a new 5G ProSe direct link. In this case, which 5G ProSe direct link is to be released is up to UE implementation.

The initiating UE may initiate the procedure to release an established 5G ProSe direct link upon expiry of the timer T5084.

If:

- a) the initiating UE acts as 5G ProSe layer-3 UE-to-network relay UE; and
- b) the PDU session established for relaying the traffic of the target UE is released by the initiating UE or the network as specified in 3GPP TS 24.501 [11] clause 6.3.3 or clause 6.4.3;

the initiating UE should initiate the 5G ProSe direct link release procedure.

If the initiating UE which is acting as 5G ProSe layer-3 UE-to-network relay UE establishes a new PDU session after receiving 5GSM cause value #39 "reactivation requested" as specified in 3GPP TS 24.501 [11] clause 6.3.2.3, the UE may initiate the 5G ProSe direct link release procedure.

If the initiating UE is a 5G ProSe layer-3 UE-to-network relay UE, the PDU session for relaying the service is an LADN PDU session and:

- a) the UE is outside the LADN service area; or
- b) the UE receives the 5GSM cause value #46 "out of LADN service area" in the PDU SESSION MODIFICATION REJECT message as specified in as specified in 3GPP TS 24.501 [11] clause 6.4.2.4.1;

and there is at least one 5G ProSe layer-3 remote UE which is served on the PDU session, then the UE should initiate the 5G ProSe direct link release procedure.

If:

- a) the initiating UE acts as 5G ProSe layer-2 remote UE or 5G ProSe layer-3 remote UE for relay with N3IWF support; and
- b) the initiating UE is in 5GMM-IDLE mode;

the initiating UE may initiate the 5G ProSe direct link release procedure.

If:

- a) the initiating UE acts as 5G ProSe layer-2 remote UE, 5G ProSe layer-3 remote UE or 5G ProSe layer-2 UE-to-network relay UE; and
- b) the service authorization for the initiating UE to act as 5G ProSe layer-2 remote UE, 5G ProSe layer-3 remote UE or 5G ProSe layer-2 UE-to-network relay UE is revoked after receiving the configuration parameters for 5G ProSe UE-to-network relay as specified in clause 5.2.5;

the initiating UE should initiate the 5G ProSe direct link release procedure.

If:

- a) the initiating UE acts as 5G ProSe layer-3 UE-to-network relay UE; and
- b) the service authorization for the initiating UE to act as 5G ProSe layer-3 UE-to-network relay UE in the serving PLMN or the serving SNPN is revoked after receiving the configuration parameters for 5G ProSe UE-to-network relay as specified in clause 5.2.5;

the initiating UE should initiate the 5G ProSe direct link release procedure, and the initiating UE releases the PDU session established for relaying the traffic of the target UE as specified in 3GPP TS 24.501 [11] clause 6.4.3.

If:

- a) the initiating UE acts as 5G ProSe layer-3 UE-to-network relay UE;
- b) the 5G ProSe direct link was established with an RSC that is specific for emergency services; and
- c) the initiating UE becomes involved into its own emergency services as specified in 3GPP TS 24.501 [11] and the initiating UE decides to prioritize its own emergency services due to local regulations or implementation specific requirements;

the initiating UE shall initiate the 5G ProSe direct link release procedure, and the initiating UE releases the PDU session established for relaying the traffic of the target UE as specified in 3GPP TS 24.501 [11] clause 6.4.3.

If:

- a) the initiating UE acts as 5G ProSe end UE or 5G ProSe UE-to-UE relay UE; and
- b) the service authorization for the initiating UE to act as 5G ProSe end UE or 5G ProSe UE-to-UE relay UE is revoked after receiving the configuration parameters for 5G ProSe UE-to-UE relay as specified in clause 5.2.7;

the initiating UE should initiate the 5G ProSe direct link release procedure.

If:

- a) the initiating UE is acting as a 5G ProSe layer-3 UE-to-UE relay UE;
- b) the direct link that is between a 5G ProSe layer-3 end UE and the initiating UE has been released; and
- c) there are one or more direct links between the initiating UE and the peer 5G ProSe layer-3 end UEs that have PC5 QoS flow(s) only for the communication with the 5G ProSe layer-3 end UE;

the initiating UE may initiate the 5G ProSe direct link release procedure toward the peer 5G ProSe layer-3 end UEs.

If:

- a) the initiating UE is acting as a 5G ProSe layer-3 UE-to-UE relay UE;
- b) a PROSE DIRECT LINK MODIFICATION REQUEST message is received from a 5G ProSe layer-3 end UE to release 5G ProSe UE-to-UE relay communication with one of the peer 5G ProSe layer-3 end UEs; and
- c) the 5G ProSe direct link between the initiating UE and the target peer 5G ProSe layer-3 end UE has PC5 QoS flow(s) only for the communication with the 5G ProSe layer-3 end UE;

the initiating UE may initiate the 5G ProSe direct link release procedure toward the target peer 5G ProSe layer-3 end UE.

For 5G ProSe layer-2 UE-to-UE relay, if:

- a) the initiating UE is acting as a 5G ProSe layer-2 end UE;
- b) the initiating UE has released the end-to-end 5G ProSe direct link between the initiating UE and its peer 5G ProSe layer-2 end UE; and
- c) the 5G ProSe direct link between the initiating UE and the 5G ProSe layer-2 UE-to-UE relay UE has PC5 QoS flow(s) only for the end-to-end communication between the initiating UE and its peer 5G ProSe layer-2 end UE;

the initiating UE may initiate the 5G ProSe direct link release procedure toward the 5G ProSe layer-2 UE-to-UE relay UE.

If the 5G ProSe direct link is for 5G ProSe direct communication between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE, for Ethernet traffic, and the initiating UE acting as the 5G ProSe layer-3 UE-to-UE relay UE detects that the MAC address of 5G ProSe layer-3 end UE is not unique, i.e., the MAC address of the target 5G ProSe layer-3 end UE was also provided by another 5G ProSe layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe layer-3 UE-to-UE relay UE shall send a PROSE DIRECT LINK RELEASE REQUEST message containing PC5 signalling protocol cause value #23 "MAC address not unique" to the target 5G ProSe layer-3 end UE.

If the 5G ProSe direct link is for 5G ProSe direct communication between the 5G ProSe multi-hop layer-3 UE-to-UE relay UE and the target 5G ProSe multi-hop layer-3 end UE or between any two 5G ProSe multi-hop layer-3 UE-to-UE relay UE, for Ethernet traffic, and the initiating UE acting as the 5G ProSe multi-hop layer-3 UE-to-UE relay UE detects that the MAC address of 5G ProSe multi-hop layer-3 end UE is not unique, i.e., the MAC address of the target 5G ProSe multi-hop layer-3 end UE was also provided by another 5G ProSe multi-hop layer-3 end UE in an existing ProSe 5G direct link, the 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall send a PROSE DIRECT LINK RELEASE REQUEST message containing PC5 signalling protocol cause value #23 "MAC address not unique" to the target 5G ProSe layer-3 end UE.

In order to initiate the 5G ProSe direct link release procedure, the initiating UE shall create a PROSE DIRECT LINK RELEASE REQUEST message with a PC5 signalling protocol cause IE indicating one of the following cause values:

- #1 direct communication to the target UE not allowed;
- #2 direct communication to the target UE no longer needed;
- #4 direct connection is not available anymore;
- #5 lack of resources for 5G ProSe direct link;
- #13 congestion situation;
- #20 Failure from 5G ProSe end UE;
- #23 MAC address not unique; or
- #111 protocol error, unspecified.

If the 5G ProSe direct link was established for 5G ProSe UE-to-network relay and:

- a) the NAS level mobility management congestion control as specified in clause 5.3.9 of TS 24.501 [11] is activated at the initiating UE acting as a 5G ProSe UE-to-network relay UE; or
- b) the initiating UE acting as a 5G ProSe UE-to-network relay UE is under congestion;

the initiating UE shall send a PROSE DIRECT LINK RELEASE REQUEST message containing PC5 signalling protocol cause value #13 "congestion situation". The initiating UE may provide a back-off timer value to the target UE in the PROSE DIRECT LINK RELEASE REQUEST message. The initiating UE shall not accept any 5G ProSe direct link establishment request for 5G ProSe UE-to-network relaying if the back-off timer NAS level mobility management congestion control is running.

If the 5G ProSe direct link was established for 5G ProSe UE-to-UE relay and:

- a) the initiating UE acting as a 5G ProSe UE-to-UE relay UE is under congestion;

the initiating UE shall send a PROSE DIRECT LINK RELEASE REQUEST message containing PC5 signalling protocol cause value #13 "congestion situation". The initiating UE may provide a back-off timer value to the target UE in the PROSE DIRECT LINK RELEASE REQUEST message.

NOTE 1: How the initiating UE determines that it is under congestion is implementation specific (e.g., any relaying related operational overhead, etc).

NOTE 2: In case the initiating UE is under the NAS level mobility management congestion control, it is an implementation option that the provided back-off timer value to the target UE is set to the mobility management back-off timer T3346 or with an additional offset value.

If the 5G ProSe direct link was established by the initiating UE which is a 5G ProSe layer-2 remote UE, and the NAS level mobility management congestion control as specified in clause 5.3.9 of 3GPP TS 24.501 [11] is activated at the initiating UE, then the initiating UE shall send a PROSE DIRECT LINK RELEASE REQUEST message containing PC5 signalling protocol cause value #13 "congestion situation".

If:

- a) the initiating UE is acting as a 5G ProSe layer-3 end UE;
- b) the direct link is between the initiating UE and a 5G ProSe layer-3 UE-to-UE relay UE; and
- c) the communication between the initiating UE and the peer 5G ProSe layer-3 end UE is no longer available;

the initiating UE shall send a PROSE DIRECT LINK RELEASE REQUEST message containing PC5 signalling protocol cause value #2 "direct communication to the target UE no longer needed".

If the initiating UE:

- a) is no longer allowed to maintain the 5G ProSe direct link, e.g., based on operator policy or configuration parameters for ProSe direct communication over PC5 as specified in clause 5.2; or

- b) the initiating UE acting as a 5G ProSe layer-3 UE-to-network relay UE decides to prioritize its own emergency services due to local regulations or implementation specific requirements, and the 5G ProSe direct link was established with an RSC that is specific for emergency services;

the initiating UE shall send a PROSE DIRECT LINK RELEASE REQUEST message containing PC5 signalling protocol cause value #1 "direct communication to the target UE not allowed".

If the initiating UE is acting as a 5G ProSe layer-3 UE-to-UE relay UE and decides to release the 5G ProSe direct link with a 5G ProSe layer-3 end UE because the direct link between the peer 5G ProSe layer-3 end UE and the initiating UE has been released by the peer UE, the initiating UE shall send a PROSE DIRECT LINK RELEASE REQUEST message containing PC5 signalling protocol cause value #20 "Failure from 5G ProSe end UE" to the 5G ProSe layer-3 end UE. The initiating UE may include in the PROSE DIRECT LINK RELEASE REQUEST message the PC5 end UE release cause IE set to the PC5 signalling protocol cause received from the peer UE that has released the 5G ProSe direct link.

The initiating UE shall include the new 2 MSBs of K_{NRP} ID in the PROSE DIRECT LINK RELEASE REQUEST message.

After the PROSE DIRECT LINK RELEASE REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication and shall stop T5090 if running. The initiating UE shall start timer T5087.

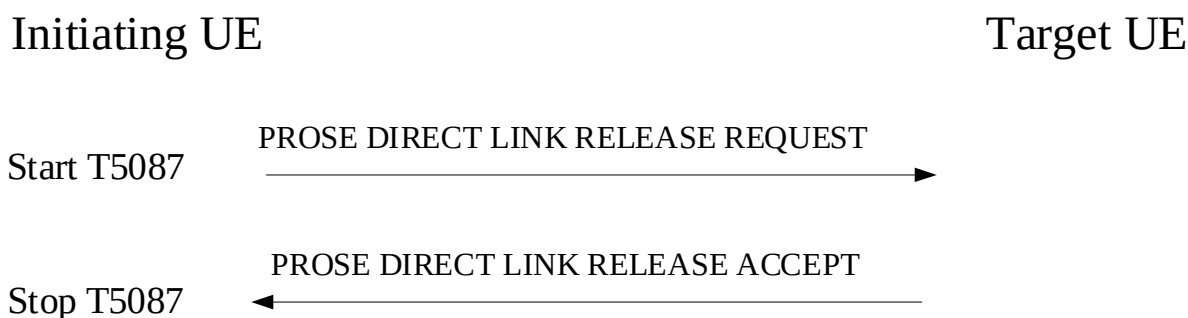


Figure 7.2.6.2.1: 5G ProSe direct link release procedure

7.2.6.3 5G ProSe direct link release procedure accepted by the target UE

Upon receiving a PROSE DIRECT LINK RELEASE REQUEST message, the target UE shall stop all running timers for this 5G ProSe direct link and abort any other ongoing PC5 signalling protocol procedures on this 5G ProSe direct link.

If the PC5 signalling protocol cause value in the PROSE DIRECT LINK RELEASE REQUEST message is #13 "congestion situation" and a back-off timer value is provided in the PROSE DIRECT LINK RELEASE REQUEST message, the target UE shall start timer T5088 associated with the layer-2 ID of the initiating UE and set its value to the provided timer value.

The target UE shall respond with a PROSE DIRECT LINK RELEASE ACCEPT message. The target UE shall include the new 2 LSBs of K_{NRP} ID in the PROSE DIRECT LINK RELEASE ACCEPT message. After the message is sent, the target UE shall release the 5G ProSe direct link by performing the following behaviours:

- a) inform the lower layer along with the PC5 link identifier that the 5G ProSe direct link has been released; and
- b) delete the 5G ProSe direct link context of the 5G ProSe direct link after an implementation specific time.

The target UE shall form the new K_{NRP} ID from the new MSBs of K_{NRP} ID received in the PROSE DIRECT LINK RELEASE REQUEST message and the new LSBs of K_{NRP} ID included in the PROSE DIRECT LINK RELEASE ACCEPT message. The target UE shall replace the existing K_{NRP} ID with the new K_{NRP} ID. The target UE may include the new K_{NRP} ID in PROSE DIRECT LINK ESTABLISHMENT REQUEST message with the initiating UE as specified in clause 7.2.2.2.

The target UE may initiate the 5G ProSe direct link modification procedure as specified in clause 7.2.3 to the target 5G ProSe end UE to remove the corresponding PC5 QoS flow if:

- a) the 5G ProSe direct link between the target UE and the source 5G ProSe end UE is released; and
- b) the target UE is acting as a 5G ProSe UE-to-UE relay UE and determines to keep the 5G ProSe direct link with the peer 5G ProSe end UE.

7.2.6.4 5G ProSe direct link release procedure completion by the initiating UE

Upon receipt of the PROSE DIRECT LINK RELEASE ACCEPT message, the initiating UE shall stop timer T5087 and shall release the 5G ProSe direct link by performing the following behaviours:

- a) inform the lower layer along with the PC5 link identifier that the 5G ProSe direct link has been released; and
- b) delete the 5G ProSe direct link context of the 5G ProSe direct link after an implementation specific time.

The initiating UE shall form the new K_{NRP} ID from the MSBs of K_{NRP} ID included in the PROSE DIRECT LINK RELEASE REQUEST message and the LSBs of K_{NRP} ID received in the PROSE DIRECT LINK RELEASE ACCEPT message. The initiating UE shall replace the existing K_{NRP} ID with the new K_{NRP} ID. The initiating UE may include the new K_{NRP} ID in PROSE DIRECT LINK ESTABLISHMENT REQUEST message with the target UE as specified in clause 7.2.2.2 when the initiating UE reconnects with the same target UE.

7.2.6.5 Abnormal cases

7.2.6.5.1 Abnormal cases at the initiating UE

If retransmission timer T5087 expires and the PC5 signalling protocol cause included in the PC5 signalling protocol cause IE in the PROSE DIRECT LINK RELEASE REQUEST message was #4 "direct connection is not available anymore" or #5 "lack of resources for 5G ProSe direct link", the initiating UE shall release the 5G ProSe direct link locally and delete the K_{NRP} ID associated with this link. From this time onward the initiating UE shall no longer send or receive any messages via this link.

If retransmission timer T5087 expires and the PC5 signalling protocol cause included in the PC5 signalling protocol cause IE in the PROSE DIRECT LINK RELEASE REQUEST message was not #4 "direct connection is not available anymore" or not #5 "lack of resources for 5G ProSe direct link", the initiating UE shall initiate the transmission of the PROSE DIRECT LINK RELEASE REQUEST message again and restart timer T5087.

If no response is received from the target UE after reaching the maximum number of allowed retransmissions, the initiating UE shall release the 5G ProSe direct link locally and delete the K_{NRP} ID associated with this link. From this time onward the initiating UE shall no longer send or receive any messages via this link.

NOTE: The maximum number of allowed retransmissions is UE implementation specific.

7.2.7 PC5 QoS flow establishment over 5G ProSe direct link

In order to establish a PC5 QoS flow establishment over 5G ProSe direct link, the UE shall derive the PC5 QoS parameters based on the ProSe application requirements provided by the upper layers (if available) and the ProSe identifier(s) according to the PC5 QoS mapping rules defined in clause 5.2.4. The UE shall create the PC5 QoS flow(s) based on the derived PC5 QoS parameters. For each PC5 QoS flow to be created, the UE shall perform the following operations:

- a) self-assign a PQFI;
- b) create a PC5 QoS flow context, which contains:
 - 1) the PQFI;
 - 2) the ProSe identifier(s); and
 - 3) the derived PC5 QoS parameters;
- c) create a new PC5 QoS rule which contains:

- 1) a PC5 QoS rule identifier;
 - 2) the PQFI;
 - 3) a set of packet filters; and
 - 4) a precedence value; and
- d) pass the following parameters to the lower layers:
- 1) the PQFI;
 - 2) the PC5 QoS parameters;
 - 3) the PC5 link identifier; and
 - 4) optionally, the source and destination layer-2 IDs.

Three types of packet filters are supported for unicast mode 5G ProSe direct communication over PC5, i.e., the ProSe IP packet filter set, the ProSe packet filter set and the ProSe Ethernet packet filter set. A PC5 QoS Rule contains one of the following:

- a) the ProSe IP packet filter set;
- b) the ProSe packet filter set; or
- c) the ProSe Ethernet packet filter set.

The ProSe IP packet filter set is defined as content of the packet filter contents field specified in 3GPP TS 24.501 [11] figure 9.11.4.13.4 and table 9.11.4.13.1.

The ProSe packet filter set shall support packet filters based on at least any combination of:

- a) ProSe identifier;
- b) the source layer-2 ID and the destination layer-2 ID; and
- c) application layer ID (e.g., Station ID).

The ProSe Ethernet packet filter set is defined as content of the Ethernet packet filter set as specified in 3GPP TS 24.501 [11] figure 9.11.4.13.4 and table 9.11.4.13.1.

Each PC5 QoS rule additionally contains the ProSe identifier(s) when the ProSe identifier is not included in the PC5 packet filter set.

The UE shall also pass the one or more ProSe NR frequencies associated with the ProSe identifier of the ProSe application and the communication mode which is set to unicast mode for the ProSe identifier to the lower layers based on the ProSe identifier to ProSe NR frequency mapping rules for 5G ProSe communication over PC5 as specified in clause 5.2.4.

If the 5G ProSe direct link is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, PC5 QoS flow establishment over the 5G ProSe direct link is performed as specified in clause 8.2.6.

If the 5G ProSe direct link is for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, PC5 QoS flow establishment over the 5G ProSe direct link is performed as specified in clause 8a.2.7.

If the 5G ProSe direct link is for direct communication between the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE, or between two 5G ProSe multi-hop layer-3 UE-to-UE relay UEs, PC5 QoS flow establishment over the 5G ProSe direct link is performed as specified in clause 8c.2.7.

7.2.8 PC5 QoS flow match over 5G ProSe direct link

When service data or request from the upper layers is received, the UE determines if there is any existing PC5 QoS flow(s) matching the service data or request, i.e., based on the PC5 QoS rules for the existing PC5 QoS flow(s).

If there is no PC5 QoS rules for the existing PC5 QoS flow(s) matching the service data or request, the UE shall derive the PC5 QoS parameters based on the ProSe application requirements provided by the upper layers (if available) and the ProSe identifier(s) according to the PC5 QoS mapping rules defined in clause 5.2.4 and shall perform the following:

- a) if there is no existing PC5 QoS flow that fulfils the derived PC5 QoS parameters, then the UE shall create a new PC5 QoS flow as specified in clause 7.2.7;
- b) if there is an existing PC5 QoS flow that fulfils the derived PC5 QoS parameters, then the UE shall update the PC5 packet filter set in the PC5 QoS rule of this PC5 QoS flow, e.g., add the new packet filter in the PC5 QoS rule of this existing PC5 QoS flow; and
- c) the UE shall use the new PC5 QoS flow created as described in bullet a) or the existing PC5 QoS flow with the updated PC5 QoS rules as described in bullet b) to perform the transmission of ProSe direct communication over PC5 as specified in clause 7.2.9.

If there is a PC5 QoS rule for the existing PC5 QoS flow matching the service data or request, the UE shall use this existing PC5 QoS flow to perform transmission of ProSe direct communication over PC5 as specified in clause 7.2.9.

7.2.9 Data transmission over 5G ProSe direct link

7.2.9.1 Transmission

When receiving user data from upper layers to be sent over 5G ProSe direct link to a specific UE, the transmitting UE shall determine the 5G ProSe direct link context corresponding to the application layer ID and then shall tag each outgoing protocol data unit with the following information before passing it to the lower layers for transmission:

- a) a layer-3 protocol data unit type (see 3GPP TS 38.323 [16]) set to:
 - 1) IP, if the ProSe message contains IP data;
 - 2) Ethernet, if the ProSe message contains Ethernet data; or
 - 3) Unstructured, if the ProSe message contains Unstructured data;
- b) the PC5 link identifier associated with the 5G ProSe direct link context;
- c) optionally, the source layer-2 ID set to the source layer-2 ID associated with the 5G ProSe direct link context;
- d) optionally, the destination layer-2 ID set to the destination layer-2 ID associated with the 5G ProSe direct link context; and
- e) the PQFI set to the value corresponding to the ProSe identifier and the optional ProSe application requirements according to the mapping rules specified in clause 5.2.4.

If the 5G ProSe direct link is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the association of the ProSe application on the PC5 QoS flow over the 5G ProSe direct link is performed as specified in clause 8.2.6.

7.2.9.2 Procedure for UE to use provisioned radio resources for ProSe communication over PC5

The procedures described for using NR-PC5 in clause 7.3.2.3 apply.

7.2.10 5G ProSe direct link security mode control procedure

7.2.10.1 General

The 5G ProSe direct link security mode control procedure is used to establish security between two UEs during a 5G ProSe direct link establishment procedure or a 5G ProSe direct link re-keying procedure. Security is not established if the UE PC5 signalling integrity protection is not activated. After successful completion of the 5G ProSe direct link security mode control procedure, the selected security algorithms and their non-null associate keys are used to integrity protect and cipher all PC5 signalling messages exchanged over this 5G ProSe direct link between the UEs and the

security context can be used to protect all PC5 user plane data exchanged over this 5G ProSe direct link between the UEs. The UE sending the PROSE DIRECT LINK SECURITY MODE COMMAND message is called the "initiating UE" and the other UE is called the "target UE".

7.2.10.2 5G ProSe direct link security mode control procedure initiation by the initiating UE

The initiating UE shall meet the following pre-conditions before initiating the 5G ProSe direct link security mode control procedure:

- a) the target UE has initiated a 5G ProSe direct link establishment procedure toward the initiating UE by sending a PROSE DIRECT LINK ESTABLISHMENT REQUEST message and:
 - 1) the PROSE DIRECT LINK ESTABLISHMENT REQUEST message:
 - i) includes a target user info IE which includes the application layer ID of the initiating UE; or
 - ii) does not include a target user info IE and the initiating UE is interested in the ProSe service identified by the ProSe identifier in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message; and
 - 2) the initiating UE:
 - i) if the direct communication is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE nor between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using security procedure with network assistance, has either identified an existing K_{NRP} based on the K_{NRP} ID included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message or derived a new K_{NRP} ;
 - ii) if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE with the security procedure over user plane being used, has received a new K_{NRP} according to the security procedure over user plane as specified in 3GPP TS 33.503 [34];
 - iii) if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE with the security procedure over control plane being used, has received a new $K_{\text{NR\_ProSe}}$ according to the security procedure over control plane as specified in 3GPP TS 33.503 [34];
 - iv) if the direct communication is between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE with the security procedure over user plane being used, has received a new K_{NRP} according to the security procedure over user plane as specified in 3GPP TS 33.503 [34];
 - v) if the direct communication is between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE with the security procedure over control plane being used, has received a new $K_{\text{NR\_ProSe}}$ according to the security procedure over control plane as specified in 3GPP TS 33.503 [34];
 - vi) has decided not to activate security protection based on its UE 5G ProSe direct signalling security policy and the target UE's 5G ProSe direct signalling security policy;
 - vii) the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, and the target UE is identified by a PEI, has generated a new K_{NRP} in an implementation defined way; or
 - viii) if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, and the security procedure over control plane or the security procedure over user plane as specified in 3GPP TS 33.503 [34] fails, has generated a new $K_{\text{NR\_ProSe}}$ or K_{NRP} in an implementation defined way; or
- b) the target UE has initiated a 5G ProSe direct link re-keying procedure toward the initiating UE by sending a PROSE DIRECT LINK REKEYING REQUEST message and:
 - 1) if the target UE has included a Re-authentication indication in the PROSE DIRECT LINK REKEYING REQUEST message, the initiating UE has derived a new K_{NRP} .

When:

- a) the direct communication is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE nor between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using security procedure with network assistance, if a new K_{NRP} has been derived by the initiating UE; or
- b) the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, if a new K_{NRP} or $K_{\text{NR\_ProSe}}$ has been received by the initiating UE according to the security procedure over user plane or the security procedure over control plane, respectively, as specified in 3GPP TS 33.503 [34];

the initiating UE shall generate the 2 MSBs of K_{NRP} ID to ensure that the resultant K_{NRP} ID will be unique in the initiating UE.

NOTE 1: If the direct communication is not between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the K_{NRP} ID holds the ID that corresponds to K_{NRP} . If the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the K_{NRP} ID holds the ID that corresponds to K_{NRP} (if security procedure over user plane is used) or $K_{\text{NR\_ProSe}}$ (if security procedure over control plane is used).

NOTE 1A: If the direct communication is not between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using security procedure with network assistance, the K_{NRP} ID holds the ID that corresponds to K_{NRP} . If the direct communication is between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using security procedure with network assistance, the K_{NRP} ID holds the ID that corresponds to K_{NRP} (if security procedure over user plane is used) or $K_{\text{NR\_ProSe}}$ (if security procedure over control plane is used).

The initiating UE shall select security algorithms in accordance with its UE 5G ProSe direct signalling security policy and the target UE's 5G ProSe direct signalling security policy. If the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure, the initiating UE shall not select the null integrity protection algorithm if the initiating UE or the target UE's 5G ProSe direct signalling integrity protection policy is set to "Signalling integrity protection required". If the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link re-keying procedure, the initiating UE:

- a) shall not select the null integrity protection algorithm if the integrity protection algorithm currently in use for the 5G ProSe direct link is different from the null integrity protection algorithm;
- b) shall not select the null ciphering protection algorithm if the ciphering protection algorithm currently in use for the 5G ProSe direct link is different from the null ciphering protection algorithm;
- c) shall select the null integrity protection algorithm if the integrity protection algorithm currently in use is the null integrity protection algorithm; and
- d) shall select the null ciphering protection algorithm if the ciphering protection algorithm currently in use is the null ciphering protection algorithm.

Then the initiating UE shall:

- a) if the direct communication is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE nor between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance:
 - 1) generate a 128-bit Nonce_2 value;
 - 2) derive $K_{\text{NRP\_sess}}$ from Nonce_1 received in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, K_{NRP} and Nonce_2, as specified in 3GPP TS 33.536 [37]; and
 - 3) derive the NR PC5 encryption key NRPEK and the NR PC5 integrity key NRPIK from $K_{\text{NRP\_sess}}$ and the selected security algorithms as specified in 3GPP TS 33.536 [37];
- b) if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used and completed successfully:
 - 1) derive $K_{\text{relay\_sess}}$ from $K_{\text{NR\_ProSe}}$, Nonce_2 and Nonce_1 received in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message as specified in 3GPP TS 33.503 [34]; and

- 2) derive the NR PC5 encryption key $K_{\text{relay-enc}}$ and the NR PC5 integrity key $K_{\text{relay-int}}$ from $K_{\text{relay-sess}}$ and the selected security algorithms as specified in 3GPP TS 33.503 [34];
- c) if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE and the security procedure over user plane as specified in 3GPP TS 33.503 [34] is used and completed successfully:
 - 1) derive $K_{\text{NRP-sess}}$ from K_{NRP} , K_{NRP} freshness parameter 2 and K_{NRP} freshness parameter 1 received in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message as specified in 3GPP TS 33.503 [34]; and
 - 2) derive the NR PC5 encryption key NRPEK and the NR PC5 integrity key NRPIK from $K_{\text{NRP-sess}}$ and the selected security algorithms as specified in 3GPP TS 33.503 [34]; and
- d) create a PROSE DIRECT LINK SECURITY MODE COMMAND message. In this message, the initiating UE:
 - 1) shall include the key establishment information container IE if:
 - i) the 5G ProSe direct link is neither for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, nor for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using security procedure with network assistance;
 - ii) a new K_{NRP} has been derived at the initiating UE; and
 - iii) the authentication method used to generate K_{NRP} requires sending information to complete the 5G ProSe direct link authentication procedure;

NOTE 2: The key establishment information container is provided by upper layers.

- 2) shall include the MSBs of K_{NRP} ID IE if a new K_{NRP} has been derived or a new K_{NRP} or $K_{\text{NR-ProSe}}$ has been received at the initiating UE;
- 3) shall include a Nonce_2 IE set to:
 - i) the 128-bit nonce value generated by the initiating UE when the direct communication is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE nor between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using security procedure with network assistance;
 - ii) the K_{NRP} freshness parameter 2 value received by the initiating UE when the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE with the security procedure over user plane as specified in 3GPP TS 33.503 [34] being used; or
 - iii) the Nonce_2 value received by the initiating UE when the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE with the security procedure over control plane as specified in 3GPP TS 33.503 [34] being used;

for the purpose of session key establishment over this 5G ProSe direct link if the selected integrity protection algorithm is not the null integrity protection algorithm;

- 4) shall include the selected security algorithms. If the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, and:
 - i) the security procedure over control plane or the security procedure over user plane as specified in 3GPP TS 33.503 [34] fails; or
 - ii) the target UE is identified by a PEI;

the initiating UE shall indicate the null integrity protection algorithm and the null ciphering protection algorithm as the selected security algorithms;

- 5) shall include the UE security capabilities received from the target UE in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message or PROSE DIRECT LINK REKEYING REQUEST message;
- 6) shall include the UE 5G ProSe direct signalling security policy received from the target UE in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message;

- 7) shall include the LSB of $K_{\text{NRP-sess}}$ ID chosen by the initiating UE as specified in 3GPP TS 33.536 [37] if the selected integrity protection algorithm is not the null integrity protection algorithm;

NOTE 3: If the direct communication is not between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the $K_{\text{NRP-sess}}$ ID holds the ID that corresponds to $K_{\text{NRP-sess}}$. If the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the $K_{\text{NRP-sess}}$ ID holds the ID that corresponds to $K_{\text{NRP-sess}}$ (if security procedure over user plane is used) or $K_{\text{relay-sess}}$ (if security procedure over control plane is used).

NOTE 3A: If the direct communication is not between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using security procedure with network assistance, the $K_{\text{NRP-sess}}$ ID holds the ID that corresponds to $K_{\text{NRP-sess}}$. If the direct communication is between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using security procedure with network assistance, the $K_{\text{NRP-sess}}$ ID holds the ID that corresponds to $K_{\text{NRP-sess}}$ (if security procedure over user plane is used) or $K_{\text{relay-sess}}$ (if security procedure over control plane is used).

- 8) shall include the GPI if received from the 5G PKMF according to the security procedure over user plane as specified in 3GPP TS 33.503 [34], when the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE; and
- 9) shall include the EAP message if received from the network according to the security procedure over control plane as specified in 3GPP TS 33.503 [34], when the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

If the security protection of this 5G ProSe direct link is activated by using non-null integrity protection algorithm or non-null ciphering protection algorithm, the initiating UE shall form the $K_{\text{NRP-sess}}$ ID from the MSB of $K_{\text{NRP-sess}}$ ID received in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message or PROSE DIRECT LINK REKEYING REQUEST message and the LSB of $K_{\text{NRP-sess}}$ ID included in the PROSE DIRECT LINK SECURITY MODE COMMAND message. The initiating UE shall use the $K_{\text{NRP-sess}}$ ID to identify the new security context.

The initiating UE shall set the source layer-2 ID and destination layer-2 ID as follows:

- 1) if the initiating UE is acting as a 5G ProSe UE-to-network relay UE or a 5G ProSe UE-to-UE relay UE, and the EAP-AKA' based authentication method is used as specified in clause 6.3.3.3 of 3GPP TS 33.503 [34],
the source layer-2 ID set to the source layer-2 ID used in PROSE AA MESSAGE TRANSPORT REQUEST message, and the destination layer-2 ID set to the destination layer-2 ID used in PROSE AA MESSAGE TRANSPORT REQUEST message;
- 2) if the initiating UE is not acting as a 5G ProSe UE-to-network relay UE or a 5G ProSe UE-to-UE relay UE using the security procedure with network assistance, and a 5G ProSe direct link authentication procedure has been initiated:
the source layer-2 ID set to the source layer-2 ID used in PROSE DIRECT LINK AUTHENTICATION REQUEST message, and the destination layer-2 ID set to the destination layer-2 ID used in PROSE DIRECT LINK AUTHENTICATION REQUEST message;
- 3) otherwise, self-assign a source layer-2 ID, and the destination layer-2 ID set to the source layer-2 ID in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message.

NOTE 4: The UE implementation ensures that any value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct discovery as specified in clause 6.2.14, clause 6.2.15 and clause 8.2.1, and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

NOTE 5: It is possible for the target UE to reuse the target UE's layer-2 ID used in previous 5G ProSe direct link with the same peer UE.

After the PROSE DIRECT LINK SECURITY MODE COMMAND message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the source layer-2 ID and the destination layer-2 ID, NRPIK (or $K_{\text{relay-int}}$ when applicable), NRPEK (or $K_{\text{relay-enc}}$ when applicable) if applicable, $K_{\text{NRP-sess}}$ ID, the selected security algorithm as specified in TS 33.536 [37]; an indication of activation of the 5G ProSe direct signalling security protection for the 5G ProSe direct link with the new security context, if applicable and start timer T5089. The initiating

UE shall not send a new PROSE DIRECT LINK SECURITY MODE COMMAND message to the same target UE while timer T5089 is running.

NOTE 6: The PROSE DIRECT LINK SECURITY MODE COMMAND message is integrity protected (and not ciphered) at the lower layer using the new security context.

If the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link re-keying procedure, the initiating UE shall provide to the lower layers an indication of activation of the 5G ProSe direct user plane security protection for the 5G ProSe direct link with the new security context, if applicable, along with the initiating UE's layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID for 5G ProSe direct communication.

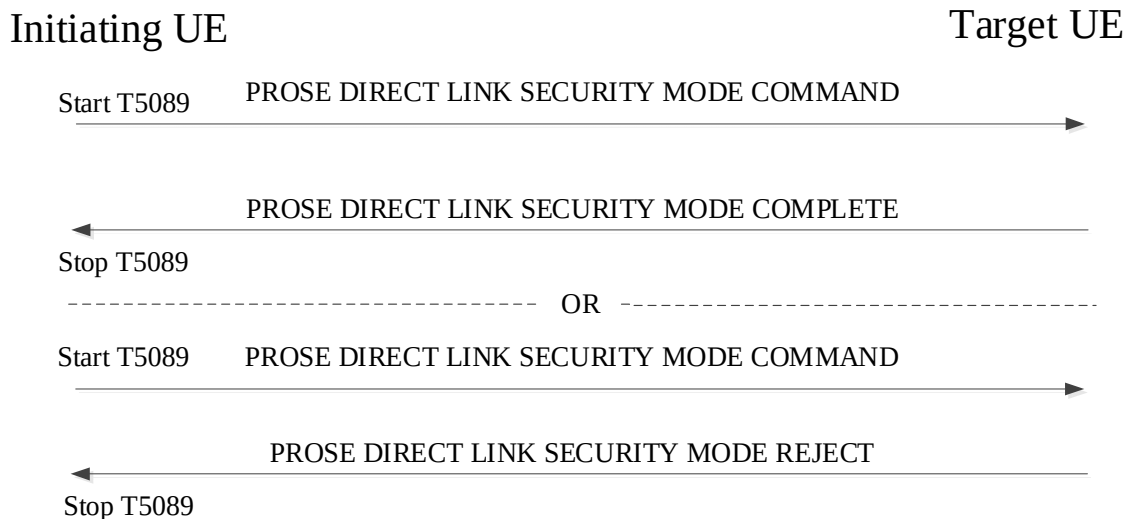


Figure 7.2.10.2.1: 5G ProSe direct link security mode control procedure

7.2.10.3 5G ProSe direct link security mode control procedure accepted by the target UE

Upon receipt of a PROSE DIRECT LINK SECURITY MODE COMMAND message, if a new assigned initiating UE's layer-2 ID is included and if the 5G ProSe direct link authentication procedure has not been executed, the target UE shall replace the original initiating UE's layer-2 ID with the new assigned initiating UE's layer-2 ID for 5G ProSe direct communication. The target UE shall check the selected security algorithms IE included in the PROSE DIRECT LINK SECURITY MODE COMMAND message. If "null integrity algorithm" is included in the selected security algorithms IE, the integrity protection is not offered for this 5G ProSe direct link and the signalling messages are transmitted unprotected. If "null ciphering algorithm" and an integrity algorithm other than "null integrity algorithm" are included in the selected algorithms IE, the ciphering protection is not offered for this 5G ProSe direct link and the signalling messages are transmitted unprotected. If the target UE's 5G ProSe direct signalling integrity protection policy is set to "Signalling integrity protection required", the target UE shall check the selected security algorithms IE in the PROSE DIRECT LINK SECURITY MODE COMMAND message does not include the null integrity protection algorithm. If the selected integrity protection algorithm is not the null integrity protection algorithm, the target UE shall:

- a) if the direct communication is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, nor between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE when security procedure with network assistance is used:
 - 1) derive $K_{\text{NRP-secs}}$ from K_{NRP} , Nonce_1 and Nonce_2 received in the PROSE DIRECT LINK SECURITY MODE COMMAND message as specified in 3GPP TS 33.536 [37];
 - 2) derive NRPIK from $K_{\text{NRP-secs}}$ and the selected integrity algorithm as specified in 3GPP TS 33.536 [37]; and
 - 3) if the $K_{\text{NRP-secs}}$ is derived and the selected ciphering protection algorithm is not the null ciphering protection algorithm, then the target UE shall derive NRPEK from $K_{\text{NRP-secs}}$ and the selected ciphering algorithm as specified in 3GPP TS 33.536 [37]; or

- b) if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE when security procedure with network assistance is used and:
- the RSC is not specific for emergency services; or
 - the RSC is specific for emergency services, and the selected integrity protection algorithm is not the null integrity protection algorithm;

then:

- 1) if the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, derive $K_{\text{relay-sess}}$ according to the security procedure over control plane, and derive $K_{\text{relay-int}}$ from $K_{\text{relay-sess}}$ and the selected integrity algorithm as specified in 3GPP TS 33.503 [34]. If the $K_{\text{relay-sess}}$ is derived and the selected ciphering protection algorithm is not the null ciphering protection algorithm, then the target UE shall derive $K_{\text{relay-enc}}$ from $K_{\text{relay-sess}}$ and the selected ciphering algorithm as specified in 3GPP TS 33.503 [34]; or
- 2) if security procedure over user plane as specified in 3GPP TS 33.503 [34] is used, derive $K_{\text{NRP-sess}}$ according to the security procedure over user plane, and derive NRPIK from $K_{\text{NRP-sess}}$ and the selected integrity algorithm as specified in 3GPP TS 33.503 [34]. If the $K_{\text{NRP-sess}}$ is derived and the selected ciphering protection algorithm is not the null ciphering protection algorithm, then the target UE shall derive NRPEK from $K_{\text{NRP-sess}}$ and the selected ciphering algorithm as specified in 3GPP TS 33.503 [34].

The target UE shall determine whether or not the PROSE DIRECT LINK SECURITY MODE COMMAND message can be accepted by:

- a) checking that the selected security algorithms IE in the PROSE DIRECT LINK SECURITY MODE COMMAND message does not include the null integrity protection algorithm if the target UE's 5G ProSe direct signalling integrity protection policy is set to "Signalling integrity protection required";
- b) asking the lower layers to check the integrity of the PROSE DIRECT LINK SECURITY MODE COMMAND message using NRPIK (or $K_{\text{relay-int}}$ when applicable) and the selected integrity protection algorithm, if the selected integrity protection algorithm is not the null integrity protection algorithm;
- c) checking that the received UE security capabilities have not been altered compared to the values that the target UE sent to the initiating UE in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message or PROSE DIRECT LINK REKEYING REQUEST message;
- d) if the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure,
 - 1) checking that the received UE 5G ProSe direct signalling security policy has not been altered compared to the values that the target UE sent to the initiating UE in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message; and
 - 2) checking that the LSB of $K_{\text{NRP-sess}}$ ID included in the PROSE DIRECT LINK SECURITY MODE COMMAND message are not set to the same value as those received from another UE in response to the target UE's PROSE DIRECT LINK ESTABLISHMENT REQUEST message; and
- e) if the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link re-keying procedure and the integrity protection algorithm currently in use for the 5G ProSe direct link is different from the null integrity protection algorithm, checking that the selected security algorithms IE in the PROSE DIRECT LINK SECURITY MODE COMMAND message do not include the null integrity protection algorithm.

If the target UE did not include a K_{NRP} ID in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, the target UE included a Re-authentication indication in the PROSE DIRECT LINK REKEYING REQUEST message or the initiating UE has chosen to derive:

- a) a new K_{NRP} if the direct communication is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, nor between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE when security procedure with network assistance is used; the target UE shall derive K_{NRP} as specified in 3GPP TS 33.536 [37];
- b) a new K_{NRP} , if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the security procedure

over user plane as specified in 3GPP TS 33.503 [34] is used, the target UE shall derive K_{NR} as specified in 3GPP TS 33.536 [37]; or

- c) a new K_{NR_ProSe} , if the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, the target UE shall derive K_{NR_ProSe} as specified in 3GPP TS 33.536 [37]; and

the target UE shall choose the 2 LSBs of K_{NR} ID to ensure that the resultant K_{NR} ID will be unique in the target UE. The target UE shall form K_{NR} ID from the received MSB of K_{NR} ID and its chosen 2 LSBs of K_{NR} ID and shall store the complete K_{NR} ID with K_{NR}/K_{NR_ProSe} .

NOTE 1: If the direct communication is not between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the K_{NR} ID holds the ID that corresponds to K_{NR} . If the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the K_{NR} ID holds the ID that corresponds to K_{NR} (if security procedure over user plane is used) or K_{NR_ProSe} (if security procedure over control plane is used).

NOTE 1A: If the direct communication is not between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance, the K_{NR} ID holds the ID that corresponds to K_{NR} . If the direct communication is between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance, the K_{NR} ID holds the ID that corresponds to K_{NR} (if security procedure over user plane is used) or K_{NR_ProSe} (if security procedure over control plane is used).

If the GPI is included in the PROSE DIRECT LINK SECURITY MODE COMMAND message and the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, the target UE shall derive the UP-PRUK and obtain the UP-PRUK ID from the GPI, and use the UP-PRUK in deriving the K_{NR} , according to the security procedure over user plane as specified in 3GPP TS 33.503 [34].

If the target UE accepts the PROSE DIRECT LINK SECURITY MODE COMMAND message, the target UE shall create a PROSE DIRECT LINK SECURITY MODE COMPLETE message. In this message, the target UE:

- a) if the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure:
 - 1) shall include the PQFI and the corresponding PC5 QoS parameters if the 5G ProSe direct link is neither for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE nor between the target 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance; or
 - 2) may include the PQFI and the corresponding PC5 QoS parameters if the 5G ProSe direct link is for 5G ProSe direct communication between 5G ProSe layer-3 remote UE and 5G ProSe layer-3 UE-to-network relay UE;

NOTE 2: The PQFI and the corresponding PC5 QoS parameters are not included if the 5G ProSe direct link is for 5G ProSe direct communication between 5G ProSe remote UE and 5G ProSe layer-2 UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe layer-2 UE-to-UE relay UE.

- b) if IP communication is used, the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure, and the 5G ProSe direct link is not for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe layer-2 UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe layer-2 UE-to-UE relay UE, shall include an IP address configuration IE set to one of the following values:
 - 1) "IPv6 router" if only IPv6 address allocation mechanism is supported by the target UE, i.e., acting as an IPv6 router;
 - 2) "DHCPv4 server" if only IPv4 address allocation mechanism is supported by the target UE, i.e., acting as a DHCPv4 server;
 - 3) "DHCPv4 server & IPv6 Router" if both IPv4 and IPv6 address allocation mechanism are supported by the target UE; or

- 4) "address allocation not supported" if neither IPv4 nor IPv6 address allocation mechanism is supported by the target UE and the 5G ProSe direct link is not for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe layer-3 UE-to-network relay UE;

NOTE 3: The UE doesn't include an IP address configuration IE nor a link local IPv6 address IE if Ethernet or Unstructured data unit type is used for communication.

- c) if IP communication is used, the IP address configuration IE is set to "address allocation not supported" and the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure, shall include a link local IPv6 address IE formed locally based on IETF RFC 4862 [25];
- d) if a new K_{NRP} was derived or a new K_{NRP} or K_{NR_ProSe} was received, shall include the 2 LSBs of K_{NRP} ID;
- e) if the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure, shall include its UE 5G ProSe direct user plane security policy for this 5G ProSe direct link. In the case where the different ProSe services are mapped to the different 5G ProSe direct user plane security policies, when more than one ProSe identifier is included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, each of the user plane security policies of those ProSe services shall be compatible, e.g., "user plane integrity protection not needed" and "user plane integrity protection required" are not compatible. If the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, the RSC is specific for emergency services, and the null integrity protection algorithm and the null ciphering protection algorithm are the selected security algorithms, the target UE shall indicate the user plane integrity protection policy set to "user plane integrity protection not needed" and the user plane ciphering policy set to "User plane ciphering not needed"; and
- f) if the 5G ProSe direct link security mode control procedure is triggered during a 5G ProSe direct link establishment procedure for 5G ProSe direct communication between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, and for Ethernet traffic, shall include the MAC address of the source 5G ProSe layer-3 end UE.

If the selected integrity protection algorithm is not the null integrity protection algorithm, the target UE shall form the K_{NRP_sess} ID from the MSB of K_{NRP_sess} ID it had sent in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message or PROSE DIRECT LINK REKEYING REQUEST message and the LSB of K_{NRP_sess} ID received in the PROSE DIRECT LINK SECURITY MODE COMMAND message. The target UE shall use the K_{NRP_sess} ID to identify the new security context.

After the PROSE DIRECT LINK SECURITY MODE COMPLETE message is generated, the target UE shall pass this message to the lower layers for transmission along with the target UE's layer-2 ID for 5G ProSe direct communication and the initiating UE's layer-2 ID for 5G ProSe direct communication, NRPIK (or $K_{relay-int}$ when applicable), NRPEK (or $K_{relay-enc}$ when applicable) if applicable, K_{NRP_sess} ID, the selected security algorithm as specified in 3GPP TS 33.536 [37] and an indication of activation of the 5G ProSe direct signalling security protection for the 5G ProSe direct link with the new security context, if applicable.

NOTE 4: The PROSE DIRECT LINK SECURITY MODE COMPLETE message and further 5G ProSe direct signalling messages are integrity protected and ciphered (if applicable) at the lower layer using the new security context.

If the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link re-keying procedure, the target UE shall provide to the lower layers an indication of activation of the 5G ProSe direct user plane security protection for the 5G ProSe direct link with the new security context, if applicable, along with the initiating UE's layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID for 5G ProSe direct communication.

7.2.10.4 5G ProSe direct link security mode control procedure completion by the initiating UE

Upon receiving a PROSE DIRECT LINK SECURITY MODE COMPLETE message, the initiating UE shall stop timer T5089. If the selected integrity protection algorithm is not the null integrity protection algorithm, the UE checks the integrity of the PROSE DIRECT LINK SECURITY MODE COMPLETE message. If the integrity check passes, the initiating UE shall then continue the procedure which triggered the 5G ProSe direct link security mode control procedure. If the selected integrity protection algorithm is the null integrity protection algorithm, the UE continues the procedure without checking the integrity protection.

After receiving the PROSE DIRECT LINK SECURITY MODE COMPLETE message, the initiating UE shall delete the old security context it has for the target UE, if any.

7.2.10.5 5G ProSe direct link security mode control procedure not accepted by the target UE

If the PROSE DIRECT LINK SECURITY MODE COMMAND message cannot be accepted, the target UE shall send a PROSE DIRECT LINK SECURITY MODE REJECT message and the target UE shall abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link security mode control procedure unless the ongoing procedure is a 5G ProSe direct link establishment procedure and the Target user info is not included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message. The PROSE DIRECT LINK SECURITY MODE REJECT message contains a PC5 signalling protocol cause IE indicating one of the following cause values:

- #5: lack of resources for 5G ProSe direct link;
- #7: integrity failure;
- #8: UE security capabilities mismatch;
- #9: LSB of $K_{\text{NRP-session}}$ ID conflict;
- #10: UE PC5 unicast signalling security policy mismatch;
- #14: Authentication synchronisation error; or
- #111: protocol error, unspecified.

If this 5G ProSe direct link security mode control procedure is triggered during the 5G ProSe direct link establishment procedure and the implementation-specific maximum number of established NR 5G ProSe direct links has been reached, then the target UE shall send a PROSE DIRECT LINK SECURITY MODE REJECT message containing PC5 signalling protocol cause value #5 "lack of resources for 5G ProSe direct link".

If the PROSE DIRECT LINK SECURITY MODE COMMAND message cannot be accepted because the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure, that the selected security algorithms IE in the PROSE DIRECT LINK SECURITY MODE COMMAND message included the null integrity protection algorithm and the target UE's 5G ProSe direct signalling integrity protection policy is set to "Signalling integrity protection required", the target UE shall include PC5 signalling protocol cause #10 "UE PC5 unicast signalling security policy mismatch" in the PROSE DIRECT LINK SECURITY MODE REJECT message.

If the PROSE DIRECT LINK SECURITY MODE COMMAND message cannot be accepted because the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link re-keying procedure, the integrity protection algorithm currently in use for the 5G ProSe direct link is different from the null integrity protection algorithm and the selected security algorithms IE in the PROSE DIRECT LINK SECURITY MODE COMMAND message include the null integrity protection algorithm, the target UE, the target UE shall include PC5 signalling protocol cause #10 "UE PC5 unicast signalling security policy mismatch" in the PROSE DIRECT LINK SECURITY MODE REJECT message.

If the target UE detects that the received UE security capabilities IE in the PROSE DIRECT LINK SECURITY MODE COMMAND message has been altered compared to the latest values that the target UE sent to the initiating UE in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message or PROSE DIRECT LINK REKEYING REQUEST message, the target UE shall include PC5 signalling protocol cause #8 "UE security capabilities mismatch" in the PROSE DIRECT LINK SECURITY MODE REJECT message.

If the target UE detects that the LSB of $K_{\text{NRP-session}}$ ID included in the PROSE DIRECT LINK SECURITY MODE COMMAND message are set to the same value as those received from another UE in response to the target UE's PROSE DIRECT LINK ESTABLISHMENT REQUEST message, the target UE shall include PC5 signalling protocol cause #9 "LSB of $K_{\text{NRP-session}}$ ID conflict" in the PROSE DIRECT LINK SECURITY MODE REJECT message.

If the 5G ProSe direct link security mode control procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the PROSE DIRECT LINK SECURITY MODE COMMAND message cannot be accepted due to a synchronisation error when processing the authentication vector contained in the GPI sent by the 5G ProSe UE-to-network relay UE to the 5G ProSe remote UE or by the 5G ProSe UE-to-UE relay UE to the 5G ProSe end UE, if any, the target UE shall include PC5 signalling protocol cause #14 "Authentication synchronisation error" in the PROSE DIRECT LINK

SECURITY MODE REJECT message and shall include the RAND and AUTS parameters in the PROSE DIRECT LINK SECURITY MODE REJECT message.

After the PROSE DIRECT LINK SECURITY MODE REJECT message is generated, the target UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID for 5G ProSe direct communication.

Upon receipt of the PROSE DIRECT LINK SECURITY MODE REJECT message, the initiating UE shall stop timer T5089, provide an indication to the lower layer of deactivation of the 5G ProSe direct security protection and deletion of security context for the 5G ProSe direct link, if applicable and:

- a) if the PC5 signalling protocol cause IE in the PROSE DIRECT LINK SECURITY MODE REJECT message is set to #9 "LSB of $K_{NRP\text{-}sess}$ ID conflict", retransmit the PROSE DIRECT LINK SECURITY MODE COMMAND message with a different value for the LSB of $K_{NRP\text{-}sess}$ ID and restart timer T5089;
- b) if the PC5 signalling protocol cause IE in the PROSE DIRECT LINK SECURITY MODE REJECT message is set to #14 "Authentication synchronisation error", the message contained a RAND and an AUTS, and the 5G ProSe direct link security mode control procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, may fetch a fresh GPI from the PKMF by sending a Key Request message including RAND and AUTS as specified in 3GPP TS 33.503 [34]; or
- c) if the PC5 signalling protocol cause IE is set to the value other than #9 "LSB of $K_{NRP\text{-}sess}$ ID conflict" and other than #14 "Authentication synchronisation error", abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link security mode control procedure.

7.2.10.6 Abnormal cases

7.2.10.6.1 Abnormal cases at the initiating UE

- a) Timer T5089 expires.

The initiating UE shall retransmit the PROSE DIRECT LINK SECURITY MODE COMMAND message and restart timer T5089. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct link security mode control procedure, shall provide an indication to the lower layer of deactivation of the 5G ProSe direct security protection and deletion of security context for the 5G ProSe direct link, if applicable and shall abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link security mode control procedure.

NOTE 1: The maximum number of allowed retransmissions is UE implementation specific.

- b) The need to use this 5G ProSe direct link no longer exists before the 5G ProSe direct link security mode control procedure is completed.

The initiating UE shall abort the procedure, shall provide an indication to the lower layer of deactivation of the 5G ProSe direct security protection and deletion of security context for the 5G ProSe direct link, if applicable and shall abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link security mode control procedure.

- c) If PROSE DIRECT LINK MODIFICATION REQUEST message or PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message is received when the timer T5089 is running, the initiating UE shall discard the PROSE DIRECT LINK MODIFICATION REQUEST message or PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message.
- d) For the same 5G ProSe direct link, if PROSE DIRECT LINK RELEASE REQUEST message is received when the timer T5089 is running, the initiating UE shall stop the timer T5089, abort the 5G ProSe direct link security mode control procedure and proceed with the 5G ProSe direct link release procedure.

NOTE 2: The abnormal cases as described in bullet c) or d) only happen when the 5G ProSe direct link security mode control procedure is used to establish security between two UEs during a 5G ProSe direct link re-keying procedure.

7.2.11 5G ProSe direct link re-keying procedure

7.2.11.1 General

The purpose of the 5G ProSe direct link re-keying procedure is to derive:

- a) a new $K_{\text{NRP-sess}}$ and, optionally, a new K_{NRP} for an existing 5G ProSe direct link that is neither between 5G ProSe remote UE and 5G ProSe UE-to-network relay UE nor between 5G ProSe end UE and 5G ProSe UE-to-UE relay UE using the security procedure with network assistance;
- b) a new $K_{\text{NRP-sess}}$ for an existing 5G ProSe direct link that is between 5G ProSe remote UE and 5G ProSe UE-to-network relay UE or between 5G ProSe end UE and 5G ProSe UE-to-UE relay UE when the security procedure over user plane as specified in 3GPP TS 33.503 [34] is used; or
- c) a new $K_{\text{relay-sess}}$ for an existing 5G ProSe direct link that is between 5G ProSe remote UE and 5G ProSe UE-to-network relay UE or between 5G ProSe end UE and 5G ProSe UE-to-UE relay UE when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used.

The UE sending the PROSE DIRECT LINK REKEYING REQUEST message is called the "initiating UE" and the other UE is called the "target UE".

NOTE: There is no benefit in performing the 5G ProSe direct link re-keying procedure when using the null integrity protection algorithm, hence it is recommended not to trigger it when using the null integrity protection algorithm.

7.2.11.2 5G ProSe direct link re-keying procedure initiation by the initiating UE

The initiating UE shall meet the following pre-condition before initiating the 5G ProSe direct link re-keying procedure:

- a) there is a 5G ProSe direct link between the initiating UE and the target UE; and
 - 1) if the session key $K_{\text{NRP-sess}}$ or $K_{\text{relay-sess}}$ (see clause 7.2.11.1) used to protect 5G ProSe direct link needs to be refreshed and neither timer T5089 nor T5091 are running;
 - 2) if the UE wants to refresh K_{NRP} , when the 5G ProSe direct link is neither between 5G ProSe remote UE and 5G ProSe UE-to-network relay UE nor between 5G ProSe end UE and 5G ProSe UE-to-UE relay UE, and neither timer T5089 nor T5091 are running; or
 - 3) if the lower layers indicate that a 5G ProSe direct link re-keying procedure needs to be performed.

In order to initiate the 5G ProSe direct link re-keying procedure, the initiating UE shall create a PROSE DIRECT LINK REKEYING REQUEST message. In this message, the initiating UE:

- a) shall include the Key establishment information container IE if the 5G ProSe direct link is neither for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, nor for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance, and the null integrity protection algorithm is not in use;

NOTE 1: The key establishment information container is provided by upper layers.

- b) shall include a Nonce_1 IE set to the 128-bit nonce value generated by the initiating UE for the purpose of session key refresh over this 5G ProSe direct link if the null integrity protection algorithm is not in use;
- c) shall include its UE security capabilities indicating the list of algorithms that the initiating UE supports for the re-keying of this 5G ProSe direct link;
- d) shall include the MSB of $K_{\text{NRP-sess}}$ ID or the MSB of $K_{\text{relay-sess}}$ ID (see clause 7.2.11.1) chosen by the initiating UE as specified in 3GPP TS 33.503 [34] if the null integrity protection algorithm is not in use;

NOTE 2: The MSB of $K_{\text{NRP-sess}}$ ID IE in the PROSE DIRECT LINK REKEYING REQUEST message is used to hold the value of MSB of $K_{\text{NRP-sess}}$ ID or MSB of $K_{\text{relay-sess}}$ ID.

- e) may include a Re-authentication indication if the initiating UE wants to derive a new K_{NRP} and the 5G ProSe direct link re-keying procedure is neither between the 5G ProSe remote UE and the 5G ProSe UE-to-network

relay UE nor between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance;

NOTE 3: When the 5G ProSe direct link re-keying procedure is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance, the Re-authentication indication is not included because a new KNRP is always derived according to the security procedure over user plane or the security procedure over control plane as specified in 3GPP TS 33.503 [34].

f) shall include the User security key ID IE set to:

1) UP-PRUK ID of the initiating UE if:

- i) the UE has a valid UP-PRUK;
- ii) the 5G ProSe direct link re-keying procedure is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance; and
- iii) the security procedure over user plane as specified in 3GPP TS 33.503 [34] is used; or

2) CP-PRUK ID of the initiating UE that is associated with the relay service code of the target UE if:

- i) the UE has a valid CP-PRUK associated with the relay service code of the target UE;
- ii) the 5G ProSe direct link re-keying procedure is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE using the security procedure with network assistance; and
- iii) the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used; and

g) shall include the HPLMN ID of the 5G ProSe remote UE or the 5G ProSe end UE if the UP-PRUK ID is included and is not in NAI format (see 3GPP TS 33.503 [34]).

NOTE 3A: In case of SNPN, the HPLMN ID includes the PLMN ID of the subscribed SNPN.

After the PROSE DIRECT LINK REKEYING REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication and start timer T5091. The UE shall not send a new PROSE DIRECT LINK REKEYING REQUEST message to the same target UE while timer T5091 is running.

NOTE 4: In order to ensure successful 5G ProSe direct link re-keying, T5091 should be set to a value larger than the sum of T5092 and T5089.

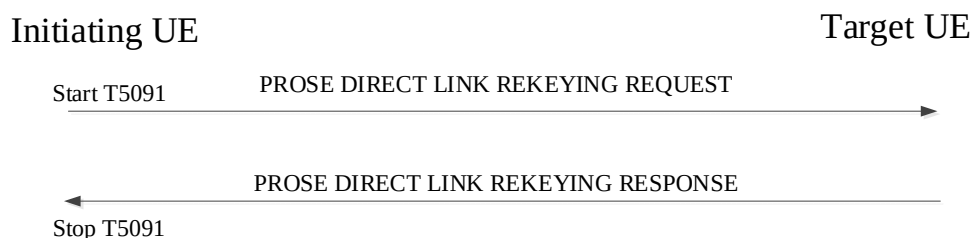


Figure 7.2.11.2.1: 5G ProSe direct link re-keying procedure

7.2.11.3 5G ProSe direct link re-keying procedure accepted by the target UE

Upon receipt of a PROSE DIRECT LINK REKEYING REQUEST message, if the PROSE DIRECT LINK REKEYING REQUEST message includes a re-authentication indication, the target UE shall derive a new K_{NRP} . This may require performing one or more 5G ProSe direct link authentication procedures as specified in clause 7.2.12.

NOTE: How many times the 5G ProSe direct link authentication procedure needs to be performed to derive a new K_{NR} depends on the authentication method used.

Then the target UE shall initiate a 5G ProSe direct link security mode control procedure as specified in clause 7.2.10, where if the 5G ProSe direct link re-keying procedure is sent from the 5G ProSe remote UE to the 5G ProSe UE-to-network relay UE or from the 5G ProSe end UE to the 5G ProSe UE-to-UE relay UE, the target UE shall proceed to establish a new K_{NR} or K_{NR_ProSe} according to the security procedure over user plane or the security procedure over control plane, respectively, as specified in 3GPP TS 33.503 [34].

Upon successful completion of the 5G ProSe direct link security mode control procedure, the target UE shall create a PROSE DIRECT LINK REKEYING RESPONSE message.

After the PROSE DIRECT LINK REKEYING RESPONSE message is generated, the target UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication.

7.2.11.4 5G ProSe direct link re-keying procedure completion by the initiating UE

Upon receipt of the PROSE DIRECT LINK REKEYING RESPONSE message, the initiating UE shall stop timer T5091 and check the integrity of the PROSE DIRECT LINK REKEYING RESPONSE message using the new NRPIK.

After receiving the PROSE DIRECT LINK REKEYING RESPONSE message, the initiating UE shall delete the old security context it has for the target UE.

7.2.11.5 Abnormal cases at the initiating UE

The following abnormal cases can be identified:

- a) Timer T5091 expires.

The initiating UE shall retransmit the PROSE DIRECT LINK REKEYING REQUEST message and restart timer T5091. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct link re-keying procedure, shall provide an indication of deactivation of the PC5 unicast security protection and deletion of security context for the 5G ProSe direct link to the lower layer, if applicable, along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication and may initiate the 5G ProSe direct link release procedure.

NOTE: The maximum number of allowed retransmissions is UE implementation specific.

- b) The need to use this 5G ProSe direct link no longer exists before the 5G ProSe direct link re-keying procedure is completed.

The initiating UE shall abort the procedure and shall provide an indication of deactivation of the PC5 unicast security protection and deletion of security context for the 5G ProSe direct link to the lower layer, if applicable, along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication.

- c) For the same 5G ProSe direct link, if the initiating UE receives a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message after initiating the 5G ProSe direct link re-keying procedure, the initiating UE shall stop the timer T5091, abort the 5G ProSe direct link re-keying procedure and proceed with the 5G ProSe direct link identifier update procedure.

7.2.12 5G ProSe direct link authentication procedure

7.2.12.1 General

The 5G ProSe direct link authentication procedure is used to perform mutual authentication of UEs establishing a 5G ProSe direct link and to derive a new K_{NR} shared between two UEs during a 5G ProSe direct link establishment procedure or a 5G ProSe direct link re-keying procedure. After successful completion of the 5G ProSe direct link authentication procedure, the new K_{NR} is used for security establishment during the 5G ProSe direct link security mode control procedure as specified in clause 7.2.10. The UE sending the PROSE DIRECT LINK AUTHENTICATION REQUEST message is called the "initiating UE" and the other UE is called the "target UE".

NOTE 1: The 5G ProSe direct link authentication procedure is applicable for neither 5G ProSe layer-3 UE-to-network relay nor 5G ProSe layer-2 UE-to-network relay.

NOTE 2: The 5G ProSe direct link authentication procedure is applicable for the source 5G ProSe layer-2 end UE and the target 5G ProSe layer-2 end UE via a 5G ProSe layer-2 UE-to-UE relay UE.

7.2.12.2 5G ProSe direct link authentication procedure initiation by the initiating UE

The initiating UE shall meet one of the following pre-conditions when establishing the non-null signalling integrity protection based on the decision of the initiating UE, before initiating the 5G ProSe direct link authentication procedure:

- a) the target UE has initiated a 5G ProSe direct link establishment procedure toward the initiating UE by sending a PROSE DIRECT LINK ESTABLISHMENT REQUEST message and:
 - 1) the PROSE DIRECT LINK ESTABLISHMENT REQUEST message:
 - i) includes a target user info IE which includes the application layer ID of the initiating UE; or
 - ii) does not include a target user info IE and the initiating UE is interested in the ProSe service identified by the ProSe identifier in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message; and
 - 2) the K_{NRP} ID is not included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message or the initiating UE does not have an existing K_{NRP} for the K_{NRP} ID included in PROSE DIRECT LINK ESTABLISHMENT REQUEST message or the initiating UE derives a new K_{NRP} ; or
- b) the target UE has initiated a 5G ProSe direct link re-keying procedure toward the initiating UE by sending a PROSE DIRECT LINK REKEYING REQUEST message and the PROSE DIRECT LINK REKEYING REQUEST message includes a Re-authentication indication.

In order to initiate the 5G ProSe direct link authentication procedure, the initiating UE shall create a PROSE DIRECT LINK AUTHENTICATION REQUEST message. In this message, the initiating UE:

- a) shall include the key establishment information container IE.

NOTE 1: The Key establishment information container is provided by upper layers.

The initiating UE shall self-assign a source layer-2 ID, and the destination layer-2 ID set to the source layer-2 ID in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message.

NOTE 2: The UE implementation ensures that any value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct discovery as specified in clause 6.2.14, clause 6.2.15 and clause 8.2.1 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

NOTE 3: It is possible for the target UE to reuse the target UE's layer-2 ID used in previous 5G ProSe direct link with the same peer UE.

After the PROSE DIRECT LINK AUTHENTICATION REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication.

The initiating UE shall start timer T5092. The UE shall not send a new PROSE DIRECT LINK AUTHENTICATION REQUEST message to the same target UE while timer T5092 is running.

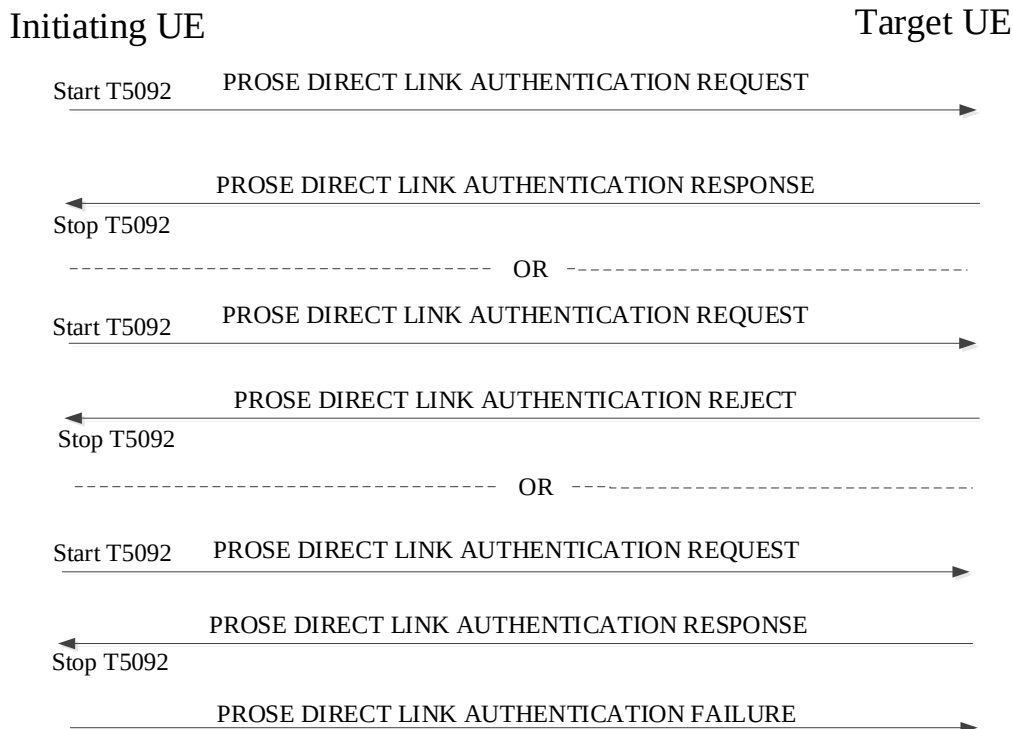


Figure 7.2.12.2.1: 5G ProSe direct link authentication procedure

7.2.12.3 5G ProSe direct link authentication procedure accepted by the target UE

Upon receipt of a PROSE DIRECT LINK AUTHENTICATION REQUEST message, if a new assigned initiating UE's layer-2 ID is included, the target UE shall replace the original initiating UE's layer-2 ID with the new assigned initiating UE's layer-2 ID for unicast communication. If the target UE determines that the PROSE DIRECT LINK AUTHENTICATION REQUEST message can be accepted, the target UE shall create a PROSE DIRECT LINK AUTHENTICATION RESPONSE message. The target UE shall check if the number of established 5G ProSe direct links is less than the implementation-specific maximum number of established NR 5G ProSe direct links allowed in the UE at a time. In this message, the target UE:

- a) shall include the Key establishment information container IE.

NOTE: The key establishment information container is provided by upper layers.

After the PROSE DIRECT LINK AUTHENTICATION RESPONSE message is generated, the target UE shall pass this message to the lower layers for transmission along with the target UE's layer-2 ID for unicast communication and the initiating UE's layer-2 ID for unicast communication.

7.2.12.4 5G ProSe direct link authentication procedure completion by the initiating UE

Upon receiving a PROSE DIRECT LINK AUTHENTICATION RESPONSE message, if the initiating UE determines that the PROSE DIRECT LINK AUTHENTICATION RESPONSE message can be accepted, the initiating UE shall stop timer T5092.

NOTE: When the initiating UE derives the new KNRP during the 5G ProSe direct link authentication procedure depends on the authentication method in use.

7.2.12.5 5G ProSe direct link authentication procedure not accepted by the target UE

If the PROSE DIRECT LINK AUTHENTICATION REQUEST message cannot be accepted, the target UE shall create a PROSE DIRECT LINK AUTHENTICATION REJECT message. In this message, the target UE shall include a PC5 signalling protocol cause IE indicating one of the following cause values:

#5: lack of resources for 5G ProSe direct link;

#6: authentication failure.

If this 5G ProSe direct link authentication procedure is triggered during the 5G ProSe direct link establishment procedure and the implementation-specific maximum number of established NR 5G ProSe direct links has been reached, then the target UE shall send a PROSE DIRECT LINK AUTHENTICATION REJECT message containing PC5 signalling protocol cause value #5 "lack of resources for 5G ProSe direct link".

After the PROSE DIRECT LINK AUTHENTICATION REJECT message is generated, the target UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication.

The target UE shall abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link authentication procedure if the ongoing procedure is the 5G ProSe direct link establishment procedure and the target user info is included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message.

Upon receipt of the PROSE DIRECT LINK AUTHENTICATION REJECT message, the initiating UE shall stop timer T5092 and abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link authentication procedure.

7.2.12.6 5G ProSe direct link authentication procedure not accepted by the initiating UE

If the PROSE DIRECT LINK AUTHENTICATION RESPONSE message cannot be accepted, the initiating UE shall stop timer T5092 and create a PROSE DIRECT LINK AUTHENTICATION FAILURE message. In this message, the initiating UE may include the Key establishment information container IE if provided by upper layers.

After the PROSE DIRECT LINK AUTHENTICATION FAILURE message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication.

The initiating UE shall abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link authentication procedure.

Upon receipt of the PROSE DIRECT LINK AUTHENTICATION FAILURE message, the target UE shall abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link authentication procedure and shall indicate to upper layers that authentication has failed.

7.2.12.7 Abnormal cases

7.2.12.7.1 Abnormal cases at the initiating UE

- a) Timer T5092 expires.

The initiating UE shall retransmit the PROSE DIRECT LINK AUTHENTICATION REQUEST message and restart timer T5092. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct link authentication procedure and shall abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link authentication procedure.

NOTE 1: The maximum number of allowed retransmissions is UE implementation specific.

- b) The need to use this 5G ProSe direct link no longer exists before the 5G ProSe direct link authentication procedure is completed.

The initiating UE shall abort the 5G ProSe direct link authentication procedure and shall abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link authentication procedure.

- c) For the same 5G ProSe direct link, if the initiating UE receives a PROSE DIRECT LINK RELEASE REQUEST message during the 5G ProSe direct link authentication procedure, the initiating UE shall stop all running timers for this 5G ProSe direct link, abort the 5G ProSe direct link authentication procedure and proceed with the 5G ProSe direct link release procedure.

NOTE 2: The abnormal cases as described in bullet c) only happens when the 5G ProSe direct link authentication procedure is used to perform mutual authentication of UEs during a 5G ProSe direct link re-keying procedure.

7.2.13 5G ProSe UE-to-UE relay update procedure

7.2.13.1 General

The 5G ProSe UE-to-UE relay update procedure is used to update the target 5G ProSe end UE(s) with the source 5G ProSe end UE's new IP address/prefix, or new application layer ID, or both during a 5G ProSe direct link identifier update procedure between the source 5G ProSe end UE and the 5G ProSe layer-3 UE-to-UE relay UE. The 5G ProSe layer-3 UE-to-UE relay UE initiates the 5G ProSe UE-to-UE relay update procedure with each target end UE as indicated by the source 5G ProSe end UE during the 5G ProSe direct link identifier update procedure.

The 5G ProSe layer-3 UE-to-UE relay UE is called the initiating UE in this procedure and the target 5G ProSe end UE is called target UE.

7.2.13.2 5G ProSe UE-to-UE relay update procedure initiation by initiating UE

The initiating UE shall initiate the 5G ProSe UE-to-UE relay update procedure with the target UE, if the initiating UE receives a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message from the source 5G ProSe end UE as part of 5G ProSe direct link identifier update procedure.

The initiating UE retrieves the target UEs' entry from its local table based on the target 5G ProSe end UE(s) user info received in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message. The initiating UE initiates the 5G ProSe relay update procedure with each 5G ProSe target end UE.

In order to initiate the 5G ProSe UE-to-UE relay update procedure, the initiating UE shall create a PROSE UE TO UE RELAY UPDATE REQUEST message. In this message, the initiating UE:

- a) shall include the initiating UE's new layer-2 ID assigned by itself;
- b) shall include the new MSB of KNRP-sess ID;
- c) shall include the source 5G ProSe end UE's old IP address/prefix, if the source 5G ProSe end UE's IP address/prefix has changed or is to be changed (i.e. allocated by the initiating UE);

NOTE 1: The source 5G ProSe end UE's old IP address/prefix is set to the source 5G ProSe end UE's new IP address/prefix indicated in the latest 5G ProSe UE-to-UE relay update procedure with the target UE in case the latest 5G ProSe UE-to-UE relay update procedure with the target UE was completed successfully.

- d) shall include the source 5G ProSe end UE's old application layer ID, if the source 5G ProSe end UE's application layer ID has changed;

NOTE 2: The source 5G ProSe end UE's old application layer ID is set to the source 5G ProSe end UE's new application layer ID indicated in the latest 5G ProSe UE-to-UE relay update procedure with the target UE in case the latest 5G ProSe UE-to-UE relay update procedure with the target UE was completed successfully.

- e) shall include the source 5G ProSe end UE's new application layer ID, if the new application layer ID of the source 5G ProSe end UE is received in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message; and
- f) shall include the source 5G ProSe end UE's new IP address/prefix, if the new IP address/prefix of the source 5G ProSe end UE is received in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message, or if the IP address/prefix needed indication is received in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message and new IP address/prefix of the source 5G ProSe end UE is allocated by the initiating UE.

The initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's old layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID for 5G ProSe direct communication and start timer T5097. The initiating UE shall not send a new PROSE UE TO UE RELAY UPDATE REQUEST message to the same target UE while timer T5097 is running.

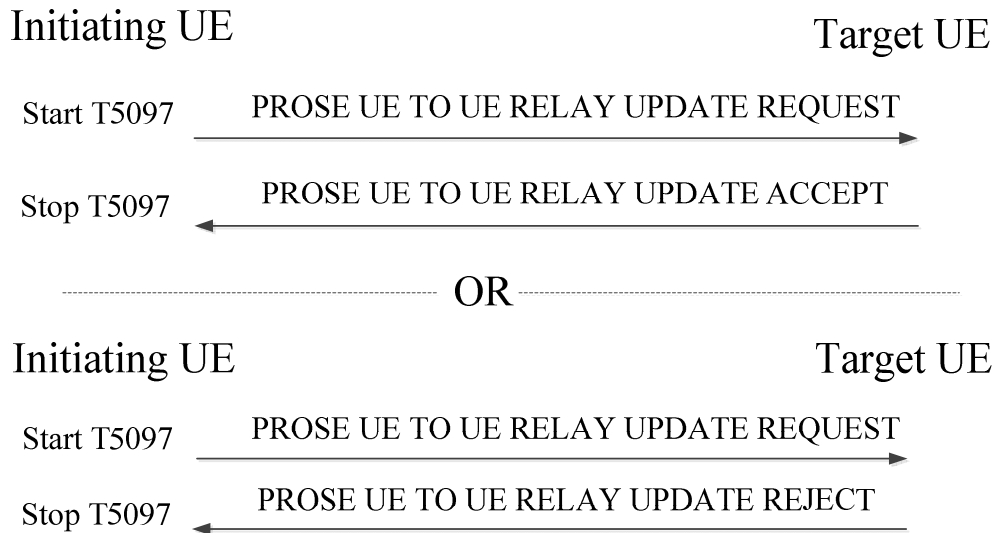


Figure 7.2.13.2.1: 5G ProSe direct relay update procedure

7.2.13.3 5G ProSe UE-to-UE relay update procedure accepted by the target UE

Upon receipt of a PROSE UE TO UE RELAY UPDATE REQUEST message, if the target UE determines the 5G ProSe direct link associated with this request message is still valid, then the target UE accepts this request.

If the target UE determines that the PROSE UE TO UE RELAY UPDATE REQUEST message can be accepted, the target UE shall replace the original source 5G ProSe end UE's IP address/prefix with the new source 5G ProSe end UE's IP address/prefix for unicast communication if received in the message. The target UE shall replace the original source 5G ProSe end UE's Application ID with the new source 5G ProSe end UE's Application ID for unicast communication if received in the PROSE UE TO UE RELAY UPDATE REQUEST message. The target UE shall create a PROSE UE TO UE RELAY UPDATE ACCEPT message. In this message, the target UE:

- a) shall include the target UE's new layer-2 ID assigned by itself;
- b) shall include the new LSB of KNRP-sess ID;
- c) shall include the initiating UE's new MSB of KNRP-sess ID;
- d) shall include the initiating UE's new layer-2 ID;
- e) shall include the source 5G ProSe end UE's old IP address/prefix, if received from the initiating UE;
- f) shall include the source 5G ProSe end UE's old application layer ID, if received from the initiating UE;
- g) shall include the source 5G ProSe end UE's new application layer ID, if received from the initiating UE; and
- h) shall include the source 5G ProSe end UE's new IP address/prefix, if received from the initiating UE.

After the PROSE UE TO UE RELAY UPDATE ACCEPT message is generated, the target UE shall pass this message to the lower layers for transmission along with the target UE's old layer-2 ID for 5G ProSe direct communication and the initiating UE's old layer-2 ID for 5G ProSe direct communication.

Before the target UE receives the traffic using the new layer-2 IDs, the target UE shall continue to receive the traffic with the old layer-2 IDs (i.e., initiating UE's old layer-2 ID and target UE's old layer-2 ID) from the initiating UE.

Before the target UE receives the traffic using the new IP address/prefix, the target UE shall continue to receive the traffic with the old IP address/prefix (i.e., source 5G ProSe end UE's old IP address/prefix and target 5G ProSe end UE's old IP address/prefix) from the source 5G ProSe end UE.

7.2.13.4 5G ProSe UE-to-UE relay update procedure completion by the initiating UE

Upon receiving a PROSE UE TO UE RELAY UPDATE ACCEPT message, if the initiating UE determines that the PROSE UE TO UE RELAY UPDATE ACCEPT message can be accepted, the initiating UE shall stop timer T5097.

If more than one target 5G ProSe end UE is included on the received PROSE UE TO UE RELAY UPDATE REQUEST message, the initiating UE may wait for the responses from all target UEs before stopping timer T5097.

7.2.13.5 5G ProSe UE-to-UE relay update procedure not accepted by the target UE

If the PROSE UE TO UE RELAY UPDATE REQUEST message cannot be accepted, the target UE shall create a PROSE UE TO UE RELAY UPDATE REJECT message. In this message, the target UE shall include a PC5 signalling protocol cause IE indicating one of the following cause values:

#17: unknown initiating end UE's IP address/prefix or initiating UE's Application layer ID;

After the PROSE UE TO UE RELAY UPDATE REJECT message is generated, the target UE shall pass this message to the lower layers for transmission along with initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication.

Upon receipt of the PROSE UE TO UE RELAY UPDATE REJECT message, the initiating UE shall stop timer T5097 and shall continue the ongoing procedure that triggered the initiation of the 5G ProSe UE-to-UE relay update procedure indicating the failing target UE(s) to the source 5G ProSe end UE as specified in clause 7.2.4.6.

7.2.13.6 Abnormal cases

7.2.13.6.1 Abnormal cases at the initiating UE

a) Timer T5097 expires.

The initiating UE shall retransmit the PROSE UE TO UE RELAY UPDATE REQUEST message and restart timer T5097. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe UE-to-UE relay update procedure and shall continue the ongoing procedure that triggered the initiation of the 5G ProSe UE-to-UE relay update procedure indicating the failing target end UE(s) to the source 5G ProSe end UE as specified in clause 7.2.4.6.

NOTE 1: The maximum number of allowed retransmissions is UE implementation specific.

7.2.14 5G ProSe direct link identification procedure

7.2.14.1 General

The 5G ProSe direct link identification procedure is used by a 5G ProSe UE-to-network relay UE to request a 5G ProSe remote UE to provide specific identification parameters, e.g. the IMEI or the IMEISV. The UE sending the PROSE DIRECT LINK IDENTITY REQUEST message is called the "initiating UE" and the other UE is called the "target UE".

7.2.14.2 5G ProSe direct link identification procedure initiated by initiating UE

The initiating UE shall initiate the procedure by sending a PROSE DIRECT LINK IDENTITY REQUEST message to request the 5G ProSe remote UE to provide its PEI if the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE with the security procedure over control plane or over user plane as specified in 3GPP TS 33.503 [34]:

a) fails when the 5G ProSe remote UE is attempting for emergency services; or

- b) is not required and no PEI is received from the 5G ProSe remote UE when the 5G ProSe remote UE is attempting for emergency services.

In the PROSE DIRECT LINK IDENTITY REQUEST message, the initiating UE shall include the UE identity type IE with "Type of identity" set to "IMEI" or "IMEISV".

After the PROSE DIRECT LINK IDENTITY REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission and start timer T5099. The UE shall not send a new PROSE DIRECT LINK IDENTITY REQUEST message to the same target UE while timer T5099 is running.

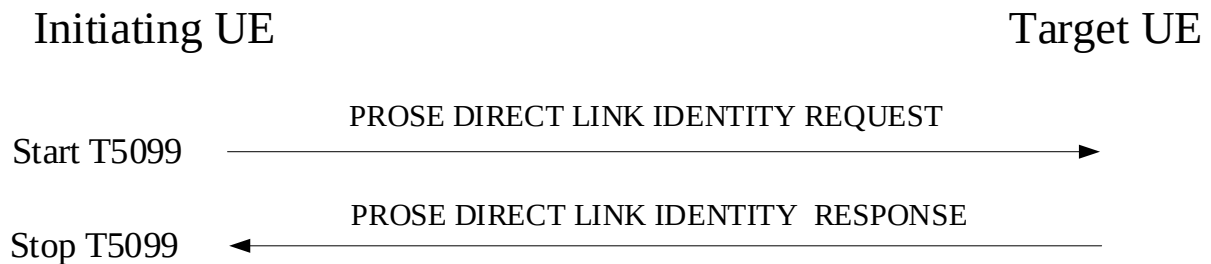


Figure 7.2.14.2.1: ProSe direct link identification procedure

7.2.14.3 5G ProSe direct link identification procedure responded by the UE

Upon receipt of the PROSE DIRECT LINK IDENTITY REQUEST message, if the target UE is attempting to establish a 5G ProSe direct link for emergency services, the target UE shall create a PROSE DIRECT LINK IDENTITY RESPONSE message and include the UE identity IE with the IMEI or IMEISV as requested in the PROSE DIRECT LINK IDENTITY REQUEST message.

7.2.14.4 5G ProSe direct link identification procedure completion by the initiating UE

Upon receipt of the PROSE DIRECT LINK IDENTITY RESPONSE the initiating UE shall stop the timer T5099.

7.2.14.5 Abnormal cases

7.2.14.5.1 Abnormal cases at the initiating UE

Upon expiry of the timer T5099, the initiating UE may retransmit the PROSE DIRECT LINK IDENTITY REQUEST message and reset and restart the timer T5099. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct link identification procedure.

NOTE: The maximum number of allowed retransmissions is UE implementation specific.

7.2.14.5.2 Abnormal cases at the target UE

Upon receipt of the PROSE DIRECT LINK IDENTITY REQUEST message and if the target UE is not attempting to establish a 5G ProSe direct link for emergency services, the target UE shall ignore the PROSE DIRECT LINK IDENTITY REQUEST message.

7.3 Broadcast mode 5G ProSe direct communication over PC5

7.3.1 Overview

This clause describes the 5G ProSe communication over PC5 reference point in broadcast mode operation. The UE is configured with the related information as described in clause 5.2.4.

7.3.2 Transmission of broadcast mode 5G ProSe communication over PC5

7.3.2.1 Initiation

7.3.2.1.1 Broadcast mode 5G ProSe communication over PC5 triggered by upper layers

When the UE is requested by upper layers to send data unit(s) of a ProSe application identified by a ProSe identifier using 5G ProSe communication over PC5, the request from the upper layers includes:

- a) the data unit(s) of the ProSe application;
- b) the ProSe identifier of the ProSe application for the data unit(s);
- c) the type of data in the data unit(s) (i.e., IP, Ethernet, Address Resolution Protocol, or Unstructured);
- d) optionally the communication mode which is set to broadcast mode; and
- e) optionally the 5G ProSe application requirements (e.g., priority requirement, reliability requirement, delay requirement).

Upon a request from upper layers to send data unit(s) of a ProSe application identified by a ProSe identifier using 5G ProSe communication over PC5, the UE passes the one or more ProSe NR frequencies associated with the ProSe identifier based on the ProSe identifier to ProSe NR frequency mapping rules for 5G ProSe communication over PC5 as specified in clause 5.2.4 and the communication mode which is set to broadcast mode for the data unit(s) to the lower layers.

Upon a request from upper layers to send data unit(s) of a ProSe application identified by a ProSe identifier using 5G ProSe communication over PC5, the UE determines the NR Tx profiles based on the list of ProSe identifiers to NR Tx profiles for broadcast and groupcast mapping rules as specified in clause 5.2.4 and passes the NR Tx profiles to the lower layers as specified in clause 7.3.2.2. Additionally, when the UE is not served by NG-RAN, the UE also passes the configured PC5 DRX configuration as specified in clause 5.2.4 to the lower layers.

The UE shall maintain a list of ProSe services the UE is interested in, including the ProSe services in use, the ProSe services that the UE is interested for transmission or both, for each destination layer-2 ID. The ProSe services are identified by the ProSe identifiers.

NOTE: How the UE maintains the list of ProSe services the UE is interested in is left to UE implementation.

Then, if:

- a) the following conditions are met:
 - 1) the UE is served by NG-RAN for 5G ProSe communication;
 - 2) the UE intends to use the radio resources (i.e., carrier frequency) provided by a serving cell;
 - 3) the registered PLMN is in the list of PLMNs in which the UE is authorized to use 5G ProSe communication over PC5 when the UE is served by NG-RAN for 5G ProSe communication over PC5 as specified in clause 5.2.4; or for SNPN the RSNPN is the subscribed SNPN and the UE is authorized to use 5G ProSe direct communication over PC5 interface in the subscribed SNPN, and
 - 4) the ProSe identifier of the ProSe application is included in the list of ProSe applications authorized for 5G ProSe communication over PC5 as specified in clause 5.2.4; or
- b) the following conditions are met:
 - 1) the UE is:
 - i) not served by NG-RAN for 5G ProSe communication over PC5;
 - ii) in limited service state as specified in 3GPP TS 23.122 [14], if the reason for the UE being in limited service state is one of the following:

- A) the UE is unable to find a suitable cell in the selected PLMN or the selected SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" or, for SNPN, cause #74 "Temporarily not authorized for this SNPN" or cause #75 "Permanently not authorized for this SNPN", as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; or
- iii) in limited service state as specified in 3GPP TS 23.122 [14] for reasons other than A), B) or C) above and located in a geographical area for which the UE is provisioned with "non-operator managed" radio parameters as specified in clause 5.2.4;
- 2) the UE is authorized to use 5G ProSe communication over PC5 when the UE is not served by NG-RAN for 5G ProSe communication as specified in clause 5.2.4; and
 - 3) the ProSe identifier of the ProSe application is included in the list of ProSe applications authorized for 5G ProSe communication over PC5 as specified in clause 5.2.4;

then the UE shall proceed as specified in clause 7.3.2.1.2, else the UE shall not perform transmission of 5G ProSe communication over PC5.

7.3.2.1.2 PC5 QoS flow match and establishment

In order to determine if any existing PC5 QoS flow matches the request from upper layers, UE shall proceed as follows:

- a) according to the PC5 QoS mapping rules specified in clause 5.2.4, the UE shall use the PC5 QoS parameters corresponding to the ProSe identifier and optionally 5G ProSe application requirements;
- b) according to the ProSe identifier to destination layer-2 ID for broadcast mapping rules specified in clause 5.2.4, the UE shall use the destination layer-2 ID corresponding to the ProSe identifier;
- c) if there is no existing context for the destination layer-2 ID, then:
 - 1) build a new context for the destination layer-2 ID;
 - 2) self-assign a new source layer-2 ID; and

NOTE: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct discovery as specified in clause 6.2.14, clause 6.2.15 and clause 8.2.1 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

- 3) pass the source layer-2 ID and the destination layer-2 ID to lower layers.
- d) if in the context for the destination layer-2 ID, there is no PC5 QoS rule for the existing PC5 QoS flow(s) matching the service data or request, the UE shall derive the PC5 QoS parameters based on the 5G ProSe application requirements provided by the upper layers (if available) and the ProSe identifier according to the PC5 QoS mapping rules defined in clause 5.2.4 and shall perform the following:
 - 1) if there is no existing PC5 QoS flow that fulfils the derived PC5 QoS parameters, then the UE shall create a new PC5 QoS flow by performing the following operations:
 - i) self-assign a new PQFI;
 - ii) create a new PC5 QoS flow context which contains:
 - A) the PQFI;
 - B) the ProSe identifier(s); and
 - C) the derived PC5 QoS parameters;
 - iii) create a new PC5 QoS rule which contains:

- A) a PC5 QoS rule identifier;
 - B) the PQFI;
 - C) a set of packet filters; and
 - D) a precedence value; and
- iv) pass the following parameters to the lower layers:
- A) the PQFI;
 - B) the PC5 QoS parameters;
 - C) the source layer-2 ID and the destination layer-2 ID; and
 - D) the NR Tx profile, if available, as determined for the respective ProSe identifier based on the list of ProSe identifiers to NR Tx profiles for broadcast and groupcast mapping rules as specified in clause 5.2.4;
- 2) if there is an existing PC5 QoS flow that fulfils the derived PC5 QoS parameters, then the UE shall update the PC5 packet filter set in the PC5 QoS rule of this PC5 QoS flow, e.g. add the new packet filter in the PC5 QoS rule of this existing PC5 QoS flow; and
- 3) the UE shall use the new PC5 QoS flow created as described in bullet 1) or the existing PC5 QoS flow with the updated PC5 QoS rules as described in bullet 2) to perform the transmission of 5G ProSe communication over PC5 as specified in clause 7.3.2.2; and
- e) if in the context for the destination layer-2 ID, there is a PC5 QoS rule for the existing PC5 QoS flow matching the service data or request, the UE shall use this existing PC5 QoS flow to perform transmission of 5G ProSe communication over PC5 as specified in clause 7.3.2.2.

Three types of packet filters are supported for broadcast mode 5G ProSe direct communication over PC5, i.e., the ProSe IP packet filter set, the ProSe packet filter set and the ProSe Ethernet packet filter set. The three types of packet filters are defined the same as specified in clause 7.2.7.

7.3.2.2 Transmission

The UE shall include the data unit(s) in a protocol data unit with the following parameters:

- a) a layer-3 protocol data unit type (see 3GPP TS 38.323 [16]) set to:
 - 1) IP, if the data unit(s) contains IP data;
 - 2) Ethernet, if the data unit(s) contains Ethernet data;
 - 3) Address Resolution Protocol, if the data unit(s) contains Address Resolution Protocol data; or
 - 4) Unstructured, if the data unit(s) contains Unstructured data;
- b) the source layer-2 ID set to the layer-2 ID self-assigned by the UE for 5G ProSe communication over PC5 as specified in clause 7.3.2.1.2;
- c) the destination layer-2 ID set to the destination layer-2 ID associated with the ProSe identifier of the ProSe application in this list of ProSe applications authorized for 5G ProSe communication over PC5 as specified in clause 5.2.4;
- d) if the data unit(s) contains IP data, the source IP address set to the source IP address allocated to the UE as specified in clause 7.3.4;

NOTE: How to set the destination IP address is left to UE implementation.

- e) the PQFI set to the value corresponding to the PC5 QoS rules as specified in clause 7.3.2.1, and
- f) the NR Tx profile based on the ProSe identifiers to NR Tx profiles for broadcast and groupcast mapping rules as specified in clause 5.2.4. If the list of ProSe services the UE is interested in for the destination layer-2 ID

changes, the UE shall provide all the NR Tx profiles for the ProSe identifier(s) in the list of ProSe services the UE is interested in for the destination layer-2 ID to the lower layers,

then UE shall request radio resources for 5G ProSe communication over PC5 as specified in 3GPP TS 38.300 [21] and pass the data unit(s) on the PC5 QoS Flow identified by the PQFI to lower layers for transmission. The PC5 QoS Rules corresponding to the PQFIs map the data unit(s) with the same ProSe identifier and with the same PC5 QoS parameters to the same PC5 QoS Flow and apply PQFI to the data unit(s).

If the UE is camped on a serving cell indicating that 5G ProSe communication over PC5 is supported by the network, but not broadcasting any carrier frequencies and radio resources for 5G ProSe communication over PC5 as specified in 3GPP TS 38.331 [13], the UE shall request radio resources for 5G ProSe communication over PC5 as specified in 3GPP TS 24.501 [11].

7.3.2.3 Procedure for UE to use provisioned radio resources for 5G ProSe communication over PC5

When the UE is not served by NG-RAN for 5G ProSe communication and is authorized to use 5G ProSe communication over PC5, the UE shall identify the NR-PC5 to be used for 5G ProSe communication over PC5. After identifying NR-PC5 to be used for 5G ProSe communication over PC5, the UE shall select the corresponding radio parameters to be used for 5G ProSe communication over PC5 as follows:

- a) if the UE can determine itself located in a geographical area and the UE is provisioned with radio parameters for the geographical area, the UE shall select the radio parameters associated with that geographical area; or
- b) in all other cases, the UE shall not initiate 5G ProSe communication over PC5.

If the UE intends to use "non-operator managed" radio parameters as specified in clause 5.2.4, the UE shall initiate 5G ProSe communication over PC5 with the selected radio parameters.

If the UE intends to use "operator managed" radio parameters as specified in clause 5.2.4, before initiating 5G ProSe communication over PC5, the UE shall check with lower layers whether the selected radio parameters can be used in the current location without causing interference to other cells as specified in 3GPP TS 38.331 [13]; and:

- a) if the lower layers indicate that the usage would not cause any interference, the UE shall initiate 5G ProSe communication over PC5; or

NOTE: If the lower layers find that there exists a cell operating the provisioned radio resources (i.e., carrier frequency) and the cell belongs to the registered PLMN or a PLMN equivalent to the registered PLMN, or for SNPN, to the RSNPN and the RSNPN is the subscribed SNPN, and the UE is authorized for 5G ProSe communication over PC5 in this PLMN or this RSNPN, the UE can use the radio parameters indicated by the cell as specified in 3GPP TS 38.331 [13].

- b) else if the lower layers report that one or more PLMNs or SNPNs operate in the provisioned radio resources (i.e., carrier frequency) then:

1) if the following conditions are met:

- i) none of the PLMNs reported by the lower layers is the registered PLMN or equivalent to the registered PLMN, or for SNPN none of the SNPNs reported by the lower layers is the RSNPN and the RSNPN is not the subscribed SNPN;
- ii) at least one of the PLMNs reported by the lower layers is in the list of authorized PLMNs for 5G ProSe communication over PC5 and provides radio resources for 5G ProSe communication over PC5 as specified in 3GPP TS 38.331 [13], or for SNPN one of the SNPNs reported by the lower layer is the subscribed SNPN and the UE is authorized to use 5G ProSe direct communication over PC5 interface in the subscribed SNPN; and

iii) the UE does not have an emergency PDU session;

then the UE shall:

- i) if in 5GMM-IDLE mode, perform PLMN selection triggered by 5G ProSe communication over PC5, or SNPN selection triggered by ProSe communications, as specified in 3GPP TS 23.122 [14]; or

ii) else if in 5GMM-CONNECTED mode, either:

A) perform a De-registration procedure as specified in 3GPP TS 24.501 [11] and then perform PLMN selection triggered by 5G ProSe communication over PC5, or SNPN selection triggered by ProSe communications, as specified in 3GPP TS 23.122 [14]; or

B) not initiate 5G ProSe communication over PC5.

Whether the UE performs A) or B) above is left up to UE implementation; or

2) else the UE shall not initiate 5G ProSe communication over PC5.

If the registration to the selected PLMN or the selected SNPN is successful, the UE shall proceed with the procedure to initiate 5G ProSe communication over PC5 as specified in clause 7.3.2.1.

If the UE is performing 5G ProSe communication over PC5 using radio parameters associated with a geographical area and moves out of that geographical area, the UE shall stop performing 5G ProSe communication over PC5 and then:

- a) if the UE is not served by NG-RAN for 5G ProSe communication over PC5 or the UE intends to use radio resources for 5G ProSe communication over PC5 other than those operated by the serving cell, the UE shall select appropriate radio parameters for the new geographical area as specified above; or
- b) if the UE is served by NG-RAN for 5G ProSe communication over PC5 and intends to use radio resources for 5G ProSe communication over PC5 operated by the serving cell, the UE shall proceed with the procedure to initiate 5G ProSe communication over PC5 when served by NG-RAN for 5G ProSe communication over PC5.

7.3.2.4 Privacy of 5G ProSe transmission over PC5

Upon initiating transmission of 5G ProSe communication over PC5, if:

- a) the ProSe identifier of a ProSe application requesting transmission of 5G ProSe communication over PC5 is in the list of ProSe applications which require privacy for 5G ProSe communication over PC5 as specified in clause 5.2.4; and
- b) the UE is located in a geographical area in which this ProSe application requires privacy for 5G ProSe communication over PC5 as specified in clause 5.2.4, or the UE is not provisioned any geographical areas in which this ProSe applications requires privacy for 5G ProSe communication over PC5,

then the UE shall proceed as follows:

- a) if timer T5100 is not running, start timer T5100 and set its timer value as the privacy timer value as specified in clause 5.2.4;
- b) upon:
 - 1) getting an indication from upper layers that the application layer identifier has been changed; or
 - 2) timer T5100 expiry,

then:

- 1) change the value of the source layer-2 ID self-assigned by the UE for the 5G ProSe communication over PC5;

NOTE 1: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct discovery as specified in clause 6.2.14, clause 6.2.15 and clause 8.2.1 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

- 2) if the data unit(s) contains IP data, change the value of the source IP address self-assigned by the UE for 5G ProSe communication over PC5;

NOTE 2: How to change and randomise the UE's source layer-2 ID and source IP address including IP prefix (if used) is specified in clause 5.5 of 3GPP TS 33.536 [37] with the consideration of replacing V2X with 5G ProSe.

- 3) provide an indication to upper layers that the source layer-2 ID, or the source IP address, or both the source layer-2 ID and the source IP address are changed;

- 4) pass the changed source layer-2 ID and destination layer-2 ID, along with the corresponding PQFI down to the lower layer;
- 5) restart timer T5100; and
- 6) upon stopping transmission of the 5G ProSe communication over PC5, stop timer T5100.

7.3.3 Reception of broadcast mode 5G ProSe communication over PC5

The UE may be configured by upper layers with one or more destination layer-2 ID(s) for reception of data unit(s) over PC5.

The UE shall maintain a list of ProSe services the UE is interested in, including the ProSe services in use, ProSe services that the UE is interested for reception or both, for each destination layer-2 ID. The ProSe services are identified by the ProSe identifiers.

NOTE 1: How the UE maintains the list of ProSe services it is interested in is left to UE implementation.

The receiving UE shall determine the PC5 QoS parameters for this broadcast ProSe service in the same way described in clause 7.3.2.1.2 and shall determine the NR Tx profile as described in clause 5.2.4, and shall provide the PC5 QoS parameters, the NR Tx profile and the destination layer-2 ID(s) to lower layers. If the list of ProSe services the UE is interested in for the destination layer-2 ID changes, the receiving UE shall update the lower layers for the NR Tx Profiles information by providing all the NR Tx profiles for the ProSe identifier(s) in the list of ProSe services the UE is interested in for the destination layer-2 ID to the lower layers.

For each received protocol data unit over PC5, the receiving UE shall check if the destination layer-2 ID of the received protocol data unit matches one of the configured destination layer-2 IDs. If yes, the UE shall then check whether the protocol data unit type as defined 3GPP TS 38.323 [16] provided by the lower layers for the received packet is set to IP, Ethernet, Address Resolution Protocol or Unstructured and pass the protocol data unit to the corresponding upper layer entity.

NOTE 2: When the PC5 DRX operation is needed based on the provided NR Tx profile, the lower layers use PC5 QoS parameters and the destination layer-2 ID(s) to determine the PC5 DRX parameter values (see 3GPP TS 38.300 [21]) for reception operation over PC5 reference point.

7.3.4 IP address allocation for broadcast mode 5G ProSe communication over PC5

When the UE needs to perform 5G ProSe communication over PC5 reference point in broadcast mode operation and the type of data in the data unit is IP, the UE:

- a) for IPv4,
 - 1) shall use the pre-configured link local IPv4 address as source address; or
 - 2) shall use dynamic configuration of IPv4 link-local addresses as specified in IETF RFC 3927 [38] if there is no pre-configured link local IPv4 address; and
- b) for IPv6,
 - 1) shall auto-configure a link local IPv6 address following procedures defined in IETF RFC 4862 [25]; and
 - 2) may use this IP address for direct communication without sending Neighbour Solicitation and Neighbour Advertisement message for Duplicate Address Detection.

7.4 Groupcast mode 5G ProSe direct communication over PC5

7.4.1 Overview

This clause describes the 5G ProSe communication over PC5 reference point in groupcast mode operation. The UE is configured with the related information as described in clause 5.2.4. For commercial services, the application layer

group ID is provided by application server. For public safety services, the pre-configured or provisioned application layer group ID as described in clause 5.2.4 will be used for groupcast communication.

7.4.2 Transmission of groupcast mode 5G ProSe communication over PC5

7.4.2.1 Initiation

7.4.2.1.1 Initiation of forming a group

Before the UE is requested by upper layers to send data unit(s) of a ProSe application identified by a ProSe identifier using 5G ProSe communication over PC5, for the users sharing the same application layer group ID as configured in clause 5.2.4 may perform a group member discovery procedure as specified in clause 6.2.15.

When the group is formed, the following information may be exchanged within the group members included in the application layer discovery message:

- a) group size; and
- b) member ID.

NOTE: Whether to transmit the application layer discovery message as metadata in a 5G ProSe direct discovery message or as user traffic over PC5 is UE implementation specific.

7.4.2.1.2 Requirements for 5G ProSe direct communication over PC5

The requirements for groupcast mode 5G ProSe direct communication over PC5 is the same as described in clause 7.3.2.1.1, with the following additions:

- a) When the UE is requested by upper layers to send data unit(s) of a ProSe application identified by a ProSe identifier using 5G ProSe communication over PC5, the request from the upper layers includes:
 - 1) the application layer group ID;
 - 2) the group size and the member IDs;
 - 3) the range requirement; or
 - 4) the communication mode which is set to groupcast mode.

7.4.2.1.3 PC5 QoS flow match and establishment

The PC5 QoS flow match and establishment for groupcast mode 5G ProSe direct communication over PC5 is the same as described in clause 7.3.2.1.2, with the following modifications:

- a) The UE shall determine the destination layer-2 ID as:
 - 1) if no application layer group ID is provided by the application layer, then according to the mapping rules specified in clause 5.2.4, the UE shall set the destination layer-2 ID to the destination layer-2 ID corresponding to the ProSe identifier as specified in clause 5.2.4;
 - 2) if application layer group ID is provided by the application layer and there is a context for the application layer group ID as specified in clause 5.2.4, then UE shall set the destination layer-2 ID to the ProSe layer-2 group ID in the context; and
 - 3) if application layer group ID is provided by the application layer and there is no context for the application layer group ID as specified in clause 5.2.4, then the UE shall convert the application layer group ID into a destination layer-2 ID as following:
 - i) to use the group identifier as the input to the SHA-256 hashing algorithm as specified in ISO/IEC 10118-3:2018 [28]; and
 - ii) to use the 24 least significant bits of the 256 bits of the output as destination layer-2 ID; and

NOTE: SHA-256 hashing algorithm is implemented in the ME.

b) If there is no existing context for the destination layer-2 ID and optional group identifier, the UE shall proceed as:

- 1) to establish a new context for the destination layer-2 ID and optional group identifier;
- 2) self-assign a new source layer-2 ID; and
- 3) to pass the source/destination layer-2 IDs, optional group size and optional member IDs to lower layers.

7.4.2.2 Transmission

The transmission of groupcast mode 5G ProSe direct communication over PC5 is same as described in clause 7.3.2.2, with the following additions:

- a) If group identifier is provided, then the destination layer-2 ID shall be set to the destination layer-2 ID in the context for the group identifier as specified in clause 7.4.2.1.3.

7.4.2.3 Procedure for UE to use provisioned radio resources for 5G ProSe direct communication over PC5

The procedures described in clause 7.3.2.3 apply.

7.4.2.4 Privacy of 5G ProSe direct transmission over PC5

The procedures described in clause 7.3.2.4 apply with the following additions:

- a) using the privacy timer T5200 for groupcast; and
- b) how to change and randomise the UE's source layer-2 ID and source IP address including IP prefix (if used) is specified in clause 5.4 of 3GPP TS 33.536 [37] with the consideration of replacing V2X with 5G ProSe.

7.4.3 Reception of groupcast mode 5G ProSe direct communication over PC5

The reception of groupcast mode 5G ProSe direct communication over PC5 is the same as described in clause 7.3.3, with the following additions:

- a) besides the configured destination layer-2 ID(s) for receiving messages over PC5, the UE shall also derive the destination layer-2 ID(s) based on group identifier(s) if provided by upper layers as specified in clause 7.4.2.1.

7.4.4 IP address allocation for groupcast mode 5G ProSe communication over PC5

When the UE needs to perform 5G ProSe communication over PC5 reference point in groupcast mode operation and the type of data in the data unit is IP, the UE uses the same IP address allocation mechanism as specified in clause 7.3.4.

7.5 Void

7.6 PC3ach control protocol for 5G ProSe direct communication

7.6.1 Transport protocol for PC3ach control protocol for 5G ProSe direct communication

The UE and 5G DDNMF CTF (ADF) shall use HTTP/1.1 as specified in IETF RFC 9112 [3] and IETF RFC 9110 [4] as the transport protocol for messages transmitted over the PC3ach interface. The 5G ProSe messages described here shall be included in the body of either an HTTP request message or an HTTP response message.

7.6.2 Procedures for PC3ach control protocol for 5G ProSe direct communication

7.6.2.1 Usage information report list sending procedure

7.6.2.1.1 General

The purpose of the usage information report list sending procedure is to enable a 5G ProSe-enabled UE to provide information necessary for composing of charging events related to the 5G ProSe direct communication as defined in 3GPP TS 32.277 [45].

The UE shall perform the usage information report list sending procedure with the Accounting Data Forwarding (ADF) function block of the Charging Trigger Function (CTF) in the 5G DDNMF (5G DDNMF CTF (ADF)) residing in the HPLMN or subscribed SNPN.

The UE shall construct the usage information report based on the configuration described in clause 5.2.

7.6.2.1.2 Usage information report list sending procedure initiation

The UE shall perform the usage information report list sending procedure if the UE is in NG-RAN coverage and if:

a) the following is true:

- 1) the configured collection period has elapsed, either since the beginning of 5G ProSe direct communication (if it is the first usage information report list sending procedure performed after the beginning of 5G ProSe direct communication) or since the end of the previous usage information report list sending procedure;
- 2) the configured reporting window has not elapsed after the configured collection period elapsed;
- 3) the UE is in the RRC_CONNECTED mode (see 3GPP TS 38.300 [21]); and
- 4) the UE has usage information for at least one collection period; or

b) the following is true:

- 1) the configured collection period has elapsed, either since the beginning of 5G ProSe direct communication (if it is the first usage information report list sending procedure performed after the beginning of 5G ProSe direct communication) or since the end of the previous usage information report list sending procedure;
- 2) the configured reporting window has elapsed after the configured collection period elapsed; and
- 3) the UE has usage information for at least one collection period.

The UE shall initiate the usage information report list sending procedure by sending a PROSE_USAGE_INFORMATION_REPORT_LIST message to the 5G DDNMF CTF (ADF).

If the UE is configured with the address of the 5G DDNMF CTF (ADF) for uploading the usage information reports, the UE shall send the PROSE_USAGE_INFORMATION_REPORT_LIST message to the configured address of the 5G DDNMF CTF (ADF). If the UE is not configured with the address of the 5G DDNMF CTF (ADF) for uploading the

usage information reports, the UE shall send the PROSE_USAGE_INFORMATION_REPORT_LIST message to the IP address of the 5G DDNMF discovered as described in clause 6.1.2.2.

In the PROSE_USAGE_INFORMATION_REPORT_LIST message, the UE:

- a) shall include a new transaction ID;
- b) for each collection period:
 - 1) shall include a sequence number of the usage information report;
 - 2) if the UE is configured to report the time stamps when it went in and out of NG-RAN coverage during the collection period in the usage information, for each going in or out of NG-RAN coverage:
 - i) shall include the information of whether the UE was in or out of NG-RAN coverage;
 - ii) shall include the time stamp of the move; and
 - iii) if the UE was in NG-RAN coverage and the UE is configured to report the list of locations of the UE when in NG-RAN coverage during the collection period in the usage information, for each camping on a cell or usage of a cell in the 5GMM-CONNECTED mode:
 - A) shall include the NG-RAN cell global identification of the cell; and
 - B) shall include the time stamp of beginning of the camping on the cell or of beginning of the usage of the cell in the 5GMM-CONNECTED mode;
 - 3) in case of broadcast and groupcast mode 5G ProSe direct communication, for each group identified by ProSe layer-2 group ID:
 - i) if the UE is configured to report the group parameters in the usage information, shall include the ProSe layer-2 group ID, ProSe group IP multicast address, the IP address used by the UE as a source IP address, and the layer-2 ID used by the UE as a source layer-2 ID;
 - ii) if the UE transmitted data during the collection period and the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include the time stamp of the first transmission to the ProSe Group IP multicast address in the collection period;
 - iii) if the UE received data during the collection period and the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include the time stamp of the first reception from the ProSe Group IP multicast address in the collection period;
 - iv) for each transmitter in groupcast mode 5G ProSe direct communication, shall include the source layer-2 ID and IP address of the transmitter;
 - v) if the UE is configured to report the amount of data transmitted during the collection period with location information in the usage information, per each in or out of NG-RAN coverage period and per each NG-RAN cell used when in NG-RAN coverage:
 - A) shall indicate whether the data are sent in or out of NG-RAN coverage;
 - B) if the UE transmitted data in an NG-RAN cell during an in NG-RAN coverage period:
 - shall include the NG-RAN cell global identification of the NG-RAN cell;
 - shall include the amount of data transmitted in the NG-RAN cell;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first transmission in the NG-RAN cell; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the indicator of which radio resources were used and radio frequency used; and
 - C) if the UE transmitted data during out of NG-RAN coverage period:

- shall include the amount of data transmitted during the out of NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first transmission during the out of NG-RAN coverage period; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the used radio frequency;
- vi) if the UE is configured to report the amount of data transmitted during the collection period without location information in the usage information, per each in or out of NG-RAN coverage period:
- A) shall indicate whether the data are sent in or out of NG-RAN coverage;
- B) if the UE transmitted data during in NG-RAN coverage period:
- shall include the amount of data transmitted during the in NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first transmission during the in NG-RAN coverage period; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the indicator of which radio resources were used and radio frequency used; and
- C) if the UE transmitted data during out of NG-RAN coverage period:
- shall include the amount of data transmitted during the out of NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first transmission during the out of NG-RAN coverage period; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the used radio frequency;
- vii) if the UE is configured to report the amount of data received during the collection period with location information in the usage information, per each in or out of NG-RAN coverage period and per each NG-RAN cell used when in NG-RAN coverage:
- A) shall indicate whether the data are received in or out of NG-RAN coverage;
- B) if the UE received data in an NG-RAN cell during an in NG-RAN coverage period:
- shall include the NG-RAN cell global identification of the NG-RAN cell;
 - shall include the amount of data received in the NG-RAN cell;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first reception in the NG-RAN cell; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the indicator of which radio resources were used and radio frequency used; and
- C) if the UE received data during out of NG-RAN coverage period:
- shall include the amount of data received during the out of NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first reception during the out of NG-RAN coverage period; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the used radio frequency;

- viii) if the UE is configured to report the amount of data received during the collection period without location information in the usage information, per each in or out of NG-RAN coverage period:
- A) shall indicate whether the data are received in or out of NG-RAN coverage;
 - B) if the UE received data during in NG-RAN coverage period:
 - shall include the amount of data received during the in NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first reception during the in NG-RAN coverage period; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the indicator of which radio resources were used and radio frequency used; and
 - C) if the UE received data during out of NG-RAN coverage period:
 - shall include the amount of data received during the out of NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first reception during the out of NG-RAN coverage period; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the used radio frequency; and
- ix) if the UE is configured to report QoS flow information, per each QoS flow identified by the PQFI:
- A) if the UE transmitted the QoS flow during the collection period:
 - shall include the time stamp for start of transmission of the QoS flow in the collection period;
 - shall include the time stamp for end of transmission of the QoS flow in the collection period;
 - shall include the (initial) PC5 QoS parameters of the QoS flow in the collection period as specified in clause 10.6.4.2;
 - shall include the amount of data of the QoS flow transmitted with the (initial) PC5 QoS parameters in the collection period; and
 - if the PC5 QoS parameters of the QoS flow were changed during the collection period, shall include the time stamp for start of transmission of the QoS flow with the new PC5 QoS parameters, the new PC5 QoS parameters of the QoS flow as specified in clause 10.6.4.2, and the amount of data of the QoS flow transmitted with the new PC5 QoS parameters in the collection period; or
 - B) if the UE received the QoS flow during the collection period:
 - shall include the time stamp for start of reception of the QoS flow in the collection period;
 - shall include the time stamp for end of reception of the QoS flow in the collection period;
 - shall include the (initial) PC5 QoS parameters of the QoS flow in the collection period as specified in clause 10.6.4.2;
 - shall include the amount of data of the QoS flow received with the (initial) PC5 QoS parameters in the collection period; and
 - if the PC5 QoS parameters of the QoS flow were changed during the collection period, shall include the time stamp for start of reception of the QoS flow with the new PC5 QoS parameters, the new PC5 QoS parameters of the QoS flow as specified in clause 10.6.4.2, and the amount of data of the QoS flow received with the new PC5 QoS parameters in the collection period;
- 4) in case of unicast mode 5G ProSe direct communication, for each 5G ProSe direct communication identified by the source layer-2 ID and destination layer-2 ID for unicast communication:

- i) shall include the IP address used by the UE as a source IP address, and the layer-2 ID used by the UE as a source layer-2 ID;
- ii) if the UE transmitted data during the collection period and the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include the time stamp of the first transmission in the 5G ProSe direct communication in the collection period;
- iii) if the UE received data during the collection period and the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include the time stamp of the first reception in the 5G ProSe direct communication in the collection period;
- iv) for each transmitter in unicast mode 5G ProSe direct communication not between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, shall include the source layer-2 ID and IP address of the transmitter, target layer-2 ID and IP address of the receiver;
- v) for each transmitter in unicast mode 5G ProSe direct communication between 5G ProSe the remote UE and the 5G ProSe UE-to-network relay UE, shall include the source layer-2 ID and IP address of the transmitter, layer-2 ID and IP address of 5G ProSe UE-to-network relay UE;
- vi) if the UE is configured to report the amount of data transmitted during the collection period with location information in the usage information, per each in or out of NG-RAN coverage period and per each NG-RAN cell used when in NG-RAN coverage:
 - A) shall indicate whether the data are sent in or out of NG-RAN coverage;
 - B) if the UE transmitted data in an NG-RAN cell during an in NG-RAN coverage period:
 - shall include the NG-RAN cell global identification of the NG-RAN cell;
 - shall include the amount of data transmitted in the NG-RAN cell;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first transmission in the NG-RAN cell; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the indicator of which radio resources were used and radio frequency used; and
 - C) if the UE transmitted data during out of NG-RAN coverage period:
 - shall include the amount of data transmitted during the out of NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first transmission during the out of NG-RAN coverage period; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the used radio frequency;
- vii) if the UE is configured to report the amount of data transmitted during the collection period without location information in the usage information, per each in or out of NG-RAN coverage period:
 - A) shall indicate whether the data are sent in or out of NG-RAN coverage;
 - B) if the UE transmitted data during in NG-RAN coverage period:
 - shall include the amount of data transmitted during the in NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first transmission during the in NG-RAN coverage period; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the indicator of which radio resources were used and radio frequency used; and

- C) if the UE transmitted data during out of NG-RAN coverage period:
- shall include the amount of data transmitted during the out of NG-RAN coverage period; and
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first transmission during the out of NG-RAN coverage period;
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the used radio frequency;
- viii) if the UE is configured to report the amount of data received during the collection period with location information in the usage information, per each in or out of NG-RAN coverage period and per each NG-RAN cell used when in NG-RAN coverage:
- A) shall indicate whether the data are received in or out of NG-RAN coverage;
- B) if the UE received data in an NG-RAN cell during an in NG-RAN coverage period:
- shall include the NG-RAN cell global identification of the NG-RAN cell;
 - shall include the amount of data received in the NG-RAN cell;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first reception in the NG-RAN cell; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the indicator of which radio resources were used and radio frequency used; and
- C) if the UE received data during out of NG-RAN coverage period:
- shall include the amount of data received during the out of NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first reception during the out of NG-RAN coverage period; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the used radio frequency;
- ix) if the UE is configured to report the amount of data received during the collection period without location information in the usage information, per each in or out of NG-RAN coverage period:
- A) shall indicate whether the data are received in or out of NG-RAN coverage;
- B) if the UE received data during in NG-RAN coverage period:
- shall include the amount of data received during the in NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first reception during the in NG-RAN coverage period; and
 - if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the indicator of which radio resources were used and radio frequency used; and
- C) if the UE received data during out of NG-RAN coverage period:
- shall include the amount of data received during the out of NG-RAN coverage period;
 - if the UE is configured to report the time stamps of the first transmission/reception during the collection period in the usage information, shall include time stamp of the first reception during the out of NG-RAN coverage period; and

- if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the used radio frequency;
- x) if the UE acts as a 5G ProSe UE-to-network relay UE, per each NG-RAN cell used during the 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE:
 - A) shall include the NG-RAN cell global identification of the NG-RAN cell;
 - B) shall include the amount of data relayed by the UE;
 - C) shall include time stamp of the first data relay via the UE in the NG-RAN cell; and
 - D) if the UE is configured to report the radio parameters used for 5G ProSe direct communication during the reporting period in the usage information, shall include the indicator of which radio resources were used and the radio frequency used; and
- xi) if the UE is configured to report QoS flow information, per each QoS flow identified by the PQFI:
 - A) if the UE transmitted the QoS flow during the collection period:
 - shall include the time stamp for start of transmission of the QoS flow in the collection period;
 - shall include the time stamp for end of transmission of the QoS flow in the collection period;
 - shall include the (initial) PC5 QoS parameters of the QoS flow in the collection period as specified in clause 10.6.4.2;
 - shall include the amount of data of the QoS flow transmitted with the (initial) PC5 QoS parameters in the collection period; and
 - if the PC5 QoS parameters of the QoS flow were changed during the collection period, shall include the time stamp for start of transmission of the QoS flow with the new PC5 QoS parameters, the new PC5 QoS parameters of the QoS flow as specified in clause 10.6.4.2, and the amount of data of the QoS flow transmitted with the new PC5 QoS parameters in the collection period; or
 - B) if the UE received the QoS flow during the collection period:
 - shall include the time stamp for start of reception of the QoS flow in the collection period;
 - shall include the time stamp for end of reception of the QoS flow in the collection period;
 - shall include the (initial) PC5 QoS parameters of the QoS flow in the collection period as specified in clause 10.6.4.2;
 - shall include the amount of data of the QoS flow received with the (initial) PC5 QoS parameters in the collection period; and
 - if the PC5 QoS parameters of the QoS flow were changed during the collection period, shall include the time stamp for start of reception of the QoS flow with the new PC5 QoS parameters, the new PC5 QoS parameters of the QoS flow as specified in clause 10.6.4.2, and the amount of data of the QoS flow received with the new PC5 QoS parameters in the collection period; and
- 5) if configured radio parameters for the 5G ProSe direct communication applicable in the geographical area of the UE were used during the collection period, shall include the configured radio parameters for the 5G ProSe direct communication applicable in the geographical area of the UE; and
- c) for each application specific data received from upper layers during the collection period, shall include the received application specific data.

Figure 7.6.2.1.2.1 illustrates the interaction of the UE and the 5G DDNMF CTF (ADF) in the usage information report list sending procedure.

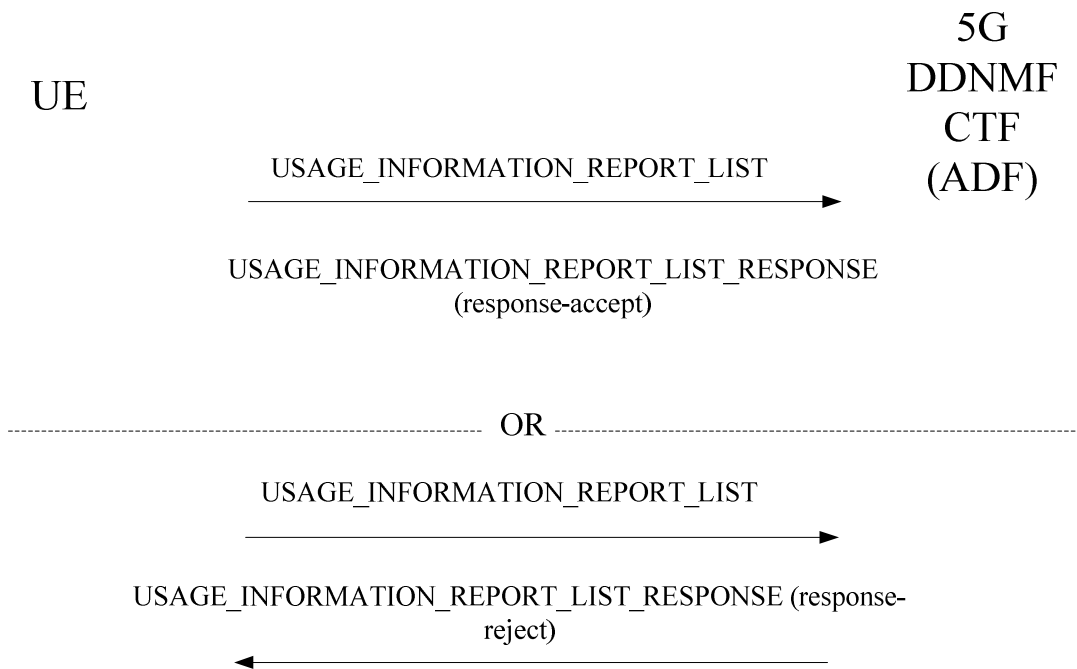


Figure 7.6.2.1.2.1: Usage information report list sending procedure

7.6.2.1.3 Usage information report list sending procedure accepted by the 5G DDNMF

Upon receiving a `PROSE_USAGE_INFORMATION_REPORT_LIST` message from UE, the 5G DDNMF CTF (ADF) triggers one or more charging data requests according to 3GPP TS 32.277 [45].

If the `PROSE_USAGE_INFORMATION_REPORT_LIST` message is accepted by the 5G DDNMF CTF (ADF), the 5G DDNMF CTF (ADF) shall send a `PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE` message to the UE, containing a `<response-accept>` element with transaction ID set to the value of the transaction ID included in the `PROSE_USAGE_INFORMATION_REPORT_LIST` message.

7.6.2.1.4 Usage information report list sending procedure successful completion by the UE

Upon receipt of the `PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE` message containing a `<response-accept>` element with transaction ID set to the value of the transaction ID included in the `PROSE_USAGE_INFORMATION_REPORT_LIST` message, the usage information report list sending procedure is successfully completed.

7.6.2.1.5 Usage information report list sending procedure not accepted by the 5G DDNMF

If the `PROSE_USAGE_INFORMATION_REPORT_LIST` message is not accepted by the 5G DDNMF CTF (ADF), the 5G DDNMF CTF (ADF) shall send a `PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE` message to the UE. In the `PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE` message, the 5G DDNMF CTF (ADF):

- 1) shall include a `<response-reject>` element with transaction ID set to the value of the transaction ID included in the `PROSE_USAGE_INFORMATION_REPORT_LIST` message; and
- 2) shall include appropriate cause value.

7.6.2.1.6 Usage information report list sending procedure unsuccessful completion by the UE

Upon receipt of the PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE message containing a <response-reject> element with transaction ID set to the value of the transaction ID included in the PROSE_USAGE_INFORMATION_REPORT_LIST message, the usage information report list sending procedure is unsuccessfully completed.

If the PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE message contains the cause value set to #3 "Invalid message format", the UE shall not perform the usage information report list sending procedure until the UE powers off and powers on again or the USIM is removed.

7.7 Communication path switching procedure between the direct communication path over Uu and the direct communication path over PC5

7.7.1 General

This clause describes the procedures for path switching procedure between the direct communication path over Uu and the direct communication path over PC5.

The communication path of direct communication path over Uu refers to the communication path between two ProSe-enabled UEs that is performed via the network over Uu reference point. The communication path of direct communication path over PC5 refers to the communication path between two ProSe-enabled UEs that is performed via the unicast mode 5G ProSe direct communication over PC5 as specified in clause 7.2.

The principle of determining the ProSe applications to be switched is defined in clause 7.7.4.

The following procedures are defined for path switching procedure between the direct communication path over Uu and the direct communication path over PC5:

- a) path switching procedure from the direct communication path over Uu to the direct communication path over PC5; and
- b) path switching procedure from the direct communication path over PC5 to the direct communication path over Uu.

7.7.2 Path switching procedure from the direct communication path over Uu to the direct communication path over PC5

7.7.2.1 General

The purpose of the path switching procedure from the direct communication path over Uu to the direct communication path over PC5 is to enable a ProSe-enabled UE to switch the communication path from the direct communication path over Uu to the direct communication path over PC5 when the UE is communicating with another ProSe-enabled UE via the direct communication path over Uu.

A UE may initiate a path switching procedure from the direct communication path over Uu to the direct communication path over PC5:

- a) when the peer UE that the UE is communicating with via the direct communication path over Uu is in proximity; or
- b) when the UE needs to switch the communication path from the direct communication path over Uu to the direct communication path over PC5 on demand (e.g. to offload some traffic from the network, a request from upper layers, etc.).

In this procedure, the UE initiating the path switching procedure from the direct communication path over Uu to the direct communication path over PC5 is called the "initiating UE" and the peer UE that the "initiating UE" is communicating with is called the "target UE".

7.7.2.2 Path switching procedure from the direct communication path over Uu to the direct communication path over PC5 initiation by initiating UE

The initiating UE shall meet the following pre-conditions before initiating this procedure for switching the direct communication path over Uu to the direct communication path over PC5:

- a) the UE is configured with the configuration parameters for unicast mode 5G ProSe direct communication over PC5 interface as specified in clause 5.2.4.

In order to initiate the path switching procedure from the direct communication path over Uu to the direct communication path over PC5:

- a) if there is an existing 5G ProSe direct link between the initiating UE and the target UE, the initiating UE shall:
 - 1) initiate a 5G ProSe direct link modification procedure as specified in clause 7.2.3.2 with the following considerations in the PROSE DIRECT LINK MODIFICATION REQUEST message:
 - i) the PQFI(s), the corresponding PC5 QoS parameters, and the ProSe identifier(s) set to the parameters corresponding to the authorized ProSe application(s) for which the communication path switching procedure is to be performed according to the ProSe application to path switching mapping rules as specified in clause 5.2.4;
 - ii) the link modification operation code set to "Associate new ProSe application(s) with existing PC5 QoS flow(s)", "Modify PC5 QoS parameters of the existing PC5 QoS flow(s)", or "Add new PC5 QoS flow(s) to the existing 5G ProSe direct link"; and

NOTE 1: Which link modification operation code is selected is up to UE implementations (e.g. based on the load of the existing 5G ProSe direct link).

- iii) may include the PC5 QoS rule(s) to indicate the packet filters of the PC5 QoS flow(s) corresponding to the authorized ProSe application(s) for which the communication path switching procedure is to be performed;

Any parameter that is not mentioned above shall follow the definitions in clause 7.2.3.2.

- b) else, the initiating UE:

- 1) may initiate a 5G ProSe direct discovery procedure over PC5 interface with model B as specified in clause 6.2.14.2.2 with the following considerations in the PROSE PC5 DISCOVERY message:
 - i) the discoveree user info set to the application layer ID of the target UE provided by the upper layers (if available).

Any parameter that is not mentioned above shall follow the definitions in clause 6.2.14.2.2; and

NOTE 2: The initiating UE is allowed to skip the 5G ProSe direct discovery procedure over PC5 interface with model B if the initiating UE ensures the target UE is in proximity. How the initiating UE ensure this is left to UE implementations.

- 2) shall initiate a 5G ProSe direct link establishment procedure as specified in clause 7.2.2.2 with the following considerations in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message:
 - i) the ProSe identifier(s) set to the determined ProSe application(s) for which the communication path switching procedure is to be performed as specified in clause 7.7.4; and
 - ii) the target user info set to the application layer ID of the target UE provided by the upper layers;

Any parameter that is not mentioned above shall follow the definitions in clause 7.2.2.2.

7.7.2.3 Path switching procedure from the direct communication path over Uu to the direct communication path over PC5 accepted by the target UE

Upon receipt of the PROSE DIRECT LINK MODIFICATION REQUEST message as specified in clause 7.7.2.2, if the received PROSE DIRECT LINK MODIFICATION REQUEST message is accepted by the target UE, the target UE shall respond with the PROSE DIRECT LINK MODIFICATION ACCEPT message as specified in clause 7.2.3.3.

Upon receipt of the PROSE DIRECT LINK ESTABLISHMENT REQUEST message as specified in clause 7.7.2.2, if the received PROSE DIRECT LINK ESTABLISHMENT REQUEST message is accepted by the target UE, the target UE shall respond with the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message as specified in clause 7.2.2.3.

The PROSE DIRECT LINK MODIFICATION ACCEPT message or the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message is considered as the path switching procedure from the direct communication path over Uu to the direct communication path over PC5 is accepted by the target UE.

7.7.2.4 Path switching procedure from the direct communication path over Uu to the direct communication path over PC5 completion by the initiating UE

Upon receipt of the PROSE DIRECT LINK MODIFICATION ACCEPT message or the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message, the initiating UE:

- a) shall perform the procedures as specified in clause 7.2.3.4 to complete the 5G ProSe direct link modification procedure, if the PROSE DIRECT LINK MODIFICATION ACCEPT message is received;
- b) shall perform the procedures as specified in clause 7.2.2.4 to complete the 5G ProSe direct link establishment procedure, if the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message is received; and
- c) shall perform the PC5 QoS flow establishment over 5G ProSe direct link as specified in clause 7.2.7 if bullet 2) is performed;

The path switching procedure from the direct communication path over Uu to the direct communication path over PC5 is considered as completed when the initiating UE has at least one PC5 QoS flow(s) over the 5G ProSe direct link for the determined ProSe application(s) for which the communication path switching procedure is to be performed.

The initiating UE shall then transmit the data traffic of the determined ProSe application(s) for which the communication path switching procedure is to be performed with the target UE as specified in clause 7.2.8 and clause 7.2.9 using the direct communication path over PC5.

When the data traffic is successfully transmitted, the initiating UE or the target UE may perform either of the followings:

- a) initiate a UE-requested PDU session release procedure as specified in clause 6.4.3 of 3GPP TS 24.501 [11] if there are no more traffic transmitted over the PDU Session; or
- b) initiate a UE-requested PDU session modification procedure as specified in clause 6.4.2 of 3GPP TS 24.501 [11] to request the deletion of the existing QoS flow description(s) corresponding to ProSe application(s) for which the path switching procedure from the direct communication path over Uu to the direct communication path over PC5 is performed.

7.7.2.5 Path switching procedure from the direct communication path over Uu to the direct communication path over PC5 not accepted by the target UE

Upon receipt of the PROSE DIRECT LINK MODIFICATION REQUEST message as specified in clause 7.7.2.2, if the received PROSE DIRECT LINK MODIFICATION REQUEST message is not accepted by the target UE, the target UE shall respond with the PROSE DIRECT LINK MODIFICATION REJECT message containing a PC5 signalling protocol cause IE as specified in clause 7.2.3.5.

Upon receipt of the PROSE DIRECT LINK ESTABLISHMENT REQUEST message as specified in clause 7.7.2.2, if the received PROSE DIRECT LINK ESTABLISHMENT REQUEST message is not accepted by the target UE, the target UE shall respond with the PROSE DIRECT LINK ESTABLISHMENT REJECT message containing a PC5 signalling protocol cause IE as specified in clause 7.2.2.5.

The PROSE DIRECT LINK MODIFICATION REJECT message or the PROSE DIRECT LINK ESTABLISHMENT REJECT message is considered as the path switching procedure from the direct communication path over Uu to the direct communication path over PC5 is not accepted by the target UE.

Upon receipt of the PROSE DIRECT LINK MODIFICATION REJECT message or the PROSE DIRECT LINK ESTABLISHMENT REJECT message, the initiating UE shall consider the path switching procedure from the direct

communication path over Uu to the direct communication path over PC5 is not accepted by the target UE and perform the procedures as specified in clause 7.2.3.5 or clause 7.2.2.5 respectively.

If the 5G ProSe direct discovery procedure over PC5 interface with model B is initiated as specified in clause 7.7.2.2, and if:

- a) the condition of discoverer UE procedure for 5G ProSe direct discovery completion is met as specified in clause 6.2.14.2.2.3; and
- b) the target UE that the initiating UE seeks to discover has not been discovered,

how to handle this for the initiating UE is up to UE implementations.

7.7.2.6 Abnormal cases

7.7.2.6.1 Abnormal cases at the initiating UE

The following abnormal cases can be identified:

- a) abnormal cases as specified in clause 7.2.2.6.1 shall apply if the 5G ProSe direct link establishment procedure as specified in clause 7.2.2.2 is initiated at the initiating UE (see clause 7.7.2.2); and
- b) abnormal cases as specified in clause 7.2.3.6.1 shall apply if the 5G ProSe direct link modification procedure as specified in clause 7.2.3.2 is initiated at the initiating UE (see clause 7.7.2.2).

7.7.2.6.2 Abnormal cases at the target UE

The following abnormal cases can be identified:

- a) abnormal cases as specified in clause 7.2.2.6.2 shall apply if the 5G ProSe direct link establishment procedure as specified in clause 7.2.2.2 is initiated at the target UE (see clause 7.7.2.3); and
- b) abnormal cases as specified in clause 7.2.3.6.2 shall apply if the 5G ProSe direct link modification procedure as specified in clause 7.2.3.2 is initiated at the target UE (see clause 7.7.2.3).

7.7.3 Path switching procedure from the direct communication path over PC5 to the direct communication path over Uu

7.7.3.1 General

The purpose of the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu is to enable a ProSe-enabled UE to switch the communication path from the direct communication path over PC5 to the direct communication path over Uu when the UE is communicating with another ProSe-enabled UE via the direct communication path over PC5.

For communication with IP data unit type, the IP addresses, IPv6 prefixes, or both to be used for the direct communication path over Uu can be shared via the application layer over the existing PC5 connection, to assist the initiating UE and the target UE to establish the communication with each other via the direct communication path over the Uu.

A UE may initiate a path switching procedure from the direct communication path over PC5 to the direct communication path over Uu:

- a) when the PC5 signal strength of the direct communication path over PC5 with the peer UE becomes weak (e.g. reaching a certain configured signal strength threshold); or
- b) when the UE needs to switch the communication path from the direct communication path over PC5 to the direct communication path over Uu on demand (e.g. a request from upper layers).

In this procedure, the UE initiating the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu is called the "initiating UE" and the peer UE that the "initiating UE" is communicating with is called the "target UE".

7.7.3.2 Path switching procedure from the direct communication path over PC5 to the direct communication path over Uu initiation by initiating UE

The initiating UE shall meet the following pre-conditions before initiating this procedure for switching the direct communication path over PC5 to the direct communication path over Uu:

- a) the initiating UE and the target UE are communicating with each other via the 5G ProSe direct link over PC5 reference point; and
- b) the communication mode of the 5G ProSe direct link is set to unicast mode.

In order to initiate the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu, the initiating UE initiates an implementation-specific timer to avoid a potential collision of the path switching procedure. When the implementation-specific timer expires, the initiating UE shall create a PROSE PATH SWITCHING REQUEST message. In the PROSE PATH SWITCHING REQUEST message, the initiating UE:

- a) shall include the required ProSe identifiers set to the ProSe identifier(s) of the determined ProSe application(s) for which the communication path switching procedure is to be performed as specified in clause 7.7.4; and
- b) may include the Uu QoS flow descriptions set to the requested QoS flow description for each ProSe identifier to be used in the communication path over Uu.

NOTE 1: The initiating UE derives the requested QoS flow description(s) based on the PC5 QoS parameters of the PC5 QoS flow(s) between the initiating UE and the target UE.

After the PROSE PATH SWITCHING REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the source layer-2 ID and destination layer-2 ID used in the existing 5G ProSe direct link with the target UE and start timer T5098. The initiating UE shall not send a new PROSE PATH SWITCHING REQUEST message to the same target UE while timer T5098 is running.

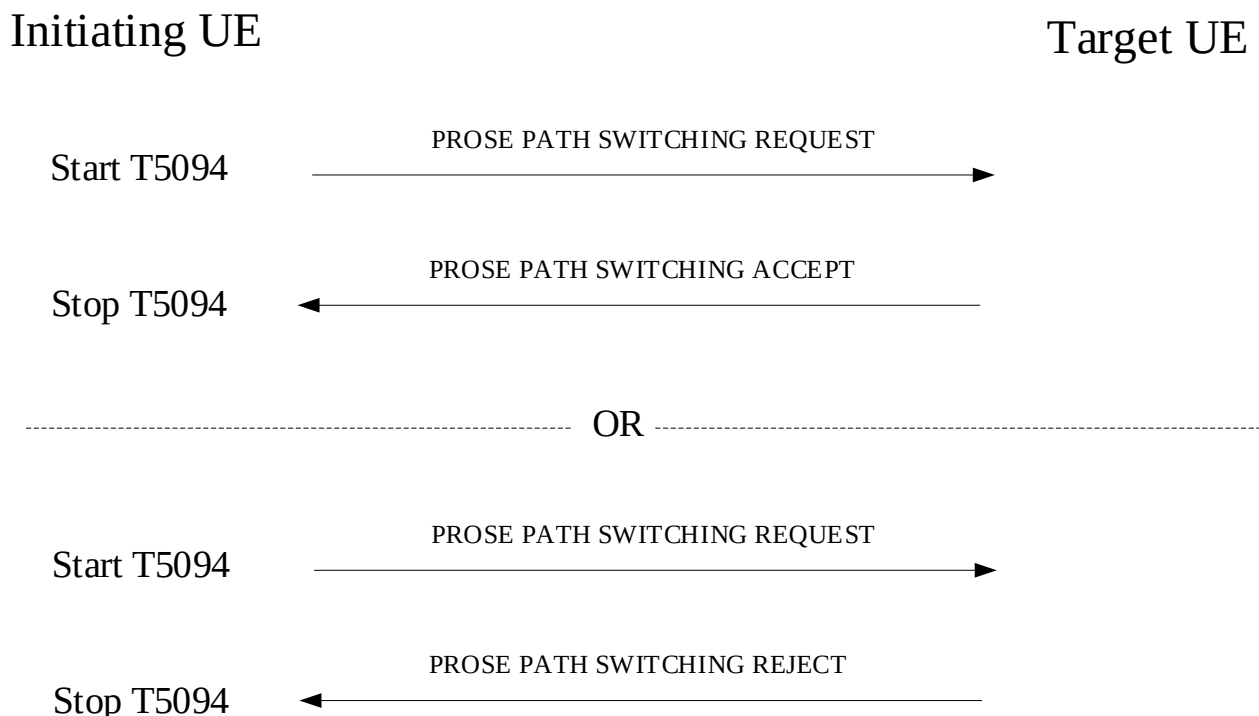


Figure 7.7.3.2.1: Path switching procedure from the direct communication path over PC5 to the direct communication path over Uu

7.7.3.3 Path switching procedure from the direct communication path over PC5 to the direct communication path over Uu accepted by the target UE

Upon receipt of the PROSE PATH SWITCHING REQUEST message, the target UE determines as specified in clause 7.7.4 if there are at least one ProSe application(s) identified by the ProSe identifier(s) in the PROSE PATH SWITCHING REQUEST message that are able to perform the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu. If there are ProSe application(s) that are acceptable to be switched from the direct communication path over PC5 to the direct communication path over Uu, the target UE shall consider the PROSE PATH SWITCHING REQUEST is acceptable, and:

- a) shall generate a PROSE PATH SWITCHING ACCEPT message. In the PROSE PATH SWITCHING ACCEPT message, the target UE:
 - 1) shall include the negotiated ProSe identifiers set to the ProSe identifier(s) of the ProSe application(s) that are acceptable to be switched from the direct communication path over PC5 to the direct communication path over Uu; and
- b) may perform either of the following:
 - 1) initiate the UE-requested PDU session establishment procedure as specified in clause 6.4.1 of 3GPP TS 24.501 [11] to establish a PDU session to be used for the direct communication path over Uu; or
 - 2) initiate the UE-requested PDU session modification procedure as specified in clause 6.4.2 of 3GPP TS 24.501 [11] to modify a PDU session to be used for the direct communication path over Uu, with the Requested QoS flow descriptions IE set to the QoS flow descriptions if received in the PROSE PATH SWITCHING REQUEST message for the accepted ProSe application(s) to be switched to the direct communication path over Uu.

After the PROSE PATH SWITCHING ACCEPT message is generated, the target UE shall pass this message to the lower layers for transmission along with the source layer-2 ID and destination layer-2 ID used in the existing 5G ProSe direct link with the initiating UE.

7.7.3.4 Path switching procedure from the direct communication path over PC5 to the direct communication path over Uu completion by the initiating UE

Upon receipt of the PROSE PATH SWITCHING ACCEPT message, the initiating UE:

- a) shall stop timer T5098; and
- b) may perform either of the following:
 - 1) initiate the UE-requested PDU session establishment procedure as specified in clause 6.4.1 of 3GPP TS 24.501 [11] to establish a PDU session to be used for the direct communication path over Uu; or
 - 2) initiate the UE-requested PDU session modification procedure as specified in clause 6.4.2 of 3GPP TS 24.501 [11] to modify a PDU session to be used for the direct communication path over Uu, with the Requested QoS flow descriptions IE set to the QoS flow descriptions if sent in the PROSE PATH SWITCHING REQUEST message for the accepted ProSe application(s) to be switched to the direct communication path over Uu.

The initiating UE shall then transmit the data traffic of the negotiated ProSe application(s) with the target UE using the direct communication path over Uu. For the ProSe application(s) that the initiating UE requested but are not included in the negotiated ProSe identifier(s) IE, the initiating UE continues to use the direct communication path over PC5 for those applications until the 5G ProSe direct link is released.

When the data traffic is successfully transmitted via the direct communication path over Uu, the initiating UE or the target UE may initiate a 5G ProSe direct link release procedure as specified in clause 7.2.6 if there are no more ProSe applications over the existing 5G ProSe direct link between the initiating UE and the target UE.

NOTE: The UE is allowed to maintain the existing 5G ProSe direct link in order to e.g. switch back from the direct communication path over Uu after the completion of the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu.

7.7.3.5 Path switching procedure from the direct communication path over PC5 to the direct communication path over Uu not accepted by the target UE

Upon receipt of the PROSE PATH SWITCHING REQUEST message, if there is no ProSe application identified by the ProSe identifier in the PROSE PATH SWITCHING REQUEST message to perform the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu as specified in clause 7.7.4, the target UE shall consider the PROSE PATH SWITCHING REQUEST is not acceptable, and shall generate a PROSE PATH SWITCHING REJECT message. The PROSE PATH SWITCHING REJECT message contains a PC5 signalling protocol cause IE set to one of the following cause values:

- #18 path switching is not allowed for the ProSe applications;
- #20 communication path over Uu is not available for path switching;
- #111 protocol error, unspecified.

If all the ProSe application(s) identified by the ProSe identifier(s):

- a) are not able to perform the communication path switching procedure from the direct communication path over PC5 to the direct communication path over Uu as specified in clause 7.7.4; or
- b) are not able to be supported because of e.g., the QoS requirements for the direct communication path over Uu;

the target UE shall send a PROSE PATH SWITCHING REJECT message with the PC5 signalling protocol cause value #18 "path switching is not allowed for the ProSe applications". In this case, the initiating UE may initiate another PROSE PATH SWITCHING REQUEST message for the ProSe application(s) that are not in the previous PROSE PATH SWITCHING REQUEST message with the same target UE.

If the communication path over Uu is not available to the target UE (because of e.g. weak signal strength over Uu) for the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu, the target UE shall send a PROSE PATH SWITCHING REJECT message with the PC5 signalling protocol cause value #20 "communication path over Uu is not available for path switching".

7.7.3.6 Abnormal cases

7.7.3.6.1 Abnormal cases at the initiating UE

The following abnormal cases can be identified:

- a) Expiry of timer T5098:

On the first expiry of the timer T5098, the UE shall resend the PROSE PATH SWITCHING REQUEST message and shall reset and restart timer T5098. This retransmission is repeated two times, i.e. on the third expiry of timer T5098, the UE shall abort the procedure and consider the target UE is not in proximity or the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu is not accepted by the target UE.

NOTE: After the third expiry of timer T5098, whether the UE performs path switching procedure to the direct communication path over Uu is up to UE implementations.

- b) For the same 5G ProSe direct link, if the initiating UE receives a PROSE PATH SWITCHING REQUEST message during the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu, the initiating UE shall stop the timer T5098 and abort the initiated procedure. Following handling is implementation dependent, e.g., the initiating UE waits for an implementation dependent time for initiating a new PROSE PATH SWITCHING REQUEST towards the target UE, if still needed.

7.7.3.6.2 Abnormal cases at the target UE

The following abnormal cases can be identified:

- a) For the same 5G ProSe direct link, if the target UE is processing the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu and the implementation-specific timer as specified in clause 7.7.3.2 is not running, upon receipt of a PROSE PATH SWITCHING REQUEST message

from the same initiating UE, the target UE shall ignore the new received PROSE PATH SWITCHING REQUEST message.

- b) For the same 5G ProSe direct link, if the implementation-specific timer as specified in clause 7.7.3.2 is running, upon receipt of a PROSE PATH SWITCHING REQUEST message from the initiating UE, the target UE shall stop the implementation-specific timer, process the received PROSE PATH SWITCHING REQUEST message, and shall not initiate a path switching procedure from the direct communication path over PC5 to the direct communication path over Uu to the initiating UE.

7.7.4 Principles of determining the ProSe applications to be switched

The UE evaluates the ProSe application to path preference mapping rules as specified in clause 5.2.4 according to the ProSe identifier of the ProSe application to obtain the preference from the network as follows:

a) if:

- 1) the ProSe application is running in the direct communication path over Uu; and
- 2) either of the following:
 - i) the ProSe identifier of the ProSe application matches the ProSe identifiers field in the ProSe application to path preference mapping rule and the corresponding PP field in the ProSe application to path preference mapping rule is set to "PC5 preferred" (see 3GPP TS 24.555 [17]); or
 - ii) the ProSe identifier of the ProSe application cannot match any ProSe identifiers field in the ProSe application to path preference mapping rule, the SI field in the ProSe application to path preference mapping rule is set to "For all ProSe services", and the PP field in the ProSe application to path preference mapping rule is set to "PC5 preferred" (see 3GPP TS 24.555 [17]);

the ProSe application is recommended by the network to perform the communication path switching from the direct communication path over Uu to the direct communication path over PC5;

b) if:

- 1) the ProSe application is running in the direct communication path over Uu; and
- 2) either of the following:
 - i) the ProSe identifier of the ProSe application matches the ProSe identifiers field in the ProSe application to path preference mapping rule and the corresponding PP field in the ProSe application to path preference mapping rule is set to "Uu preferred" (see 3GPP TS 24.555 [17]); or
 - ii) the ProSe identifier of the ProSe application cannot match any ProSe identifiers field in the ProSe application to path preference mapping rule, the SI field in the ProSe application to path preference mapping rule is set to "For all ProSe services", and the PP field in the ProSe application to path preference mapping rule is set to "Uu preferred" (see 3GPP TS 24.555 [17]);

the ProSe application is recommended by the network not to perform the communication path switching from the direct communication path over Uu to the direct communication path over PC5;

c) if:

- 1) the ProSe application is running in the direct communication path over PC5; and
- 2) either of the following:
 - i) the ProSe identifier of the ProSe application matches the ProSe identifiers field in the ProSe application to path preference mapping rule and the corresponding PP field in the ProSe application to path preference mapping rule is set to "Uu preferred" (see 3GPP TS 24.555 [17]); or
 - ii) the ProSe identifier of the ProSe application cannot match any ProSe identifiers field in the ProSe application to path preference mapping rule, the SI field in the ProSe application to path preference mapping rule is set to "For all ProSe services", and the PP field in the ProSe application to path preference mapping rule is set to "Uu preferred" (see 3GPP TS 24.555 [17]);

the ProSe application is recommended to perform the communication path switching from the direct communication path over PC5 to the direct communication path over Uu;

d) if:

- 1) the ProSe application is running in the direct communication path over PC5; and
- 2) either of the following:
 - i) the ProSe identifier of the ProSe application matches the ProSe identifiers field in the ProSe application to path preference mapping rule and the corresponding PP field in the ProSe application to path preference mapping rule is set to "PC5 preferred" (see 3GPP TS 24.555 [17]); or
 - ii) the ProSe identifier of the ProSe application cannot match any ProSe identifiers field in the ProSe application to path preference mapping rule, the SI field in the ProSe application to path preference mapping rule is set to "For all ProSe services", and the PP field in the ProSe application to path preference mapping rule is set to "PC5 preferred" (see 3GPP TS 24.555 [17]);

the ProSe application is recommended by the network not to perform the communication path switching from the direct communication path over PC5 to the direct communication path over Uu; and

e) in all other cases, the network has no preference.

The UE determines the ProSe applications to be switched with the consideration of the network preference as described above and maybe other criteria (e.g. availability of direct communication path over Uu, availability of direct communication path over PC5, requirements of the application, implementation-specific signal strength threshold, etc.).

NOTE: The UE can still choose to switch the communication to the non-preferred path of the network due to other criteria as described above.

8 5G ProSe UE-to-network relay

8.1 Overview

This clause describes the procedures for 5G ProSe UE-to-network relay. The UE is configured with the related information as described in clause 5.2.5.

For the UE acting as a 5G ProSe layer-2 remote UE, the communication path switching between direct network communication path and indirect network communication path via the 5G ProSe layer-2 UE-to-network relay UE is supported as specified in clause 6.5.2.3 of 3GPP TS 23.304 [2].

8.2 Procedures

8.2.1 UE-to-network relay discovery over PC5 interface

8.2.1.1 General

This clause describes the procedures for both layer-3 and layer-2 UE-to-network relay discovery for public safety use and commercial services at a ProSe-enabled UE over the PC5 interface. The purpose of the UE-to-network relay discovery procedure over PC5 interface is to enable a ProSe-enabled UE to detect and identify another ProSe-enabled UE over PC5 interface for UE-to-network relay communication between a UE and 5GC.

NOTE 1: Relaying Multicast/Broadcast Service traffic to a 5G ProSe remote UE by a 5G ProSe UE-to-network relay is not supported in this release of the specification.

A 5G ProSe UE-to-network relay supporting multiple relay service codes can advertise the relay service codes using multiple discovery messages, with one relay service code per discovery message.

Due to local regulations or implementation specific requirements and if the 5G ProSe layer-3 UE-to-network relay UE:

- a) is using its own emergency service;
- b) is relaying the emergency service from one 5G ProSe layer-3 remote UE; or
- c) received the emergency service support indicator for 3GPP access set to "emergency services not supported" in the latest REGISTRATION ACCEPT message from the AMF as specified in 3GPP TS 24.501 [11],

the 5G ProSe layer-3 UE-to-network relay UE shall not announce or respond to the 5G ProSe UE-to-network relay discovery message including the RSC specific for emergency service.

NOTE 2a: The prioritisation between the emergency calls of the 5G ProSe layer-3 UE-to-network relay UE itself and of the 5G ProSe layer-3 remote UE is determined by the local regulations, if available, otherwise it is left to the 5G ProSe layer-3 UE-to-network relay UE implementation.

The following principles for 5G ProSe UE-to-network relay apply when the 5G ProSe UE-to-network relay UE or the 5G ProSe remote UE is in service area restriction as defined in clause 5.3.5 of 3GPP TS 24.501 [11], except the case when the 5G ProSe UE-to-network relay UE is relaying the emergency service for the 5G ProSe remote UE:

- a) in non-allowed area of its serving PLMN, the 5G ProSe layer-3 UE-to-network relay UE is not allowed to perform relay operations (e.g., UE-to-network relay discovery as specified in clause 8.2.1, or accept the 5G ProSe direct link establishment procedure as specified in clause 7.2.2) except for e.g. high priority access as defined in clause 5.3.5 of 3GPP TS 24.501 [11] based on relay service codes as specified in clause 5.2.5;
- b) service area restriction is not applicable to the 5G ProSe layer-3 remote UE;
- c) in non-allowed area of its serving PLMN, the 5G ProSe layer-2 UE-to-network relay UE is not allowed to perform relay operations (e.g., UE-to-network relay discovery as specified in clause 8.2.1, or accept the 5G ProSe direct link establishment procedure as specified in clause 7.2.2);
- d) in non-allowed area of its serving PLMN, the 5G ProSe layer-2 remote UE follows the same principles of service area restrictions as specified in clause 5.3.5 of 3GPP TS 24.501 [11] for communication with the network via the 5G ProSe layer-2 UE-to-network relay UE; and
- e) when the 5G ProSe layer-2 remote UE is out of NG-RAN coverage, or is in allowed area of 5G ProSe layer-2 remote UE's serving PLMN, the 5G ProSe layer-2 remote UE follows the same principles of service area restrictions as specified in clause 5.3.5 of 3GPP TS 24.501 [11] for communication with the network via the 5G ProSe layer-2 UE-to-network relay UE if the 5G ProSe layer-2 remote UE determines that the 5G ProSe layer-2 UE-to-network relay UE is in the non-allowed area of the 5G ProSe layer-2 remote UE based on the TAI in the RRC container received from the 5G ProSe layer-2 UE-to-network relay UE.

NOTE 2: Closed access group information is not specified for 5G ProSe.

The following principles for 5G ProSe UE-to-network relay apply when the relay UE or the 5G ProSe remote UE is in 5GS forbidden tracking areas as defined in clause 5.3.13 of 3GPP TS 24.501 [11]:

- a) in a 5GS forbidden tracking area of its serving PLMN, the 5G ProSe UE-to-network relay UE is not allowed to perform relay operations;
- b) in a 5GS forbidden tracking area of its serving PLMN, the 5G ProSe remote UE is not allowed to access the network via the 5G ProSe UE-to-network relay UE unless the 5G ProSe remote UE is attempting for emergency service; and
- c) when the 5G ProSe layer-2 remote UE is out of NG-RAN coverage, or is in NG-RAN coverage and not in a 5GS forbidden tracking area of its serving PLMN, the 5G ProSe layer-2 remote UE shall not access the network via this 5G ProSe layer-2 UE-to-network relay except for emergency service, if the 5G ProSe layer-2 remote UE determines that the 5G ProSe layer-2 UE-to-network relay UE is in the forbidden tracking area of the 5G ProSe layer-2 remote UE based on the TAI in the RRC container received from the 5G ProSe layer-2 UE-to-network relay UE.

To perform UE-to-network relay discovery over PC5 interface, the UE is configured with the related information as described in clause 5.2.5. The following models for UE-to-network relay discovery procedure over PC5 interface as specified in 3GPP TS 23.304 [2] are supported:

- a) Model A uses a single discovery protocol message (Announcement); and
- b) Model B uses two discovery protocol messages (Solicitation and Response).

NOTE 3: If the UE is authorized to perform both 5G ProSe UE-to-network relay discovery Model A and 5G ProSe UE-to-network relay discovery Model B, it is up to UE implementation to select which model to perform or perform both models simultaneously.

The 5G ProSe UE-to-network relay UE and 5G ProSe remote UE may use the PC5 DRX mechanism to perform 5G ProSe UE-to-network relay discovery over PC5 interface when the UE is not served by NG-RAN as specified in clause 5.2.5.

The following procedures are defined for UE-to-network relay discovery procedure over PC5 interface:

- a) UE-to-network relay discovery over PC5 interface with Model A:
 - 1) Announcing UE procedure for UE-to-network relay discovery initiation;
 - 2) Announcing UE procedure for UE-to-network relay discovery completion;
 - 3) Monitoring UE procedure for UE-to-network relay discovery initiation;
 - 4) Monitoring UE procedure for UE-to-network relay discovery completion;
 - 5) Announcing UE procedure for UE-to-network relay discovery additional information; and
 - 6) Monitoring UE procedure for UE-to-network relay discovery additional information; and
- b) UE-to-network relay discovery over PC5 interface with Model B:
 - 1) Discoverer UE procedure for UE-to-network relay discovery initiation;
 - 2) Discoverer UE procedure for UE-to-network relay discovery completion;
 - 3) Discoveree UE procedure for UE-to-network relay discovery initiation; and
 - 4) Discoveree UE procedure for UE-to-network relay discovery completion.

8.2.1.2 UE-to-network relay discovery over PC5 interface with model A

8.2.1.2.1 General

In this procedure, the 5G ProSe UE-to-network relay UE acts as an "announcing UE" and the 5G ProSe remote UE acts as a "monitoring UE".

8.2.1.2.2 Announcing UE relay discovery for UE-to-network relay discovery

8.2.1.2.2.1 General

The purpose of the announcing UE procedure for UE-to-network relay discovery is:

- a) to enable a ProSe-enabled UE to announce availability of a connectivity service provided by a UE-to-network relay of the ProSe-enabled UE to other ProSe-enabled UEs, upon a request from upper layers as defined in 3GPP TS 23.304 [2]; or
- b) to enable a ProSe-enabled UE to measure the PROSE PC5 DISCOVERY message signal strength between the ProSe-enabled UE and the 5G ProSe UE-to-network relay UE(s) for relay selection/reselection.

8.2.1.2.2.2 Announcing UE procedure for UE-to-network relay discovery initiation

The UE is authorised to perform the announcing UE procedure for UE-to-network relay discovery if:

- a) the UE is authorised to act as a UE-to-network relay in the PLMN or the subscribed SNPN indicated by the serving cell as specified in clause 5.2.5, and
 - 1) the UE is served by NG-RAN and the UE is authorised to perform 5G ProSe direct discovery in the PLMN or the subscribed SNPN as specified in clause 5; or

- 2) the UE is authorised to perform 5G ProSe direct discovery when not served by NG-RAN as specified in clause 5 and intends to use the provisioned radio resources for UE-to-network relay discovery;
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be announced as specified in clause 5.2.5 and the indicated security procedure for the relay service code is supported by the UE. For 5G ProSe layer-3 UE-to-network relay UE,
 - i) the S-NSSAI associated with that relay service code shall belong to the allowed NSSAI of the UE; and
 - ii) if the UE is camped on a cell whose TAI is in the list of "non-allowed tracking areas" or is camped on a cell whose TAI is not in the list of "allowed tracking areas", then the relay service code shall be associated with high priority access as defined in clause 5.3.5 of 3GPP TS 24.501 [11]; and
 - 2) the User info ID for the UE-to-network relay discovery parameter as specified in clause 5.2.5;
- c) for 5G ProSe layer-3 UE-to-network relay UE, the UE is configured with PDU Session parameters which is used for relayed traffic for the associated relay service code, as specified in clause 5.2.5; and
- d) the back-off timer T3346 used for NAS mobility management congestion control as specified in clause 5.3.9 of 3GPP TS 24.501 [11] is not running at the UE;

otherwise, the UE is not authorised to perform the announcing UE procedure for UE-to-network relay discovery.

Figure 8.2.1.2.2.2.1 illustrates the interaction of the UEs in the announcing UE procedure for UE-to-network relay discovery.

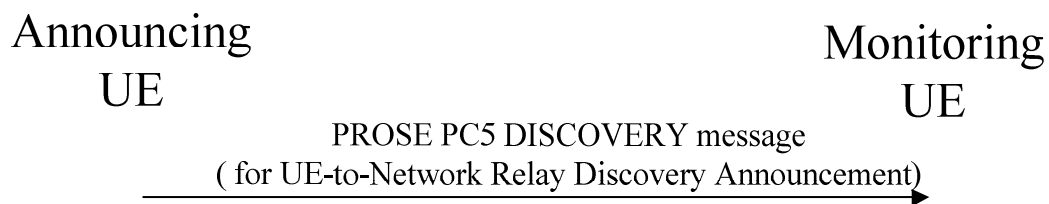


Figure 8.2.1.2.2.2.1: Announcing UE procedure for UE-to-network relay discovery

When the UE is triggered by an upper layer application to announce availability of a connectivity service provided by a UE-to-network relay, if the UE is authorised to perform the announcing UE procedure for UE-to-network relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages for relay discovery as specified in 3GPP TS 38.331 [13], shall perform a service request procedure or mobility registration procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time as specified in clause 11.2.5;
- c) shall generate a PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement according to clause 10.2.1. In the PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement, the UE:
 - 1) shall set the announcer info parameter to the User info ID configured for the UE-to-network relay discovery, as specified in clause 5.2.5;
 - 2) shall set the relay service code parameter to the relay service code configured for the connectivity service to be announced, as specified in clause 5.2.5. The relay service code parameter is set to relay service code specific for emergency service if the UE is triggered by an upper layer application to announce availability of an emergency connectivity service provided by a UE-to-network relay, and either of the following:
 - i) for 5G ProSe layer-2 UE-to-network relay UE, the UE received an indication from the lower layers that the cell supports IMS emergency bearer services for UEs in limited service mode as specified in 3GPP TS 38.331 [13]; or

- ii) for 5G ProSe layer-3 UE-to-network relay UE, the EMC bit in the 5GS network feature support IE of the REGISTRATION ACCEPT message is not set to "Emergency services not supported" as specified in 3GPP TS 24.501 [11] and the UE is neither using its own emergency service nor relaying the emergency services from one 5G ProSe layer-3 remote UE;
- 3) shall include the MIC field computed as described in 3GPP TS 33.503 [34], by using the UTC-based counter and the DUK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe UE-to-network relay is used;
- 4) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
- 5) shall set the Resource Status Indicator bit of the status indicator parameter to indicate whether or not the UE has resources available to provide a connectivity service for additional ProSe-enabled UEs;
- 6) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.8;
- 7) if acting as 5G ProSe layer-2 UE-to-network relay UE, shall set the NCGI parameter to the NCGI of its serving cell;
- 8) if acting as 5G ProSe layer-2 UE-to-network relay UE, shall set the RRC container to the RRC container if provided by the lower layers; and
- 9) shall include the PLMN ID set to its HPLMN ID and in cleartext;

NOTE 0: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 1: In case of SNPN, the HPLMN ID includes the PLMN ID of the subscribed SNPN.

- d) shall apply the DUK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
 - e) shall set the destination layer-2 ID to the default destination layer-2 ID as specified in clause 5.2.5 and self-assign a source layer-2 ID for sending the UE-to-network relay discovery announcement; and
- NOTE 1A: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.2.2, clause 6.2.15.2.2.2 and clause 8.2.1.3.1.2.
- f) shall pass the resulting PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement to the lower layers for transmission over the PC5 interface with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery.

The UE shall maintain the association(s) between the self-assigned source layer-2 ID and relay service code once generating the PROSE PC5 DISCOVERY message. Each self-assigned source layer-2 ID can be associated with only one relay service code.

The UE shall ensure that it keeps on passing the same PROSE PC5 DISCOVERY message along with the same source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission until the UE is triggered by an upper layer application to stop announcing availability of a connectivity service provided by a UE-to-network relay, or until the UE stops being authorised to perform the announcing UE procedure for UE-to-network relay discovery. How this is achieved is left up to UE implementation.

NOTE 2: The announcing UE can stop announcing UE procedure for UE-to-network relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

8.2.1.2.2.3 Announcing UE procedure for UE-to-network relay discovery completion

When the announcing UE is triggered by an upper layer application to stop announcing availability in a discovery group, or when the announcing UE stops being authorised to perform the announcing UE procedure for UE-to-network relay discovery, the UE shall instruct the lower layers to stop announcing.

NOTE: The announcing UE can stop announcing UE procedure for UE-to-network relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops announcing, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8.2.1.2.3 Monitoring UE relay discovery for UE-to-network relay discovery

8.2.1.2.3.1 General

The purpose of the monitoring UE procedure for UE-to-network relay discovery is:

- a) to enable a ProSe-enabled UE to become aware of proximity of a connectivity service provided by a UE-to-network relay, upon a request from upper layers as defined in 3GPP TS 23.304 [2]; or
- b) to enable a ProSe-enabled UE to perform measurements of signal strength of PROSE PC5 DISCOVERY messages from 5G ProSe UE-to-network relay UE(s) for relay selection/reselection.

8.2.1.2.3.2 Monitoring UE procedure for UE-to-network relay discovery initiation

The UE is authorised to perform the monitoring UE procedure for UE-to-network relay discovery if:

- a) the following is true:
 - 1) the UE is not served by NG-RAN, is authorised to perform 5G ProSe direct discovery using monitoring when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;
 - 2) the UE is served by NG-RAN and is authorised to perform 5G ProSe direct discovery monitoring in at least one PLMN or the subscribed SNPN; or
 - 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to perform 5G ProSe direct discovery using monitoring when the UE is not served by NG-RAN, and:
 - A) configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;
 - b) the UE is configured with the relay service code parameter identifying the connectivity service to be monitored, as specified in clause 5.2.5 and the indicated security procedure for the relay service code is supported by the UE; and
 - c) for 5G ProSe layer-2 remote UE, the UE is camped on a cell whose TAI is not in the list of "non-allowed tracking areas" or is camped on a cell whose TAI is in the list of "allowed tracking areas",

otherwise, the UE is not authorised to perform the monitoring UE procedure for UE-to-network relay discovery.

Figure 8.2.1.2.3.2.1 illustrates the interaction of the UEs in the monitoring UE procedure for UE-to-network relay discovery.



Figure 8.2.1.2.3.2.1: Monitoring UE procedure for UE-to-network relay discovery

When the UE is triggered by the upper layers to monitor proximity of a connectivity service provided by a UE-to-network relay or when the UE decides to perform 5G ProSe UE-to-network relay reselection as specified in clause 8.2.3, and if the UE is authorised to perform the monitoring UE procedure for UE-to-network relay discovery, then the UE shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages with the default destination layer-2 ID as specified in clause 5.2.5.

If the traffic descriptor is configured as specified in clause 5.2.5, the 5G ProSe layer-3 remote UE shall determine the monitored RSC by mapping the traffic from the upper layer application with the traffic descriptor as follows:

- a) if there are at least one ProSe application traffic descriptor(s) to be used for the relayed traffic as specified in clause 5.2.5 which has not yet been evaluated,
 - 1) if the ProSe application traffic descriptor matches upper layer application information;

the UE shall select the RSC associated with the matched ProSe application traffic descriptor for monitoring, where:

 - i) if more than one RSCs are associated with the upper layer application information and the monitored RSC for the 5G ProSe layer-3 remote UE is specific for emergency, the UE should prioritize selecting an RSC that does not provide an indication of using N3IWF access for the relayed traffic; or
 - ii) otherwise, it is up to UE implementation which RSC to select in this release of specification;
 - 2) else, the UE shall select the next ProSe application traffic descriptor which has not yet been evaluated and proceed to step 1);
- b) else, it is up to UE implementation which RSC to select, where if the monitored RSC for the 5G ProSe layer-3 remote UE is specific for emergency, the UE should prioritize selecting an RSC that does not provide an indication of using N3IWF access for the relayed traffic.

NOTE 1: Selection of relay service code is up to UE implementation if there is no ProSe application traffic descriptor(s) configured in the UE.

Upon reception of a PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement according to clause 10.2.1, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to monitor, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to monitor, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used) and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUSK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used), the UE shall use the DUSK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used), the UE shall use the DUK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement.

NOTE 2: The use of an erroneous UTC-based counter for processing received PROSE PC5 DISCOVERY messages at the ProSe-enabled UE can cause MIC check failure after DUIK is used for integrity check and malformed contents after DUSK is used for unscrambling or DUCK is used for deciphering. How a ProSe-enabled UE ensures the accuracy of the UTC-based counter is left to UE implementation.

NOTE 3: The UE can determine the received PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement is for 5G ProSe direct discovery based on an indication from the lower layer.

Then if:

- a) the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement is the same as the relay service code parameter configured as specified in clause 5 for the connectivity service being monitored; and
- b) the target announcer info is not provided by upper layers for the connectivity service being monitored, or the announcer info parameter of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement is the same as the target announcer info if the target announcer info is provided by upper layers for the connectivity service being monitored,

then the UE shall consider that the connectivity service the UE seeks to monitor has been discovered. In addition, the UE can measure the signal strength of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement for relay selection or reselection.

8.2.1.2.3.3 Monitoring UE procedure for UE-to-network relay discovery completion

When the UE is triggered by an upper layer application to stop monitoring proximity of other UEs in a discovery group, or when the UE stops being authorised to perform the monitoring UE procedure for UE-to-network relay discovery, the UE shall instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8.2.1.2.4 Announcing UE procedure for relay discovery additional information

8.2.1.2.4.1 General

The purpose of the announcing UE procedure for relay discovery additional information is to announce to the 5G ProSe remote UEs additional information about:

- a) the NCGI of the cell serving the 5G ProSe layer-3 UE-to-network relay UE; and
- b) the TAI of the cell serving the 5G ProSe layer-3 UE-to-network relay UE; and
- c) the NID of the subscribed SNPN.

as defined in 3GPP TS 23.304 [2].

8.2.1.2.4.2 Announcing procedure for relay discovery additional information

The 5G ProSe UE-to-network relay UE announces the relay discovery additional information:

- a) if the 5G ProSe remote UE requests the 5G ProSe UE-to-network relay UE to announce the NG-RAN Cell Global ID (NCGI) or TAI of the cell serving the 5G ProSe UE-to-network relay UE and optionally the NID of the SNPN in case the serving cell is operated by an SNPN and as a response the 5G ProSe UE-to-network relay UE acknowledges with the ProSe additional parameters announcement response message, then the 5G ProSe UE-to-network relay UE includes the NCGI or TAI of the serving cell and optionally the NID of the SNPN in the PROSE PC5 DISCOVERY message for relay discovery additional information until the timer T5107 expires (see clause 8.2.8).

NOTE 1: 5G ProSe UE-to-network relay UE announces the relay discovery additional information only when it is in NG-RAN coverage.

Figure 8.2.1.2.4.2.1 illustrates the interaction of the 5G ProSe UE-to-network relay UE and the 5G ProSe remote UE in the announcing UE procedure for relay discovery additional information.

5G ProSe UE-to-network relay UE

5G ProSe remote UE

PROSE PC5 DISCOVERY message
for relay discovery additional information



Figure 8.2.1.2.4.2.1: Announcing procedure for relay discovery additional information

The 5G ProSe UE-to-network relay UE may start announcing relay discovery additional information if:

- a) the 5G ProSe UE-to-network relay UE is currently authorised to perform 5G ProSe direct discovery Model A announcing in the serving PLMN or its subscribed SNPN if the UE is served by NG-RAN, and
 - 1) additional parameters announcement for the serving cell of the 5G ProSe UE-to-network relay UE has been requested and responded to 5G ProSe remote UEs, the timer T5107 has not expired (periodic reporting);
 - 2) additional parameters announcement for the serving cell of the 5G ProSe UE-to-network relay UE has been requested and responded to 5G ProSe remote UEs, the timer T5107 has not expired and the 5G ProSe UE-to-network relay UE detects camping on a new serving cell; or
 - 3) additional parameters announcement for the serving cell of the 5G ProSe UE-to-network relay UE has been requested and responded to 5G ProSe remote UEs, the timer T5107 has not expired and the 5G ProSe UE-to-network relay UE detects entering a new tracking area.

When the 5G ProSe UE-to-network relay UE has some additional information to broadcast (i.e., NCGI, TAI, NID), then the 5G ProSe UE-to-network relay UE:

- a) shall request the parameters from the lower layers for ProSe direct discovery announcing (see 3GPP TS 38.331 [13]). If the 5G ProSe UE-to-network relay UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], the 5G ProSe UE-to-network relay UE shall perform a service request procedure or mobility registration procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time as specified in clause 11.2.5;
- c) shall generate PROSE PC5 DISCOVERY message(s) for relay discovery additional information according to clause 10.2.1. In the PROSE PC5 DISCOVERY message for relay discovery additional information, the 5G ProSe UE-to-network relay UE:
 - 1) shall include the relay service code used for 5G ProSe direct communication which the 5G ProSe remote UE used to request for the relay discovery additional information;
 - 2) shall set the announcer info parameter to the User info ID parameter, configured in clause 5.2.5;
 - 3) shall set the NCGI parameter to the NCGI of the cell serving the UE, if the UE acts as 5G ProSe layer-3 UE-to-network relay UE and the NCGI is to be announced;
 - 4) shall set the Relay TAI parameter to the TAI of the cell serving the UE, if the UE acts as 5G ProSe layer-3 UE-to-network relay UE and the TAI is to be announced;
 - 5) shall include the MIC field computed as described in 3GPP TS 33.503 [34], by using the UTC-based counter and the DUIK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe UE-to-network relay is used;
 - 6) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;

- 7) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.11;
- 8) shall include the PLMN ID set to its HPLMN ID and in cleartext; and

NOTE 1A: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 1B: In case of SNPN, the HPLMN ID includes the PLMN ID of the subscribed SNPN.

- 9) for SNPN, if NCGI, Relay TAI or both is included, shall include the NID of the subscribed SNPN;
- d) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the default destination layer-2 ID as specified in clause 5.2.5 to the destination layer-2 ID and self-assign a source layer-2 ID for sending the UE-to-network relay discovery announcement; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.2.2, clause 6.2.15.2.2.2 and clause 8.2.1.3.1.2.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for relay discovery additional information along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

The 5G ProSe UE-to-network relay UE shall ensure that it keeps on passing the PROSE PC5 DISCOVERY messages periodically to the lower layers for transmission until the corresponding timer (i.e., timer T5107 when the additional information is NCGI or TAI) expires. How this is achieved is left up to UE implementation.

NOTE 3: The announcing UE can stop announcing UE procedure for relay discovery additional information for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

NOTE 4: The periodicity of sending the PROSE PC5 DISCOVERY messages for relay discovery additional information by the 5G ProSe UE-to-network relay UE is implementation specific and is normally lower than the one related to the additional parameters announcement request refresh timer T5106.

During the announcing operation, if one of the above conditions is no longer met, the 5G ProSe UE-to-network relay UE may instruct the lower layers to stop announcing.

8.2.1.2.5 Monitoring UE procedure for relay discovery additional information

8.2.1.2.5.1 General

The purpose of the monitoring UE procedure for relay discovery additional information is to enable a 5G ProSe remote UE to become aware of the additional information of the 5G ProSe UE-to-network relay UE as described in clause 8.2.1.2.4.1.

8.2.1.2.5.2 Monitoring procedure for relay discovery additional information

The 5G ProSe remote UE monitors relay discovery additional information:

- a) until the additional parameters announcement request refresh timer T5106 expires if the 5G ProSe remote UE has requested the 5G ProSe UE-to-network relay UE to announce the NCGI or TAI of the cell serving the 5G ProSe UE-to-network relay UE and received the ProSe additional parameters announcement response message from the 5G ProSe UE-to-network relay UE.

The UE may instruct the lower layers to start monitoring if:

- a) a request from upper layers to monitor for relay discovery additional information is still in place and either:
- 1) the UE is currently authorised to perform 5G ProSe direct discovery Model A monitoring in at least one PLMN or the subscribed SNPN if the UE is served by NG-RAN;
 - 2) the UE is currently authorised to perform 5G ProSe direct discovery Model A monitoring if the UE is not served by NG-RAN; or
 - 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 36.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed " as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to perform 5G ProSe direct discovery Model A monitoring when the UE is not served by NG-RAN and configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN.

If the UE is in 5GMM-CONNECTED mode, the monitoring UE shall also trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

During the monitoring operation, if one of the above conditions is no longer met, the UE may instruct the lower layers to stop monitoring. When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

Upon reception of a PROSE PC5 DISCOVERY message for relay discovery additional information according to clause 10.2.1, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to monitor, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code to be monitored, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used) and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used), the UE shall use the DUK and UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for relay discovery additional information.

NOTE 1: The use of an erroneous UTC-based counter for processing received PROSE PC5 DISCOVERY messages at the ProSe-enabled UE can cause MIC check failure after DUK is used for integrity check and malformed contents after DUSK is used for unscrambling or DUCK is used for deciphering. How a ProSe-enabled UE ensures the accuracy of the UTC-based counter is left to UE implementation.

NOTE 2: The UE can determine the received PROSE PC5 DISCOVERY message for relay discovery additional information is for 5G ProSe direct discovery based on an indication from the lower layer.

Then, if:

- a) the relay service code parameter of the PROSE PC5 DISCOVERY message for relay discovery additional information is the same as the relay service code parameter configured as specified in clause 5.2.5 for the connectivity service being monitored; and
- b) the announcer info parameter of the PROSE PC5 DISCOVERY message for relay discovery additional information is the same as the target announcer info if the target announcer info is provided by upper layers or same as the User info ID of the 5G ProSe UE-to-network relay UE to which the 5G ProSe additional parameters announcement was requested and acknowledged as specified in clause 8.2.8,

then the UE shall consider that the relay discovery additional information it intends to monitor has been discovered. In addition, the UE can measure the signal strength of the PROSE PC5 DISCOVERY message for relay discovery additional information for relay selection or reselection.

8.2.1.3 UE-to-network relay discovery over PC5 interface with model B

8.2.1.3.1 Discoverer UE procedure for UE-to-network Relay discovery

8.2.1.3.1.1 General

The purpose of the discoverer UE procedure for UE-to-network Relay discovery is:

- a) to enable a ProSe-enabled UE to solicit proximity of a connectivity service provided by a UE-to-network Relay, upon a request from upper layers; or
- b) to enable a ProSe-enabled UE to measure the PROSE PC5 DISCOVERY message signal strength between the ProSe-enabled UE and the 5G ProSe UE-to-network Relay UE(s) for relay selection/reselection.

In this procedure, the UE sending the PROSE PC5 DISCOVERY message is called the "discoverer UE" and the other UE is called the "discoveree UE".

8.2.1.3.1.2 Discoverer UE procedure for UE-to-network relay discovery initiation

The UE is authorised to perform the discoverer UE procedure for UE-to-network relay discovery if:

- a) one of the following is true:
 - 1) the UE is not served by NG-RAN, is authorised to act as a 5G ProSe remote UE towards a 5G ProSe UE-to-network relay UE and is configured with the radio parameters to be used for ProSe UE-to-network relay discovery when not served by NG-RAN;
 - 2) the UE is served by NG-RAN, is authorised to act as a 5G ProSe remote UE towards a 5G ProSe UE-to-network relay UE; or
 - 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to act as a 5G ProSe remote UE towards a 5G ProSe UE-to-network relay UE when the UE is not served by NG-RAN and configured with the radio parameters to be used for ProSe UE-to-network relay discovery use when not served by NG-RAN;
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be solicited and the indicated security procedure for the relay service code is supported by the UE; and
 - 2) the User info ID for the UE-to-network relay discovery parameter, as specified in clause 5.2.5; and
- c) for 5G ProSe layer-2 remote UE, the UE is camped on a cell whose TAI is not in the list of "non-allowed tracking areas" or is camped on a cell whose TAI is in the list of "allowed tracking areas",

otherwise, the UE is not authorised to perform the discoverer UE procedure for UE-to-network relay discovery.

Figure 8.2.1.3.1.2.1 illustrates the interaction of the UEs in the discoverer UE procedure for UE-to-network relay discovery.

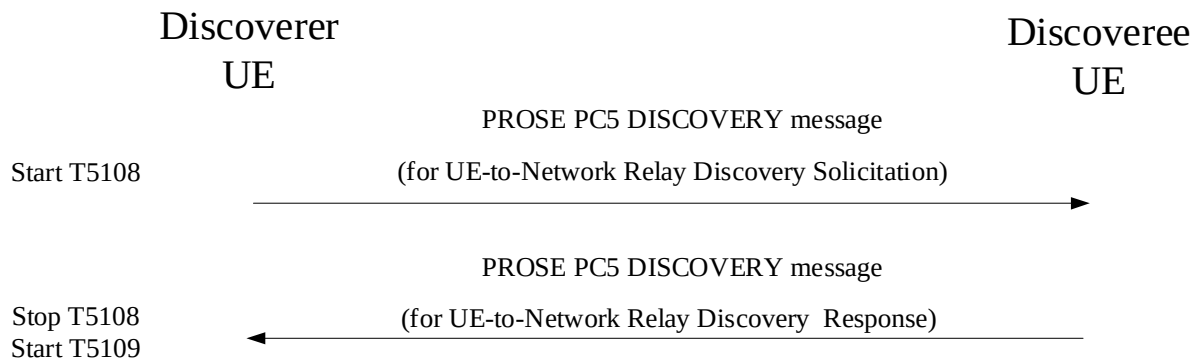


Figure 8.2.1.3.1.2.1: Discoverer UE procedure for UE-to-network Relay discovery

For PROSE PC5 DISCOVERY message signal strength measurement, the UE manages a periodic measurement timer T5109, which is used to trigger the periodic PROSE PC5 DISCOVERY message signal strength measurement between the UE and the ProSe UE-to-network relay UE with which the UE has a link established. It is started whenever the UE has established a direct link with a 5G ProSe UE-to-network relay UE and restarted whenever the UE receives the PROSE PC5 DISCOVERY message for UE-to-network relay discovery response from the 5G ProSe UE-to-network relay UE with which the UE has a link established.

When the UE is triggered by the upper layers to solicit proximity of a connectivity service provided by a 5G ProSe UE-to-network relay UE, or when the periodic measurement timer T5109 expires and if the UE is authorised to perform the discoverer UE procedure for UE-to-network relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages for relay discovery as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- c) shall generate a PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation. In the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation, the UE:

NOTE 0: If the UE has received more than one set of the <security-parameters-for-remote-UE> each associated with different PLMN ID in the PROSE_SECURITY_PARAM_RESPONSE message or the PROSE_SECURITY_MATERIAL_RESPONSE message, the UE can generate multiple PROSE PC5 DISCOVERY messages for UE-to-network relay discovery solicitation, where each message considers the parameters of one set of <security-parameters-for-remote-UE> to form that message.

- 1) shall set the discoverer info parameter to the configured User info ID for the UE-to-network relay discovery parameter, as specified in clause 5.2.5;
- 2) shall set the relay service code parameter to the relay service code parameter identifying the connectivity service to be solicited, configured in clause 5.2.5. For the 5G ProSe layer-3 remote UE, if the traffic descriptor is configured as specified in clause 5.2.5, the UE shall determine the RSC as follows:
 - i) if there are at least one ProSe application traffic descriptor(s) to be used for the relayed traffic as specified in clause 5.2.5 which has not yet been evaluated,
 - A) if the ProSe application traffic descriptor matches the upper layer application information;

the UE shall select the RSC associated with the matched ProSe application traffic descriptor for solicitation, where:

 - aa) if more than one RSCs are associated with the upper layer application information and the needed RSC for the 5G ProSe layer-3 remote UE is specific for emergency, the UE should prioritize selecting an RSC that does not provide an indication of using N3IWF access for the relayed traffic; or

- bb) otherwise, it is up to UE implementation which RSC to select in this release of specification;
- B) else, the UE shall select the next ProSe application traffic descriptor which has not yet been evaluated and proceed to step A);
- ii) else, it is up to UE implementation which RSC to select, where if the needed RSC for the 5G ProSe layer-3 remote UE is specific for emergency, the UE should prioritize selecting an RSC that does not provide an indication of using N3IWF access for the relayed traffic.

NOTE 1: Selection of relay service code is up to UE implementation if there is no ProSe application traffic descriptor(s) configured in the UE.

- 3) shall include the MIC field computed as described in 3GPP TS 33.503 [34] by using the UTC-based counter and the DUK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe UE-to-network relay is used;
- 4) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
- 5) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.9; and
- 6) may include the target discoveree info parameter set to the user info ID of the targeted discoveree user if the target discoveree info is provided by the application layer;
- d) shall apply the DUK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the default destination layer-2 ID as specified in clause 5.2.5 to the destination layer-2 ID and self-assign a source layer-2 ID for sending the UE-to-network relay discovery solicitation message; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.1.2, clause 6.2.15.2.1.2, clause 8.2.1.2.2.2 and clause 8.2.1.2.4.2.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

If the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation is used to solicit proximity of a connectivity service provided by a 5G ProSe UE-to-network relay UE, the UE shall ensure that it keeps on passing the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation for transmission until the UE is triggered by an upper layer application to stop soliciting proximity of a connectivity service provided by a 5G ProSe UE-to-network relay UE, or until the UE stops being authorised to perform the discoverer UE procedure for UE-to-network relay discovery. How this is achieved is left up to UE implementation.

NOTE 3: The discoverer UE can stop discoverer UE procedure for UE-to-network relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

If the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation is used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe UE-to-network Relay UE with which the UE has a link established, the UE shall start the retransmission timer T5108. If retransmission timer T5108 expires, the UE shall retransmit the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation and restart timer T5108. If no response is received from the ProSe UE-to-network relay UE with which the UE has a link established after reaching the maximum number of allowed retransmissions, the UE shall trigger relay reselection procedure.

NOTE 4: The maximum number of allowed retransmissions is UE implementation specific.

Upon reception of a PROSE PC5 DISCOVERY message for UE-to-network relay discovery response along with the destination layer-2 ID which the UE is configured to respond for, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to monitor, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to discover, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used) and the UTC-based counter obtained during the reception operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used), the UE shall use the DUK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for UE-to-network relay discovery response.

NOTE 5: The UE can determine the received PROSE PC5 DISCOVERY message for UE-to-network relay discovery response is for 5G ProSe direct discovery based on an indication from the lower layer.

Then if:

- a) the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery response is the same as the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation; and
- b) the target discoveree info is not provided by upper layers for the connectivity service being solicited, or the discoveree info parameter of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery response is the same as the target discoveree info if the target discoveree info is provided by upper layers for the connectivity service being solicited,

then the UE shall consider that the connectivity service the UE seeks to discover has been discovered. In addition, the UE can measure the signal strength of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery response for relay selection or reselection. If the UE has received the PROSE PC5 DISCOVERY message for UE-to-network relay discovery response from the ProSe UE-to-network Relay UE with which the UE has a link established, the UE shall stop the retransmission timer T5108 and start the periodic measurement timer T5109.

8.2.1.3.1.3 Discoverer UE procedure for UE-to-network Relay discovery completion

When the UE is triggered by an upper layer application to stop soliciting for proximity of a connectivity service provided by a UE-to-network Relay, or when the UE stops being authorised to perform the Discoverer UE procedure for UE-to-network Relay discovery, the UE shall instruct the lower layers to stop the discoverer operation.

NOTE: The discoverer UE can stop discoverer UE procedure for UE-to-network relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops discoverer operation, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8.2.1.3.2 Discoveree UE procedure for UE-to-network Relay discovery

8.2.1.3.2.1 General

The purpose of the discoveree UE procedure for UE-to-network relay discovery is to enable a ProSe-enabled UE with a UE-to-network Relay to respond to solicitation from other ProSe-enabled UEs on proximity of a connectivity service provided by the 5G ProSe UE-to-network relay UE, upon a request from upper layers.

In this procedure, the UE sending the PROSE PC5 DISCOVERY message is called the "discoverer UE" and the other UE is called the "discoveree UE".

8.2.1.3.2.2 Discoveree UE procedure for UE-to-network relay discovery initiation

The UE is authorised to perform the discoveree UE procedure for UE-to-network relay discovery if:

- a) the UE is authorised to act as a 5G ProSe UE-to-network relay UE in the PLMN or the subscribed SNPN indicated by the serving cell, and
 - 1) the UE is served by NG-RAN; or
 - 2) the UE is not served by NG-RAN and intends to use the provisioned radio resources for UE-to-network relay discovery;
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be responded to as specified in clause 5.2.5 and the indicated security procedure for the relay service code is supported by the UE. For 5G ProSe layer-3 UE-to-network relay UE,
 - i) the S-NSSAI associated with that relay service code shall belong to the allowed NSSAI of the UE; and
 - ii) if the UE is camped on a cell whose TAI is in the list of "non-allowed tracking areas" or is camped on a cell whose TAI is not in the list of "allowed tracking areas", then the relay service code shall be associated with high priority access as defined in clause 5.3.5 of 3GPP TS 24.501 [11]; and
 - 2) the User info ID for the UE-to-network relay discovery parameter, as specified in clause 5.2.5; and
- c) the back-off timer T3346 used for NAS mobility management congestion control as specified in clause 5.3.9 of 3GPP TS 24.501 [11] is not running at the UE;

otherwise, the UE is not authorised to perform the discoveree UE procedure for UE-to-network relay discovery.

Figure 8.2.1.3.2.2.1 illustrates the interaction of the UEs in the discoveree UE procedure for UE-to-network relay discovery.

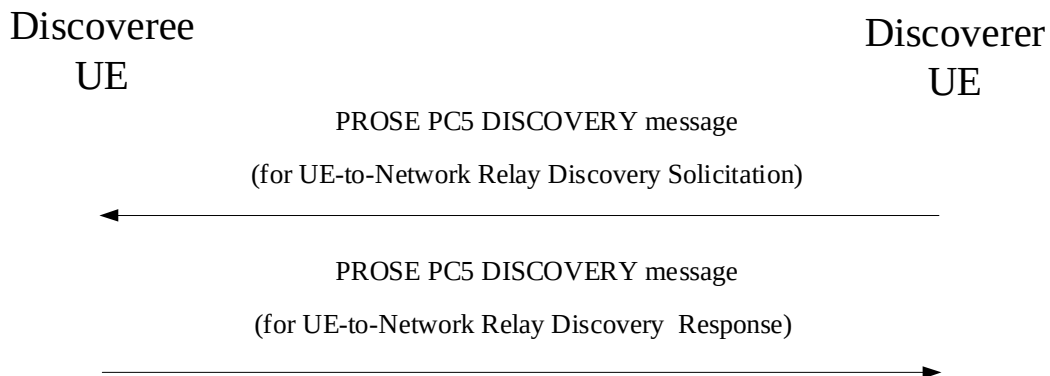


Figure 8.2.1.3.2.2.1: Discoveree UE procedure for UE-to-network Relay discovery

When the UE is triggered by an upper layer application to start responding to solicitation on proximity of a connectivity service provided by the UE-to-network Relay and if the UE is authorised to perform the discoveree UE procedure for UE-to-network Relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11]; and
- b) shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages.

Upon reception of a PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation, for the relay service code of the connectivity service which the UE is authorized to respond, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used) and the UTC-based counter obtained during the reception operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-network relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G DDNMF or 5G PKMF (if security procedure over

user plane for 5G ProSe UE-to-network relay is used), the UE shall use the DUIK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation.

NOTE 1: The UE can determine the received PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation is for 5G ProSe direct discovery based on an indication from the lower layer.

Then, if:

- a) the relay service code parameter of the received PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation is the same as the relay service code parameter configured as specified in clause 5.2.5 for the connectivity service; and
- b) the target discoveree info parameter of the received PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation is the same as the user info ID for the UE-to-network relay discovery provided by upper layers or same as the configured user info ID for the UE-to-network relay discovery as specified in clause 5.2.5, if the target discoveree info parameter is included in the received PROSE PC5 DISCOVERY message;

then the UE:

- a) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- b) shall generate a PROSE PC5 DISCOVERY message for UE-to-network relay discovery response. In the PROSE PC5 DISCOVERY message for UE-to-network relay discovery response, the UE:
 - 1) shall set the Discoveree info parameter to the configured User info ID for the UE-to-network Relay discovery parameter, as specified in clause 5.2.5;
 - 2) shall set the relay service code parameter to the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation. The relay service code parameter is set to relay service code specific for emergency service if the UE is triggered by an upper layer application to announce availability of an emergency connectivity service provided by a UE-to-network relay, and either of the following:
 - i) for 5G ProSe layer-2 UE-to-network relay UE, the UE received an indication from the lower layers that the cell supports IMS emergency bearer services for UEs in limited service mode as specified in 3GPP TS 38.331 [13]; or
 - ii) for 5G ProSe layer-3 UE-to-network relay UE, the EMC bit in the 5GS network feature support IE of the REGISTRATION ACCEPT message is not set to "Emergency services not supported" as specified in 3GPP TS 24.501 [11] and the UE is neither using its own emergency service nor relaying the emergency services from one 5G ProSe layer-3 remote UE;
 - 3) shall set the Resource Status Indicator bit of the status indicator parameter to indicate whether or not the UE has resources available to provide a connectivity service for additional ProSe-enabled UEs;
 - 4) shall include the MIC field computed as described in 3GPP TS 33.503 [34] by using the UTC-based counter and the DUIK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe UE-to-network relay is used;
 - 5) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 6) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.10;
 - 7) if acting as 5G ProSe layer-2 UE-to-network relay UE, shall set the NCGI parameter to the NCGI of its serving cell;
 - 8) if acting as 5G ProSe layer-2 UE-to-network relay UE, shall set the RRC container to the RRC container if provided by the lower layers; and
 - 9) shall include the PLMN ID set to its HPLMN ID and in cleartext;

NOTE 1A: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 1B: In case of SNPN, the HPLMN ID includes the PLMN ID of the subscribed SNPN.

- c) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- d) shall set the destination layer-2 ID to the source layer-2 ID from the discoverer UE used in the transportation of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation and self-assign a source layer-2 ID for sending the UE-to-network relay discovery response message; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

- e) shall pass the resulting PROSE PC5 DISCOVERY message for UE-to-network relay discovery response along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

The UE shall maintain the association(s) between the self-assigned source layer-2 ID and relay service code once generating the PROSE PC5 DISCOVERY message. Each self-assigned source layer-2 ID can be associated with only one relay service code.

NOTE 3: If the UE is processing a PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the same source layer-2 ID of the received PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation, it depends on UE implementation to avoid the conflict of destination layer-2 ID (e.g. send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #3 "conflict of layer-2 ID for unicast communication is detected", or ignore the PROSE DIRECT DISCOVERY message for UE-to-network relay discovery solicitation).

8.2.1.3.2.3 Discoverer UE procedure for UE-to-network relay discovery completion

When the UE is triggered by an upper layer application to stop responding to solicitation on proximity of a connectivity service provided by a 5G ProSe UE-to-network relay UE, or when the UE stops being authorised to perform the discoverer UE procedure for UE-to-network relay discovery, the UE shall instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8.2.1.4 Procedure for UE to use provisioned radio resources for 5G ProSe UE-to-network discovery

When the UE is not served by NG-RAN for 5G ProSe UE-to-network relay discovery and is authorized to use 5G ProSe UE-to-network relay discovery, the UE shall select the corresponding radio parameters to be used for 5G ProSe UE-to-network relay discovery as follows:

- a) if the UE can determine itself located in a geographical area and the UE is provisioned with radio parameters for the geographical area, the UE shall select the radio parameters associated with that geographical area; or
- b) in all other cases, the UE shall not initiate 5G ProSe UE-to-network relay discovery.

If the UE intends to use "non-operator managed" radio parameters as specified in clause 5.2.5, the UE shall initiate 5G ProSe UE-to-network relay discovery with the selected radio parameters.

If the UE intends to use "operator managed" radio parameters as specified in clause 5.2.5, before initiating 5G ProSe UE-to-network relay discovery, the UE shall check with lower layers whether the selected radio parameters can be used in the current location without causing interference to other cells as specified in 3GPP TS 38.331 [13]; and:

- a) if the lower layers indicate that the usage would not cause any interference, the UE shall initiate 5G ProSe UE-to-network relay discovery; or

NOTE: If the lower layers find that there exists a cell operating the provisioned radio resources (i.e., carrier frequency) and the cell belongs to the registered PLMN or a PLMN equivalent to the registered PLMN, or for SNPN, to the RSNPN and the RSNPN is the subscribed SNPN, and the UE is authorized for 5G ProSe UE-to-network relay discovery in this PLMN or the subscribed SNPN, the UE can use the radio parameters indicated by the cell as specified in 3GPP TS 38.331 [13].

b) else if the lower layers report that one or more PLMNs or SNPNS operate in the provisioned radio resources (i.e., carrier frequency) then:

1) if the following conditions are met:

- i) none of the PLMNs reported by the lower layers is the registered PLMN or equivalent to the registered PLMN, or for SNPN none of the SNPNS reported by the lower layers is the RSNPN and the RSNPN is not the subscribed SNPN;
- ii) at least one of the PLMNs reported by the lower layers is in the list of authorized PLMNs for 5G ProSe UE-to-network relay discovery and provides radio resources for 5G ProSe UE-to-network relay discovery as specified in 3GPP TS 38.331 [13], or for SNPN one of the SNPNS reported by the lower layer is the subscribed SNPN and the UE is authorized to use 5G ProSe direct communication over PC5 interface in the subscribed SNPN; and

iii) the UE does not have an emergency PDU session;

then the UE shall:

- i) if in 5GMM-IDLE mode, perform PLMN selection triggered by 5G ProSe UE-to-network relay discovery, or SNPN selection triggered by ProSe direct discovery, as specified in 3GPP TS 23.122 [14]; or
- ii) else if in 5GMM-CONNECTED mode, either:
 - A) perform a De-registration procedure as specified in 3GPP TS 24.501 [11] and then perform PLMN selection triggered by 5G ProSe UE-to-network relay discovery, or SNPN selection triggered by ProSe direct discovery, as specified in 3GPP TS 23.122 [14]; or
 - B) not initiate 5G ProSe direct discovery.

Whether the UE performs i) or ii) above is left up to UE implementation; or

2) else the UE shall not initiate 5G ProSe UE-to-network relay discovery.

If the registration to the selected PLMN or the selected SNPN is successful, the UE shall proceed with the procedure to initiate 5G ProSe UE-to-network relay discovery as specified in clause 8.2.1.

If the UE is performing 5G ProSe UE-to-network relay discovery using radio parameters associated with a geographical area and moves out of that geographical area, the UE shall stop performing 5G ProSe UE-to-network relay discovery and then if the UE is not served by NG-RAN for 5G ProSe UE-to-network relay discovery, the UE shall select appropriate radio parameters for the new geographical area as specified above.

8.2.2 UE-to-network relay selection procedure

8.2.2.1 General

The purpose of the UE-to-network relay selection procedure is to enable a 5G ProSe remote UE to select a suitable 5G ProSe UE-to-network relay UE to obtain a connectivity service to 5GC.

8.2.2.2 UE-to-network relay selection procedure initiation

The 5G ProSe remote UE shall trigger the UE-to-network relay selection procedure if the following conditions are met:

- a) the UE is authorised to act as a 5G ProSe remote UE towards a 5G ProSe UE-to-network relay UE as specified in clause 5.2.5:

- 1) if the 5G ProSe remote UE is expected to use 5G ProSe layer-3 UE-to-network relay, the indication whether the UE is authorized to use a 5G ProSe layer-3 UE-to-network relay UE shall be set;
 - 2) if the 5G ProSe remote UE is expected to use 5G ProSe layer-2 UE-to-network relay, the subset of the PLMN(s) provided by the 5G ProSe layer-2 UE-to-network relay UE shall be in the list of PLMNs in which the UE is authorized to use a 5G ProSe layer-2 UE-to-network relay UE, or the SNPN provided by the 5G ProSe layer-2 UE-to-network relay UE shall be the subscribed SNPN in which the UE is authorized to use a 5G ProSe layer-2 UE-to-network relay UE; and
 - 3) if the 5G ProSe remote UE is expected to use 5G ProSe layer-2 UE-to-network relay, the 5G ProSe remote UE selected PLMN shall be in the list of PLMNs in which the UE is authorized to use a 5G ProSe layer-2 UE-to-network relay UE and in the subset of the PLMN(s) provided by the 5G ProSe layer-2 UE-to-network relay UE, or the 5G remote UE selected SNPN shall be the subscribed SNPN in which the UE is authorized to use a 5G ProSe layer-2 UE-to-network relay UE and provided by the 5G ProSe layer-2 UE-to-network relay UE;
- b) the UE has obtained a list of 5G ProSe UE-to-network relay UE candidate(s) fulfilling ProSe layer criteria with the monitoring procedure for UE-to-network relay discovery as specified in clause 8.2.1.2.3 or the discoverer procedure for UE-to-network relay discovery as specified in clause 8.2.1.3.1; and
- c) the UE has obtained a list of 5G ProSe UE-to-network relay UE candidate(s) fulfilling lower layers criteria as specified in 3GPP TS 38.331 [13].

NOTE: It is left to UE implementation on how UE handles the case when there is no appropriate 5G ProSe UE-to-network relay UE around.

8.2.2.3 UE-to-network relay selection procedure completion

If there exists only one 5G ProSe UE-to-network relay UE candidate satisfying the conditions in clause 8.2.2.2, then that 5G ProSe UE-to-network relay UE is selected. If there exist more than one 5G ProSe UE-to-network relay candidate satisfying the conditions in clause 8.2.2.2, any relay candidates not satisfying the non-radio related ProSe layer criteria shall be discarded and out of the remaining relay candidates, the relay candidate with the highest ranking of the lower layer criteria shall be selected. The UE may take the value of the resource status indicator bit of the status indicator parameter of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement or PROSE PC5 DISCOVERY message for UE-to-network relay discovery response into account when deciding which 5G ProSe UE-to-network relay to select. It is up to the UE implementation whether the ProSe layer or the lower layers takes the final selection on which 5G ProSe UE-to-network relay UE to select.

8.2.3 UE-to-network relay reselection procedure

8.2.3.1 General

The purpose of the UE-to-network relay reselection procedure is to enable a 5G ProSe remote UE to reselect a 5G ProSe UE-to-network relay UE to obtain a connectivity service to 5GC when the serving 5G ProSe UE-to-network relay UE is no longer suitable.

8.2.3.2 UE-to-network relay reselection procedure initiation

The 5G ProSe remote UE shall trigger the UE-to-network relay reselection procedure if one of the following conditions is met:

- a) the UE has received a lower layers indication that the serving 5G ProSe UE-to-network relay UE no longer fulfills the lower layers criteria as specified in 3GPP TS 38.331 [13];
- b) the parameters related to 5G ProSe UE-to-network relay in the configuration parameters for 5G ProSe UE-to-network relay as specified in clause 5.2.5 (e.g., relay service code, User info ID, etc.) have been updated and the serving 5G ProSe UE-to-network relay UE no longer fulfills the conditions specified in clause 8.2.2.2;
- c) the UE has received a PROSE DIRECT LINK ESTABLISHMENT REJECT message from the 5G ProSe UE-to-network relay UE with the PC5 signalling protocol cause value #1 "direct communication to the target UE not allowed";

- d) the UE has received a PROSE DIRECT LINK RELEASE REQUEST message from the 5G ProSe UE-to-network relay UE with the PC5 signalling protocol cause value #1 "direct communication to the target UE not allowed";
- e) the UE has received a PROSE DIRECT LINK RELEASE REQUEST message from the 5G ProSe UE-to-network relay UE with the PC5 signalling protocol cause value #4 "direct connection is not available anymore";
- f) the UE has not received any response from the 5G ProSe UE-to-network relay UE after M consecutive retransmissions of PROSE DIRECT LINK ESTABLISHMENT REQUEST or PROSE DIRECT LINK KEEPALIVE REQUEST messages;
- g) the UE has not received any response from the 5G ProSe UE-to-network relay UE after M consecutive retransmissions of PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe UE-to-network relay UE with which the UE has a link established;

NOTE 1: The value of M is implementation specific and is less than or equal to the maximum number of retransmissions allowed for PC5 signalling protocol.

- h) the UE has received a PROSE DIRECT LINK ESTABLISHMENT REJECT message from the ProSe UE-to-network relay UE with the PC5 signalling protocol cause value #13 "congestion situation";
- i) the UE has received a PROSE DIRECT LINK RELEASE REQUEST message from the ProSe UE-to-network relay UE with the PC5 signalling protocol cause value #13 "congestion situation"; or
- j) the UE has received a PROSE DIRECT LINK ESTABLISHMENT REJECT message from the 5G ProSe UE-to-network relay UE with the PC5 signalling protocol cause value #15 "security procedure failure of 5G ProSe UE-to-network relay".

In cases c), d), h) and i), the 5G ProSe remote UE shall exclude the 5G ProSe UE-to-network relay UE which sent the message specified in cases c), d), h) or i) from the UE-to-network relay reselection process described below (at least for the indicated back-off time period if provided from the ProSe UE-to-network relay UE in cases h) and i)).

In case j), when the 5G ProSe remote UE has included the UE identity IE set to SUCI in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, the 5G ProSe remote UE shall exclude the 5G ProSe UE-to-network relay UE which sent the message specified in case j) from the UE-to-network relay reselection process described below.

To conduct UE-to-network relay reselection process, the UE shall first initiate one of the following procedures or both depending on UE's configuration parameters for 5G ProSe UE-to-network relay as specified in clause 5.2.5:

- a) monitoring procedure for UE-to-network relay discovery as specified in clause 8.2.1.2.3; or
- b) discoverer procedure for UE-to-network relay discovery as specified in clause 8.2.1.3.1.

After the execution of the above discovery procedure(s), the 5G ProSe remote UE performs the UE-to-network relay selection procedure as specified in clause 8.2.2.

NOTE 2: It is left to UE implementation on how UE handles the case when there is no appropriate 5G ProSe UE-to-network relay UE around.

8.2.4 Procedure for UE to use provisioned radio resources for 5G ProSe UE-to-network relay communication

When the UE is not served by NG-RAN for 5G ProSe UE-to-network relay communication and is authorized to use 5G ProSe UE-to-network relay communication, the UE shall select the corresponding radio parameters to be used for 5G ProSe UE-to-network relay communication as follows:

- a) if the UE can determine itself located in a geographical area and the UE is provisioned with radio parameters for the geographical area, the UE shall select the radio parameters associated with that geographical area; or
- b) in all other cases, the UE shall not initiate 5G ProSe UE-to-network relay communication.

If the UE intends to use "non-operator managed" radio parameters as specified in clause 5.2.5, the UE shall initiate 5G ProSe UE-to-network relay communication with the selected radio parameters.

If the UE intends to use "operator managed" radio parameters as specified in clause 5.2.5, before initiating 5G ProSe UE-to-network relay communication, the UE shall check with lower layers whether the selected radio parameters can be used in the current location without causing interference to other cells as specified in 3GPP TS 38.331 [13]; and:

- a) if the lower layers indicate that the usage would not cause any interference, the UE shall initiate 5G ProSe UE-to-network relay communication; or

NOTE: If the lower layers find that there exists a cell operating the provisioned radio resources (i.e., carrier frequency) and the cell belongs to the registered PLMN or a PLMN equivalent to the registered PLMN, or for SNPN, to the RSNPN and the RSNPN is the subscribed SNPN, and the UE is authorized for 5G ProSe UE-to-network relay communication in this PLMN or this RSNPN, the UE can use the radio parameters indicated by the cell as specified in 3GPP TS 38.331 [13].

- b) else if the lower layers report that one or more PLMNs or SNPNs operate in the provisioned radio resources (i.e., carrier frequency) then:

- 1) if the following conditions are met:

- i) none of the PLMNs reported by the lower layers is the registered PLMN or equivalent to the registered PLMN, or for SNPN none of the SNPNs reported by the lower layers is the RSNPN and the RSNPN is not the subscribed SNPN;
- ii) at least one of the PLMNs reported by the lower layers is in the list of authorized PLMNs for 5G ProSe UE-to-network relay communication and provides radio resources for 5G ProSe UE-to-network communication as specified in 3GPP TS 38.331 [13], or for SNPN one of the SNPNs reported by the lower layer is the subscribed SNPN and the UE is authorized to use 5G ProSe direct communication over PC5 interface in the subscribed SNPN; and

- iii) the UE does not have an emergency PDU session;

then the UE shall:

- i) if in 5GMM-IDLE mode, perform PLMN selection or SNPN selection triggered by 5G ProSe UE-to-network discovery as specified in 3GPP TS 23.122 [14]; or
- ii) else if in 5GMM-CONNECTED mode, either:

- A) perform a De-registration procedure as specified in 3GPP TS 24.501 [11] and then perform PLMN selection or SNPN selection triggered by 5G ProSe UE-to-network discovery as specified in 3GPP TS 23.122 [14]; or

- B) not initiate 5G ProSe UE-to-network communication.

Whether the UE performs i) or ii) above is left up to UE implementation; or

- 2) else the UE shall not initiate 5G ProSe UE-to-network relay communication.

If the registration to the selected PLMN or the selected SNPN is successful, the UE shall proceed with the procedure to initiate 5G ProSe communication over PC5 as specified in clause 7.2.

If the UE is performing 5G ProSe UE-to-network relay communication using radio parameters associated with a geographical area and moves out of that geographical area, the UE shall stop performing 5G ProSe UE-to-network relay communication.

8.2.5 IP address allocation for 5G ProSe remote UE in 5G ProSe layer-3 UE-to-network relay procedure

When one of the two UEs on the direct link acts as a 5G ProSe layer-3 UE-to-network relay UE, the PDU session type is IPv4, IPv6 or IPv4v6 and is used for relaying IP traffic over PC5 reference point, the two UEs shall select the IP version (IPv4 or IPv6) to be used based on the following rules:

- a) if the 5G ProSe layer-3 UE-to-network relay UE has indicated "DHCPv4 Server" in the IP address configuration IE, the 5G ProSe remote UE shall initiate the IPv4 address configuration with DHCPv4 procedure acting as a DHCP client, according to IETF RFC 2131 [23] and IETF RFC 4039 [24];

- b) if the 5G ProSe layer-3 UE-to-network relay UE has indicated "IPv6 Router" in the IP address configuration IE, the 5G ProSe remote UE shall initiate the IPv6 address configuration with IPv6 stateless address auto-configuration acting as an IPv6 host based on IETF RFC 4862 [25];

NOTE 1: The 5G ProSe layer-3 UE-to-network relay UE uses IPv6 prefix delegation via DHCPv6 (see clause 8.2.5a) to obtain the IPv6 prefix assigned to the 5G ProSe layer-3 remote UE.

- c) if the 5G ProSe layer-3 UE-to-network relay UE has indicated "IPv6 Router" in the IP address configuration IE, the 5G ProSe remote UE may use stateless DHCPv6 for additional parameter configuration, as defined in TS 23.501 [22]; and
- d) if the 5G ProSe layer-3 UE-to-network relay UE has indicated "DHCPv4 Server & IPv6 Router" in the IP address configuration IE, the 5G ProSe remote UE shall choose the IP version and initiate the corresponding IP address configuration procedure as a client or host.

If the UE:

- a) is acting as a 5G ProSe layer-3 UE-to-network relay UE;
- b) the SSC mode of the PDU session is SSC mode 3; and
- c) receives a 5GSM cause value #39 "reactivation requested" as specified in clause 6.3.2.3 of 3GPP TS 24.501 [11],

the UE shall advertise the new IPv6 prefix to be used by the 5G ProSe remote UE as defined in RFC 4862 [25]. The two UEs shall select the IP version according to the rules above.

NOTE 2: If the UE receives a new IPv4 address, the UE does not need to update the IPv4 address of the 5G ProSe multi-hop layer-3 remote UE since the IPv4 address of the 5G ProSe multi-hop layer-3 remote UE will be NAT translated by the UE.

8.2.5a IPv6 prefix delegation via DHCPv6 for 5G ProSe layer-3 UE-to-network relay

If the 5G ProSe layer-3 UE-to-network relay UE can indicate "IPv6 Router" or "DHCPv4 Server & IPv6 Router" in the IP address configuration IE, the 5G ProSe layer-3 UE-to-network relay UE requests additional IPv6 prefixes (i.e., prefixes in addition to the /64 default prefix which was allocated via stateless IPv6 address autoconfiguration) from the SMF as specified in 3GPP TS 24.501 [11].

Once the 5G ProSe layer-3 UE-to-network relay UE successfully obtains the network prefix shorter than the default /64 prefix using DHCPv6, the 5G ProSe layer-3 UE-to-network relay UE can assign /64 prefix from the network prefix when the 5G ProSe layer-3 remote UE requests IPv6 prefix via stateless IPv6 address autoconfiguration.

8.2.6 QoS handling for 5G ProSe UE-to-network relay

8.2.6.1 General

This clause describes the QoS handling between a 5G ProSe UE-to-network relay UE and a 5G ProSe remote UE. The purpose of QoS handling for 5G ProSe UE-to-network relay is to meet the end-to-end QoS requirement between 5G ProSe remote UE and the network.

The QoS handling for 5G ProSe UE-to-network relay can be classified with the following three cases according to the type of 5G ProSe UE-to-network relay:

- a) QoS handling for 5G ProSe remote UE accessing the network via a 5G ProSe layer-2 UE-to-network relay;
- b) QoS handling for 5G ProSe remote UE accessing the network via a 5G ProSe layer-3 UE-to-network relay without N3IWF; and
- c) QoS handling for 5G ProSe remote UE accessing the network via a 5G ProSe layer-3 UE-to-network relay with N3IWF.

8.2.6.2 QoS handling for 5G ProSe layer-2 UE-to-network relay

For a 5G ProSe layer-2 remote UE accessing the network via a 5G ProSe layer-2 UE-to-network relay, the end-to-end QoS requirement between 5G ProSe layer-2 remote UE and the network can be met by the existing 5G QoS control between the 5G ProSe layer-2 remote UE and the core network that is serving the 5G ProSe layer-2 remote UE as specified in 3GPP TS 24.501 [11].

8.2.6.3 QoS handling for 5G ProSe layer-3 UE-to-network relay without N3IWF

8.2.6.3.1 General

The QoS handling by a 5G ProSe layer-3 UE-to-network relay without an N3IWF to achieve an end-to-end QoS between the 5G ProSe layer-3 remote UE and the network is described in clause 5.6.2.1 of 3GPP TS 23.304 [2].

For a 5G ProSe layer-3 remote UE accessing the network via a 5G ProSe layer-3 UE-to-network relay without N3IWF, the end-to-end QoS requirement between 5G ProSe layer-3 remote UE and the network can be satisfied by the corresponding QoS control:

- a) QoS control between 5G ProSe layer-3 remote UE and 5G ProSe layer-3 UE-to-network relay UE (PC5 QoS control); and
- b) QoS control between 5G ProSe layer-3 UE-to-network relay UE and the network (Uu QoS control).

To achieve this, the QoS mapping can be pre-configured as specified in clause 5.2.5 or provided to the 5G ProSe UE-to-network relay UE by the PCF using Prose Policy as specified in clause 5.3.2.

8.2.6.3.2 QoS flows handling initiated by the network

For QoS flows setup initiated by the network, upon reception QoS rules and QoS flow level QoS parameters from the SMF, the 5G ProSe layer-3 UE-to-network relay UE:

- a) shall determine the PQI based on the QoS mapping rules configured in clause 5.2.5;
- b) shall set the GFBR value for the PC5 GBR QoS flow to the GFBR value from the SMF, if any;
- c) shall set the MFBR value for the PC5 GBR QoS flow to the MFBR value from the SMF, if any;
- d) shall set the averaging window value for the PC5 GBR QoS flow to the averaging value from the SMF, if any;
- e) may derive the packet filter(s) used for PC5 QoS rule(s) from the packet filter(s) used over Uu reference; and
- f) may initiate the 5G ProSe direct link modification procedure(s) as defined in clause 7.2.3 to either update the existing PC5 QoS flow or to set up a new PC5 QoS flow. The 5G ProSe layer-3 UE-to-network relay UE may include the PC5 QoS rule(s) when initiating the 5G ProSe direct link modification procedure toward a 5G ProSe layer-3 remote UE for which the IP address associated to the 5G ProSe layer-3 remote UE is included in the packet filter(s) used over Uu.

Alternatively, for dynamic QoS handling of 5G ProSe layer-3 remote UE using reflective QoS mechanism, upon the 5G ProSe layer-3 UE-to-network relay UE receiving a downlink user data packet along with the Reflective QoS Indication (RQI) as specified in 3GPP TS 24.501 [11], the 5G ProSe layer-3 UE-to-network relay UE:

- a) creates a derived QoS rule by reflective QoS in the UE as specified in clause 6.2.5.1.4, 3GPP TS 24.501 [11];
- b) shall create a new derived PC5 QoS rule or update the existing derived PC5 QoS rule for the PC5 QoS flow based on the derived QoS rule from a);
- c) shall determine the corresponding PQI for the PC5 QoS flow based on the QoS mapping rules as specified in clause 5.2.5 and the 5QI value that corresponds to the QFI of the QoS rule from b); and
- d) shall perform one of the following:
 - 1) if there is a PC5 QoS flow with the determined PQI, the 5G ProSe layer-3 UE-to-network relay UE shall perform the 5G ProSe direct link modification procedure as specified in clause 7.2.3 to associate the ProSe

application on the existing PC5 QoS flow. The 5G ProSe layer-3 UE-to-network relay UE may include the PC5 QoS rule(s) associated with the updated PC5 QoS flow; or

- 2) if there is no PC5 QoS flow with the determined PQI, the 5G ProSe layer-3 UE-to-network relay UE shall perform the 5G ProSe direct link modification procedure as specified in clause 7.2.3 to add a new PC5 QoS flow with the determined PQI and associate the ProSe application on the new PC5 QoS flow. The 5G ProSe layer-3 UE-to-network relay UE may include the PC5 QoS rule(s) associated with the newly added PC5 QoS flow.

When a derived QoS rule is deleted, the 5G ProSe layer-3 UE-to-network relay UE shall perform the 5G ProSe direct link modification procedure as specified in clause 7.2.3 to associate the ProSe application with a PC5 QoS flow such that the determined PQI maps to the 5QI of the signalled QoS rule.

8.2.6.3.3 PC5 QoS flows handling initiated by the 5G ProSe layer-3 remote UE

For PC5 QoS flows setup or modification initiated by the 5G ProSe layer-3 remote UE, the 5G ProSe layer-3 remote UE shall provide the PC5 QoS flow context as defined in clause 7.2.7 to the 5G ProSe layer-3 UE-to-network relay UE to indicate the end-to-end QoS requirements for the traffic transmission between 5G ProSe layer-3 remote UE and the network, using 5G ProSe direct link establishment procedure as specified in clause 7.2.2 or 5G ProSe direct link modification procedure as specified in clause 7.2.3.

In addition, if the 5G ProSe layer-3 remote UE wants to add new PC5 QoS flow(s) or modify the existing PC5 QoS flow(s) for IP traffic or Ethernet traffic, the 5G ProSe layer-3 remote UE may also provide the PC5 QoS rule(s) for the PC5 QoS flow(s) to be added or modified to the 5G ProSe layer-3 UE-to-network relay UE, using 5G ProSe direct link establishment procedure as specified in clause 7.2.2 or 5G ProSe direct link modification procedure as specified in clause 7.2.3.

Upon reception of the PC5 QoS flow context from the 5G ProSe layer-3 remote UE, the 5G ProSe layer-3 UE-to-network relay UE:

- a) shall perform one of the following:
 - 1) if the end-to-end QoS requirements can be supported by an entry in QoS mapping configured in clause 5.2.5, then the 5G ProSe layer-3 UE-to-network relay UE uses the 5QI of the entry for the Uu QoS control and uses the PQI of the entry for the PC5 QoS control; or
 - 2) if the end-to-end QoS requirements cannot be supported by any entry in QoS mapping configured in clause 5.2.5, then the 5G ProSe layer-3 UE-to-network relay UE determines the 5QI for the Uu QoS control and PQI for the PC5 QoS control based on its implementation;
- b) optionally, derives the packet filter(s) used over Uu reference point if the 5G ProSe layer-3 UE-to-network relay UE received PC5 QoS rule(s) from 5G ProSe layer-3 remote UE;
- c) if a new QoS flow needs to be established or the existing QoS flow(s) needs to be modified, performs UE-requested PDU session modification procedure as specified in clause 6.4.2 in 3GPP TS 24.501 [11] providing:
 - 1) the Requested QoS flow descriptions IE with the 5QI value determined in bullet a); or
 - 2) the Requested QoS rules IE with the packet filter(s) if packet filter(s) are derived in bullet b);
- d) shall further update the corresponding PC5 QoS flow with the updated PQI value if the 5G ProSe layer-3 UE-to-network relay UE receives the authorized QoS flow descriptions with a 5QI value which is different from the 5QI value indicated by the 5G ProSe layer-3 UE-to-network relay UE as described in bullet c); and
- e) shall provide the 5G ProSe layer-3 remote UE with the PQI determined in bullet a) or the PQI updated in bullet d), the corresponding PC5 QoS parameters and the corresponding ProSe identifier(s) as specified in clause 7.2.2.3 (if 5G ProSe direct link establishment procedure was initiated by the 5G ProSe layer-3 remote UE) or clause 7.2.3.3 (if 5G ProSe direct link modification procedure was initiated by the 5G ProSe layer-3 remote UE).

8.2.6.4 QoS handling for 5G ProSe layer-3 UE-to-network relay with N3IWF

8.2.6.4.1 General

As specified in clause 5.6.2.2 of 3GPP TS 23.304 [2], when the 5G ProSe layer-3 remote UE accesses 5GS via a 5G ProSe layer-3 UE-to-network relay with N3IWF, the N3IWF can use one of the following operations for QoS support in 5G ProSe layer-3 UE-to-network relay UE's serving PLMN or subscribed SNPN:

- a) a static QoS mapping mechanism; or
- b) a dynamic QoS signalling based mechanism.

For a), there is no signalling impact to the 5G ProSe layer-3 remote UE and the 5G ProSe layer-3 UE-to-network relay UE.

For b), clause 8.2.6.4.2 specifies the QoS handling with QoS signalling procedure to transport the IPsec traffic in the 5G ProSe layer-3 UE-to-network relay UE's 5GCN.

8.2.6.4.2 QoS handling with QoS signalling procedure

When the 5G ProSe layer-3 remote UE establishes or handovers a PDU session via the N3IWF as described in clause 4.12.5 of 3GPP TS 23.502 [51], the N3IWF initiates a child SA creation procedure by sending a CREATE_CHILD_SA request message to associate the QoS flow(s) of the PDU session with the child SA of the user plane as specified in clause 7.5 of 3GPP TS 24.502 [26]. In the CREATE_CHILD_SA request message, the 5G_QOS_INFO Notify payload includes the PDU session ID, one or more QFI(s), optionally a DSCP value and optionally Additional QoS Information as defined in clause 9.3.1.1 of 3GPP TS 24.502 [26]. The N3IWF can also initiate the user plane IPsec child SA modification procedure by sending an INFORMATIONAL request message including the 5G_QOS_INFO Notify payload if the child SA associated with the QoS flows of the PDU session needs to be modified as specified in clause 7.6 of 3GPP TS 24.502 [26].

Based on information in the received 5G_QoS_INFO Notify payload, the 5G ProSe layer-3 remote UE determines whether to initiate the 5G ProSe direct link modification procedure to setup or modify the PC5 QoS flows. If the 5G ProSe direct link modification procedure needs to be initiated, the 5G ProSe layer-3 remote UE shall perform the procedure as specified in clause 8.2.6.3.3 with following additions:

- a) if the Additional QoS Information is received in the 5G_QoS_INFO Notify payload, the 5G ProSe layer-3 remote UE shall set the PC5 QoS flow descriptions IE based on the Additional QoS Information; and
- b) the 5G ProSe layer-3 remote UE shall include the PC5 QoS rules IE with the packet filter containing the N3IWF IP address, the security parameter index of the child SA and the DSCP value if received in the 5G_QoS_INFO Notify payload.

The 5G ProSe layer-3 UE-to-network relay UE determines whether to initiate PDU session modification procedure to request establishment or modification of the QoS flow of the dedicated QoS rules which is associated with the IPsec traffic between the 5G ProSe layer-3 remote UE and the N3IWF. If the PDU session modification procedure needs to be initiated, the 5G ProSe layer-3 UE-to-network relay UE shall perform the procedure as specified in clause 6.4.2 of 3GPP TS 24.501 [11] with following additions:

- a) the 5G ProSe layer-3 UE-to-network relay UE sends the packet filter provided in the PC5 QoS rules IE by the 5G ProSe layer-3 remote UE to the SMF.

8.2.7 5G ProSe layer-3 UE-to-network relay with N3IWF support

8.2.7.1 General

As specified in clause 5.4.1.2 of 3GPP TS 23.304 [2], the 5G ProSe layer-3 UE-to-network relay with N3IWF support shall provide the 5G ProSe layer-3 remote UE with the connection which can access to the N3IWF. In this way, the 5G ProSe layer-3 remote UE is able to select the N3IWF and access to the 5GC via the N3IWF.

The layer-3 ProSe UE-to-network relay UE is provisioned with the UE policies for 5G ProSe layer-3 UE-to-network relay including the relay service code which corresponds to use N3IWF access for the relayed traffic as defined in 3GPP TS 24.555 [17].

For UE-to-network relay discovery with model A, the 5G ProSe UE-to-network relay UE shall include the relay service code in the PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement as specified in clause 8.2.1.2. For UE-to-network relay discovery with model B, the 5G ProSe layer-3 remote UE shall include the relay service code which corresponds to use N3IWF access for the relayed traffic in the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation as specified in clause 8.2.1.3. The relay service code in the PROSE PC5 DISCOVERY message for UE-to-network relay discovery response shall match the relay service code received from the 5G ProSe layer-3 remote UE.

NOTE 1: The UE is allowed to use the 5G ProSe layer-3 UE-to-network relay with N3IWF support if the UE is authorized to be a 5G ProSe layer-3 remote UE as specified in clause 5.2.5 and the non-3GPP access type is preferred in the selected route selection descriptor in the URSP rule as defined in 3GPP TS 24.526 [5].

If the 5G ProSe layer-3 remote UE intends to access 5GC via N3IWF, the 5G ProSe layer-3 remote UE:

- a) shall select the relay service code which corresponds to use N3IWF access for the relayed traffic in the received PROSE PC5 DISCOVERY message;
- b) shall send the PROSE DIRECT LINK ESTABLISHMENT REQUEST message including the selected relay service code in a) to the 5G ProSe layer-3 UE-to-network relay UE; and
- c) shall use either the security procedure over user plane or the security procedure over control plane as specified in 3GPP TS 33.503 [34].

NOTE 2: After using either the security procedure over user plane or the security procedure over control plane as specified in 3GPP TS 33.503 [34], the 5G ProSe layer-3 remote UE performs the security procedures as specified in clause 7.2.1 of 3GPP TS 33.501 [50].

The 5G ProSe layer-3 UE-to-network relay UE establishes the PDU session with corresponding parameters for the requested relay service code as specified in clause 8.2.7.2.

The 5G ProSe layer-3 remote UE performs the N3IWF selection as specified in 8.2.7.3 once the IP address/prefix allocation is completed.

8.2.7.2 5G ProSe layer-3 UE-to-network relay UE establishing PDU session to access N3IWF

The 5G ProSe layer-3 UE-to-network relay UE establishes the PDU session based on the UE policies for 5G ProSe layer-3 UE-to-network relay service codes defined in 3GPP TS 24.555 [17]. The PDU session establishment is triggered upon receipt of the PROSE DIRECT LINK ESTABLISHMENT REQUEST message including the relay service code. The 5G ProSe layer-3 remote UE may change 5G ProSe layer-3 UE-to-network relay(s) while maintaining the PDU session(s) established via 5G ProSe layer-3 UE-to-network relay and N3IWF, when the 5G ProSe layer-3 remote UE and the N3IWF support MOBIKE as specified TS 24.502 [26].

NOTE: If there is an existing PDU session for 5G ProSe layer-3 UE-to-network relay without N3IWF, whether to reuse that existing PDU session or to establish a new PDU session for 5G ProSe layer-3 UE-to-network relay with N3IWF is determined by 5G ProSe layer-3 UE-to-network relay UE as specified in 3GPP TS 23.503[33].

8.2.7.3 N3IWF selection for 5G ProSe layer-3 remote UE

As specified in clause 6.5.1.2.2 of 3GPP TS 23.304 [2], the 5G ProSe layer-3 remote UE selects the N3IWF using following information included in UE policies for 5G ProSe remote UE as defined in clause 5.6.2 of 3GPP TS 24.555 [17]:

- a) N3IWF identifier configuration for 5G ProSe layer-3 remote UE; and
- b) 5G ProSe layer-3 UE-to-network relay access node selection information.

The 5G ProSe layer-3 remote UE performs the N3IWF selection procedure as specified in clause 7.2.4.3 of 3GPP TS 24.502 [26] for non-emergency services and clause 7.2.6.2 of 3GPP TS 24.502 [26] for emergency services.

8.2.8 5G ProSe additional parameters announcement procedure

8.2.8.1 General

The purpose of the 5G ProSe additional parameters announcement procedure is for the 5G ProSe layer-3 remote UE to obtain NCGI or TAI of the cell serving the 5G ProSe layer-3 UE-to-network relay UE and optionally the NID of the SNPN in case the serving cell is operated by an SNPN.

The 5G ProSe remote UE in this procedure shall be a 5G ProSe-enabled UE and is authorised to act as a 5G ProSe layer-3 remote UE towards a 5G ProSe layer-3 UE-to-network relay UE based on the service authorization procedure as specified in clause 5. The 5G ProSe layer-3 UE-to-network relay UE in this procedure shall be a 5G ProSe-enabled UE and is authorised to act as a 5G ProSe layer-3 UE-to-network relay UE based on the service authorization procedure as specified in clause 5.

8.2.8.2 5G ProSe additional parameters announcement procedure initiation by the 5G ProSe layer-3 remote UE

Before initiating the 5G ProSe additional parameters announcement procedure, a direct link has been successfully established between the 5G ProSe layer-3 remote UE and the 5G ProSe layer-3 UE-to-network relay UE.

The 5G ProSe layer-3 remote UE shall initiate a 5G ProSe additional parameters announcement procedure:

- a) when the 5G ProSe layer-3 remote UE is triggered by an upper layer application to report NCGI or TAI of the serving cell to the application server, but cannot receive the PROSE PC5 DISCOVERY message for relay discovery additional information from the 5G ProSe layer-3 UE-to-network relay UE, or the NCGI or TAI is not included in the PROSE PC5 DISCOVERY message for relay discovery additional information from the 5G ProSe layer-3 UE-to-network relay UE, or the NCGI or TAI is not included in the PROSE PC5 DISCOVERY message for UE-to-network relay discovery response because the UE-to-network relay discovery with model B is used for the direct link; or
- b) when the additional parameters announcement request refresh timer T5106 expires and the 5G ProSe layer-3 remote UE still needs to obtain NCGI or TAI of the cell serving the 5G ProSe layer-3 UE-to-network relay.

The 5G ProSe layer-3 remote UE shall generate a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message and pass this message to the lower layers for transmission along with the 5G ProSe layer-3 remote UE's layer-2 ID (for unicast communication) and the 5G ProSe layer-3 UE-to-network relay UE's layer-2 ID (for unicast communication).

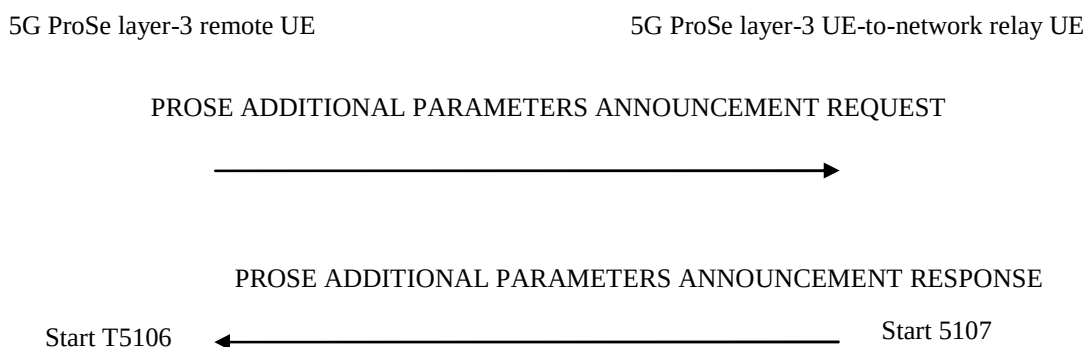


Figure 8.2.8.2.1: 5G ProSe additional parameters announcement procedure

8.2.8.3 5G ProSe additional parameters announcement procedure accepted by the 5G ProSe layer-3 UE-to-network relay UE

Upon receiving a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message, the 5G ProSe layer-3 UE-to-network relay UE shall allocate an additional parameters announcement request refresh timer T5106 to the 5G ProSe remote UE and start a timer T5107. The timer T5107 shall be longer than the additional parameters announcement request refresh timer T5106.

Then the 5G ProSe layer-3 UE-to-network relay UE shall respond a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE message with an additional parameters announcement request refresh timer T5106 IE set to the T5106 timer value assigned by the 5G ProSe layer-3 UE-to-network relay UE. The 5G ProSe layer-3 UE-to-network relay UE shall start announcing the NCGI or TAI of the serving cell by triggering the announcing UE procedure for relay discovery additional information as described in clause 8.2.1.2.4.

8.2.8.4 5G ProSe additional parameters announcement procedure completion by the 5G ProSe layer-3 remote UE

Upon receiving a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE message, the UE shall start the additional parameters announcement request refresh timer T5106 with the received value.

8.2.8.5 Abnormal cases

8.2.8.5.1 Abnormal cases in the 5G ProSe layer-3 remote UE

If there is no response from the 5G ProSe layer-3 UE-to-network relay UE after the PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message has been successfully delivered, the 5G ProSe layer-3 remote UE shall retransmit the PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

8.2.9 5G ProSe AA message reliable transport procedure

8.2.9.1 General

The purpose of the 5G ProSe AA message reliable transport procedure is to exchange the EAP messages between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE.

The 5G ProSe remote UE in this procedure shall be a 5G ProSe-enabled UE and is authorised to act as a 5G ProSe remote UE towards a 5G ProSe UE-to-network relay UE based on the service authorization procedure as specified in clause 5. The 5G ProSe UE-to-network relay UE in this procedure shall be a 5G ProSe-enabled UE and is authorised to act as a 5G ProSe UE-to-network relay UE based on the service authorization procedure as specified in clause 5.

In this clause, the 5G ProSe UE-to-network relay UE is the initiating UE and the 5G ProSe remote UE is the target UE.

8.2.9.2 5G ProSe AA message reliable transport procedure initiation

The UE shall initiate a 5G ProSe AA message reliable transport procedure when the UE receives the EAP message for the target UE from the network.

The UE shall generate a PROSE AA MESSAGE TRANSPORT REQUEST message. In this message, during an EAP based authentication procedure, the initiating UE shall include the EAP message IE set to the received EAP message for the target UE from the network as specified in 3GPP TS 24.501 [11].

NOTE 1: In this release of this specification, the EAP message IE is always included.

The initiating UE shall self-assign a source layer-2 ID and set the destination layer-2 ID to the source layer-2 ID in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, i.e., the target UE's layer-2 ID.

NOTE 2: The UE implementation ensures that any value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct discovery as specified in clause 6.2.14, clause 6.2.15 and clause 8.2.1 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

After the PROSE AA MESSAGE TRANSPORT REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID and the target UE's layer-2 ID and start timer T5093. The UE shall not send a new PROSE AA MESSAGE TRANSPORT REQUEST message to the same target UE while timer T5093 is running.

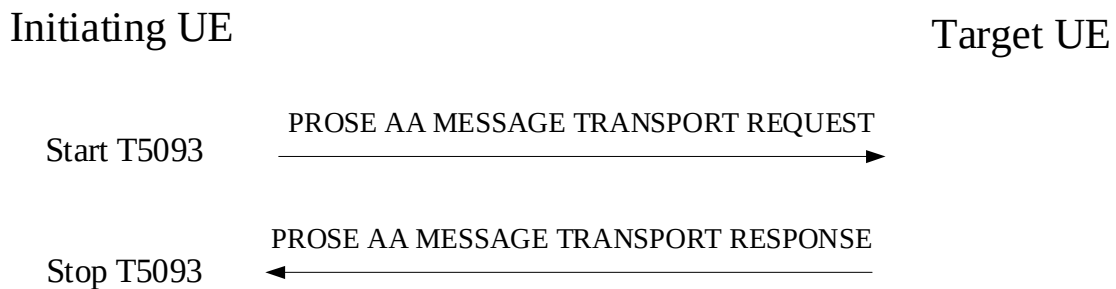


Figure 8.2.9.2.1: 5G ProSe AA message reliable transport procedure

8.2.9.3 5G ProSe AA message reliable transport procedure accepted by the target UE

Upon receiving a PROSE AA MESSAGE TRANSPORT REQUEST message, the target UE shall pass the EAP message in the EAP message IE to the upper layer for the external DN authentication.

When the upper layers provide an EAP message responding to the received EAP message, the target UE shall generate a PROSE AA MESSAGE TRANSPORT RESPONSE message including the EAP message IE set to the received EAP message from the upper layers.

After the PROSE AA MESSAGE TRANSPORT RESPONSE message is generated, the target UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID and the target UE's layer-2 ID.

8.2.9.4 5G ProSe AA message reliable transport procedure completion by the initiating UE

Upon receiving a PROSE AA MESSAGE TRANSPORT RESPONSE message, the UE shall stop timer T5093 and shall pass the EAP message in the PROSE AA MESSAGE TRANSPORT RESPONSE message to the lower layer and inform the lower layer to initiate the PDU EAP message reliable transport procedure as specified in 3GPP TS 24.501 [11].

8.2.9.5 Abnormal cases

8.2.9.5.1 Abnormal cases at the initiating UE

- a) Timer T5093 expires.

The initiating UE shall retransmit the PROSE AA MESSAGE TRANSPORT REQUEST message and restart timer T5093. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe AA message reliable transport procedure and shall abort the ongoing procedure that triggered the initiation of the 5G ProSe AA message reliable transport procedure.

NOTE: The maximum number of allowed retransmissions is UE implementation specific.

- b) The need to use this 5G ProSe direct link no longer exists before the 5G ProSe AA message reliable transport procedure is completed.

The initiating UE shall abort the 5G ProSe AA message reliable transport procedure and shall abort the ongoing procedure that triggered the initiation of the 5G ProSe AA message reliable transport procedure.

8.2.10 5G ProSe security procedures over PC8 interface

8.2.10.1 General

8.2.10.1.1 Transport protocol for PC8 messages

The UE and 5G PKMF shall use HTTP/1.1 as specified in IETF RFC 9112 [3] and IETF RFC 9110 [4] as the transport protocol for PC8 messages over the PC8 interface. The PC8 messages described here shall be included in the body of either an HTTP request message or an HTTP response message.

8.2.10.1.2 Handling of UE-initiated procedures

8.2.10.1.2.1 General

The following rules apply for UE-initiated procedures:

- a) the UE initiates 5G ProSe transactions with an HTTP request message containing the PC8 request(s);
- b) the 5G PKMF responds to the requests with an HTTP response message containing the PC8 response(s) for the PC8 request(s); and
- c) HTTP POST methods are used for 5G ProSe procedures over PC8 interface.

The UE may use UE local configuration or URSP, as defined in 3GPP TS 24.526 [5], to establish a PDU session for reaching the HPLMN 5G PKMF:

- a) if a PDU session for reaching the HPLMN 5G PKMF is not established yet, the UE shall establish the PDU session for reaching the HPLMN 5G PKMF and shall send the HTTP request message via the PDU session for reaching the HPLMN 5G PKMF; and
- b) if a PDU session for reaching the HPLMN 5G PKMF is already established (e.g., either due to other 5G ProSe feature or due to other application), the UE shall send the HTTP request message via the PDU session for reaching the HPLMN 5G PKMF.

8.2.10.1.2.2 5G PKMF discovery

The 5G PKMF address can be pre-configured in the UE, provided by the 5G DDNMF or provided in the ProSeP by the PCF.

The UE shall use the 5G PKMF address in the following order of decreasing precedence:

- a) provided in the ProSeP by the PCF;
- b) provided by the 5G DDNMF; and
- c) pre-configured in the ME.

If the UE is pre-configured with the 5G PKMF address, does not have the 5G PKMF address provided in the ProSeP by the PCF and does not have the 5G PKMF address provided by the 5G DDNMF, the UE may access the 5G PKMF using the pre-configured 5G PKMF address without requesting the 5G DDNMF to provide the 5G PKMF address. In case that the UE cannot access the 5G PKMF using the pre-configured 5G PKMF address, the UE may request the 5G DDNMF to provide the 5G PKMF address.

8.2.10.2 Procedures

8.2.10.2.1 Types of 5G ProSe procedures over PC8 interface

The following procedures are defined:

- a) 5G ProSe UE-to-network relay discovery security parameters request procedure;
- b) 5G ProSe remote user key request procedure; and
- c) Key request procedure.

In the following descriptions of 5G procedures over PC8 interface, the terms "request" and "response" refer to the corresponding PC8 messages, not to the HTTP request or response. The following procedure descriptions use a single PC8 message for illustration purposes.

The 5G ProSe procedures over PC8 interface shall be integrity protected and confidentiality protected using the security procedures using GBA or AKMA, see clause 5.2.5.3 and clause 5.2.5.4 in 3GPP TS 33.503 [34].

NOTE 1: A single HTTP request message can contain multiple PC8 requests and a single HTTP response message can contain multiple PC8 responses.

NOTE 2: The privacy of the UE identity included in the PC8 messages of 5G ProSe procedures over PC8 interface is ensured by the confidentiality protection of those procedures.

8.2.10.2.2 5G ProSe UE-to-network relay discovery security parameters request procedure

8.2.10.2.2.1 General

The purpose of the 5G ProSe UE-to-network relay discovery security parameters request procedure is for the UE:

- a) to obtain the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE, applicable when the UE acts as a 5G ProSe remote UE and uses the security procedure over user plane as specified in 3GPP TS 33.503 [34]; and
- b) to obtain the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE, applicable when the UE acts as a 5G ProSe UE-to-network relay UE and uses the security procedure over user plane as specified in 3GPP TS 33.503 [34].

8.2.10.2.2.2 5G ProSe UE-to-network relay discovery security parameters request procedure initiation

The UE shall initiate the 5G ProSe UE-to-network relay discovery security parameters request procedure:

- a) if the UE is authorized to act as a 5G ProSe remote UE and uses the security procedure over user plane as specified in 3GPP TS 33.503 [34]:
 - 1) when the UE has no 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE and the UE is in NG-RAN coverage; or
 - 2) after expiration of timer T5094, when in NG-RAN coverage or when entering NG-RAN coverage; or
- b) if the UE is authorized to act as a 5G ProSe UE-to-network relay UE and uses the security procedure over user plane as specified in 3GPP TS 33.503 [34]:
 - 1) when the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE and the UE is in NG-RAN coverage; or
 - 2) after expiration of timer T5095, when in NG-RAN coverage or when entering NG-RAN coverage.

The UE shall initiate the 5G ProSe UE-to-network relay discovery security parameters request procedure by sending a PROSE_SECURITY_PARAM_REQUEST message with the <UNR-discovery-security-parameters-request> element. In the <UNR-discovery-security-parameters-request> element, the UE:

- a) shall include a new transaction ID;
- b) shall indicate whether the UE requests the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE, the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE or both;
- c) shall include the PC5 UE security capabilities indicating ciphering algorithms supported by the UE;

- d) if the UE requests the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE, may include a list of PLMN identities of the visited PLMNs;

NOTE 1: In case of SNPN, the UE does not need to include the list of PLMN identities of the visited PLMNs since the requested security parameters are applicable only for the subscribed SNPN.

- e) may indicate the requested model indicating the model of the 5G ProSe UE-to-network relay discovery over PC5 interface for which security parameters are requested, set to "model A" or "model B"; and

- f) shall include the relay service code indicating the connectivity service to be discovered.

NOTE 2: If the requested model is not included in the PROSE_SECURITY_PARAM_REQUEST message, security parameters are requested for both model A and model B of the 5G ProSe UE-to-network relay discovery over PC5 interface.

Figure 8.2.10.2.2.1 illustrates the interaction of the UE and the 5G PKMF in the 5G ProSe UE-to-network relay discovery security parameters request procedure.

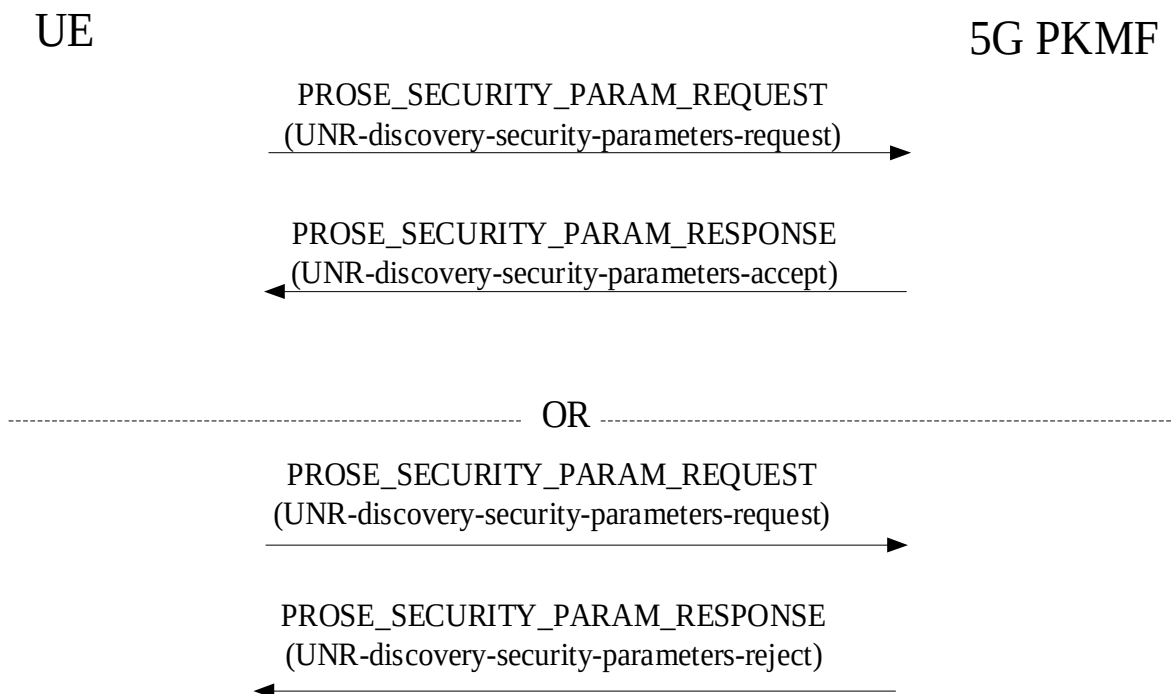


Figure 8.2.10.2.2.1: 5G ProSe UE-to-network relay discovery security parameters request procedure

8.2.10.2.2.3 5G ProSe UE-to-network relay discovery security parameters request procedure accepted by the 5G PKMF

Upon receiving a PROSE_SECURITY_PARAM_REQUEST message with the <UNR-discovery-security-parameters-request> element, if:

- the UE requests the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE only and the PROSE_SECURITY_PARAM_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe remote UE;
- the UE requests the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE only and the PROSE_SECURITY_PARAM_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe UE-to-network relay UE; or

- c) the UE requests the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE and the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE and the PROSE_SECURITY_PARAM_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe UE-to-network relay UE and authorized to act as a 5G ProSe remote UE;

the 5G PKMF shall send a PROSE_SECURITY_PARAM_RESPONSE message containing a <UNR-discovery-security-parameters-accept> element. In the <UNR-discovery-security-parameters-accept> element, the 5G PKMF:

- a) shall include the transaction ID set to the value of the transaction ID received in the PROSE_SECURITY_PARAM_REQUEST message;
- b) if the UE requests the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE:
 - 1) shall include zero or more 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE. In each of the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE, the 5G PKMF:
 - A) shall include the expiration timer of the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE; and
 - B) for the received relay service code for which the UE is authorized to act as a 5G ProSe remote UE:
 - i) if the requested model is not indicated in the PROSE_SECURITY_PARAM_REQUEST message or is set to "model A", may include the code-receiving security parameters for model A containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - ii) if the requested model is not indicated in the PROSE_SECURITY_PARAM_REQUEST message or is set to "model B", may include the code-receiving security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask and the code-sending security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - iii) shall include the selected ciphering algorithm; and
 - iv) shall include the PLMN ID for which the security parameters are associated; and

NOTE: In case of SNPN, the PLMN ID is the PLMN ID of the subscribed SNPN.

- 2) may include the PC5 security policies for the received relay service code for 5G ProSe remote UE. In the PC5 security policies for the received relay service code for 5G ProSe remote UE, the 5G PKMF:
 - A) for the received relay service code for which the UE is authorized to act as a 5G ProSe remote UE:
 - i) shall include the PC5 security policies;
- c) if the UE requests the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE:
 - 1) shall include the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE. In the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE, the 5G PKMF:
 - A) shall include the expiration timer of the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE; and
 - B) for the received relay service code for which the UE is authorized to act as a 5G ProSe UE-to-network relay UE:
 - i) if the requested model is not indicated in the PROSE_SECURITY_PARAM_REQUEST message or is set to "model A", may include the code-sending security parameters for model A containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - ii) if the requested model is not indicated in the PROSE_SECURITY_PARAM_REQUEST message or is set to "model B", may include the code-receiving security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask and the code-sending security

parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask; and

iii) shall include the selected ciphering algorithm; and

2) may include the PC5 security policies for the received relay service code for 5G ProSe UE-to-network relay UE. In the PC5 security policies for the received relay service code for 5G ProSe UE-to-network relay UE, the 5G PKMF:

A) for the received relay service code for which the UE is authorized to act as a 5G ProSe UE-to-network relay UE:

i) shall include the PC5 security policies; and

d) shall include the current time set to the current UTC-based time at the 5G PKMF and the max offset.

If the UE requests the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE, the UE identity in the PROSE_SECURITY_PARAM_REQUEST message indicates a UE authorized to act as a 5G ProSe remote UE and the PROSE_SECURITY_PARAM_REQUEST message contains a list of PLMN identities of the visited PLMNs, the 5G PKMF shall include in the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE any information received from the 5G PKMFs that are discovered based on the provided list of PLMN identities of potential 5G ProSe UE-to-network relay UEs which can serve the UE. If the PROSE_SECURITY_PARAM_REQUEST message does not contain a list of PLMN identities of the visited PLMNs, the 5G PKMF may get the PLMN identities of potential 5G ProSe UE-to-network relay UEs through different means such as local configurations. In case of SNPN, the PLMN ID is the PLMN ID of the subscribed SNPN of the potential 5G ProSe UE-to-network relay UEs.

8.2.10.2.2.4 5G ProSe UE-to-network relay discovery security parameters request procedure completion by the UE

Upon receipt of the PROSE_SECURITY_PARAM_RESPONSE message with the <UNR-discovery-security-parameters-accept>, if the transaction ID contained in the <UNR-discovery-security-parameters-accept> element matches the value sent by the UE in a PROSE_SECURITY_PARAM_REQUEST message with the <UNR-discovery-security-parameters-request> element, the UE:

- a) if the PROSE_SECURITY_PARAM_RESPONSE message contains the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE:
 - 1) shall store the one or more 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE, each associated with its received PLMN ID, shall stop timer T5094, if running and shall start timer T5094 with the value of the expiration timer indicated in the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE; and

NOTE: In case of SNPN, the PLMN ID is the PLMN ID of the subscribed SNPN.

- 2) if the PC5 security policies for the relay service code for 5G ProSe remote UE are received, shall store the PC5 security policies for the relay service code for 5G ProSe remote UE;
- b) if the PROSE_SECURITY_PARAM_RESPONSE message contains the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE:
 - 1) shall store the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE, shall stop timer T5095, if running and shall start timer T5081 with the value of the expiration timer indicated in the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE; and
 - 2) if the PC5 security policies for the relay service code for 5G ProSe UE-to-network relay UE are received, shall store the PC5 security policies for the relay service code for 5G ProSe UE-to-network relay UE; and
- c) shall set a ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter and store the received max offset.

8.2.10.2.2.5 5G ProSe UE-to-network relay discovery security parameters request procedure not accepted by the 5G PKMF

If the PROSE_SECURITY_PARAM_REQUEST message with the <UNR-discovery-security-parameters-request> element cannot be accepted by the 5G PKMF, the 5G PKMF shall send a PROSE_SECURITY_PARAM_RESPONSE message containing a <UNR-discovery-security-parameters-reject> element. In the <UNR-discovery-security-parameters-reject> element, the 5G PKMF shall include the transaction ID set to the value of the transaction ID received in the PROSE_SECURITY_PARAM_REQUEST message and shall include an appropriate PC8 control protocol cause value.

Upon receipt of the PROSE_SECURITY_PARAM_RESPONSE message with the <UNR-discovery-security-parameters-reject> element, if the transaction ID contained in the <UNR-discovery-security-parameters-reject> element matches the value sent by the UE in a PROSE_SECURITY_PARAM_REQUEST message with the <UNR-discovery-security-parameters-request> element, the UE shall consider the 5G ProSe UE-to-network relay discovery security parameters request procedure as rejected.

8.2.10.2.2.6 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of PROSE_SECURITY_PARAM_REQUEST message (e.g. after TCP retransmission timeout).

The UE shall close the existing secure connection to the 5G PKMF, establish a new secure connection and then restart the 5G ProSe UE-to-network relay discovery security parameters request procedure.

- b) No response from the 5G PKMF after the PROSE_SECURITY_PARAM_REQUEST message has been successfully delivered (e.g. TCP ACK has been received for the PROSE_SECURITY_PARAM_REQUEST message)

The UE shall retransmit the PROSE_SECURITY_PARAM_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

8.2.10.2.2.7 Abnormal cases in the 5G PKMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of PROSE_SECURITY_PARAM_RESPONSE message.

After receiving an indication from lower layer that the PROSE_SECURITY_PARAM_RESPONSE message has not been successfully acknowledged (e.g. TCP ACK is not received), the 5G PKMF shall abort the procedure.

8.2.10.2.3 5G ProSe remote user key request procedure

8.2.10.2.3.1 General

The purpose of the 5G ProSe remote user key request procedure is for the UE authorized to act as a 5G ProSe remote UE to obtain a UP-PRUK and a UP-PRUK ID.

Before initiating this procedure, the 5G ProSe remote UE needs to be authorized to use a 5G ProSe layer-3 UE-to-network relay UE or a 5G ProSe layer-2 UE-to-network relay UE in the registered PLMN or local PLMN based on the configuration parameters as specified in clause 5.2.5.

8.2.10.2.3.2 5G ProSe remote user key request procedure initiation

If the UE is authorized to use a 5G ProSe layer-3 UE-to-network relay UE or a 5G ProSe layer-2 UE-to-network relay UE in the registered PLMN or local PLMN, and needs to be able to obtain a connectivity service from a 5G ProSe UE-to-network relay UE, it shall initiate this procedure.

The UE shall initiate the 5G ProSe remote user key request procedure by sending a PROSE_PRUK_REQUEST message with the <PRUK-request> element. In the <PRUK-request> element, the UE:

- a) shall include a new transaction ID not used in any other direct discovery procedures in PC8 interface; and
- b) shall include the UP-PRUK ID set to the UP-PRUK ID associated with the UE stored UP-PRUK, if the UE stores UP-PRUK.

Figure 8.2.10.2.3.2.1 illustrates the interaction of the UE and the 5G PKMF in the 5G ProSe remote user key request procedure.

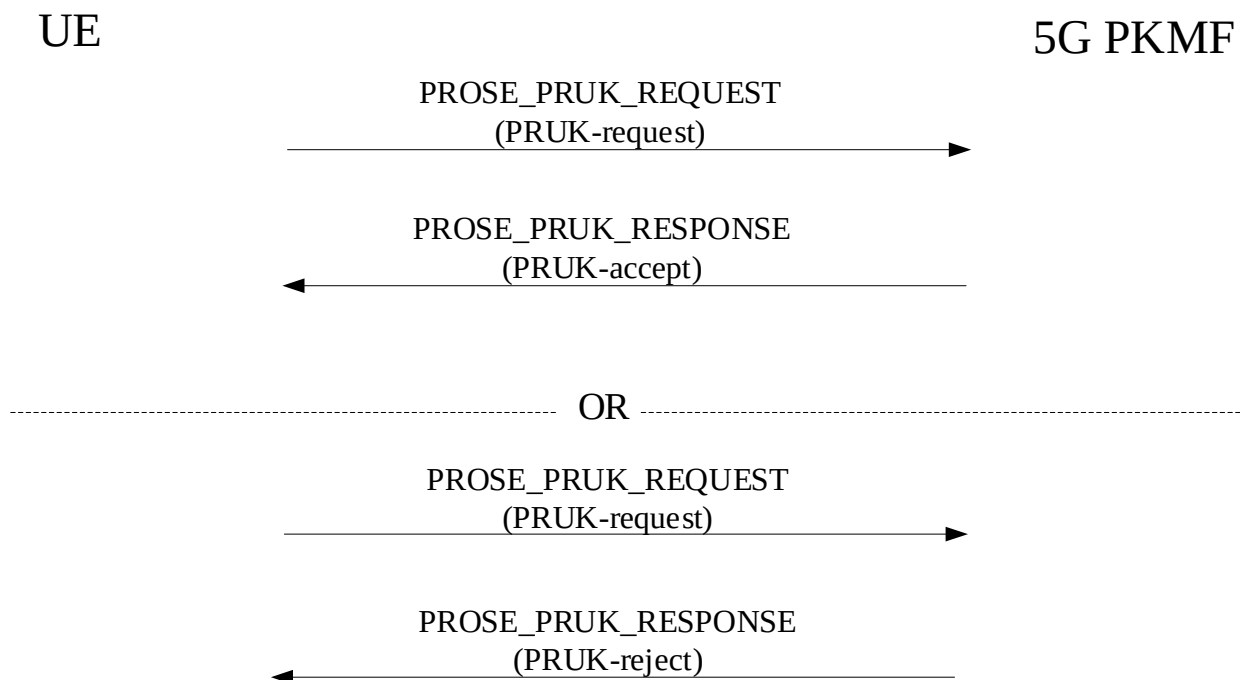


Figure 8.2.10.2.3.2.1: 5G ProSe remote user key request procedure

8.2.10.2.3.3 5G ProSe remote user key request procedure accepted by the 5G PKMF

Upon receiving a PROSE_PRUK_REQUEST message, the 5G PKMF shall check whether the UE is authorized to act as a 5G ProSe remote UE. If authorized, the 5G PKMF shall then send a PROSE_PRUK_RESPONSE message with the <PRUK-accept> element. In the <PRUK-accept> element, the 5G PKMF shall include:

- a) the transaction ID set to the value of the transaction ID received in the PROSE_PRUK_REQUEST message from the UE;
- b) the UP-PRUK ID set to the value of the UP-PRUK ID associated with the UP-PRUK; and
- c) the UP-PRUK set to the value of the allocated UP-PRUK to the UE.

8.2.10.2.3.4 5G ProSe remote user key request procedure completion by the UE

Upon receipt of the PROSE_PRUK_RESPONSE message, if the transaction ID matches the value sent by the UE in a PROSE_PRUK_REQUEST message, the UE shall delete any previously stored UP-PRUK and UP-PRUK ID and store the received UP-PRUK and the associated UP-PRUK ID.

8.2.10.2.3.5 5G ProSe remote user key request procedure not accepted by the 5G PKMF

If the PROSE_PRUK_REQUEST message cannot be accepted by the 5G PKMF, the 5G PKMF sends a PROSE_PRUK_RESPONSE message containing a <PRUK-reject> element to the UE including an appropriate PC8 control protocol cause value and including the transaction ID set to the value of the transaction ID received in the PC8_PRUK_REQUEST message.

Upon receipt of the PROSE_PRUK_RESPONSE message containing a <PRUK-reject> element, if the transaction ID matches the value sent by the UE in a PROSE_PRUK_REQUEST message, the UE shall consider the 5G ProSe remote user key request procedure as rejected.

If the UE is not authorized for acting as a 5G ProSe remote UE, the 5G PKMF shall send the PROSE_PRUK_RESPONSE message containing a <PRUK-reject> element with PC8 control protocol cause value #1 "UE authorization failure".

8.2.10.2.3.6 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of PROSE_PRUK_REQUEST message (e.g., after TCP retransmission timeout).

The UE shall close the existing secure connection to the 5G PKMF, establish a new secure connection and then restart the UP-PRUK request procedure.

- b) No response from the 5G PKMF after the PROSE_PRUK_REQUEST message has been successfully delivered (e.g., TCP ACK has been received for the PROSE_PRUK_REQUEST message).

The UE shall retransmit the PROSE_PRUK_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

8.2.10.2.3.7 Abnormal cases in the 5G PKMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of PROSE_PRUK_RESPONSE message.

After receiving an indication from lower layer that the PROSE_PRUK_RESPONSE message has not been successfully acknowledged (e.g. TCP ACK is not received), the 5G PKMF shall abort the procedure.

8.2.10.2.4 Key request procedure

8.2.10.2.4.1 General

The purpose of the key request procedure is for a UE acting as a 5G ProSe UE-to-network relay to obtain security parameter needed for establishment of 5G ProSe direct link with a 5G ProSe remote UE.

8.2.10.2.4.2 Key request procedure initiation

The UE shall initiate the key request procedure:

- a) when the UE acting as a 5G ProSe UE-to-network relay for a relay service code receives a request to establish a 5G ProSe direct link from a 5G ProSe remote UE; and
- b) when a 5G ProSe direct link security mode control procedure is rejected by the 5G ProSe remote UE due to the authentication synchronisation error.

The UE shall initiate the key request procedure by sending a PROSE_KEY_REQUEST message with the <key-request> element. In the <key-request> element, the UE:

- a) shall include a new transaction ID;
- b) shall include the relay service code for which the 5G ProSe direct link is requested to be established;
- c) shall include the SUCI or the UP-PRUK ID of the 5G ProSe remote UE, received from the 5G ProSe remote UE;
- d) shall include the K_{NRP} freshness parameter 1, received from the 5G ProSe remote UE;

- e) shall include the PLMN identity of the HPLMN of the 5G ProSe remote UE, if received from the 5G ProSe remote UE; and

NOTE: In case of SNPN, the PLMN ID is the PLMN ID of the subscribed SNPN.

- f) if the key request procedure is initiated upon a 5G ProSe direct link security mode control procedure being rejected by the 5G ProSe remote UE due to the authentication synchronisation error, shall include the AUTS and the RAND, received from the 5G ProSe remote UE.

Figure 8.2.10.2.4.2.1 illustrates the interaction of the UE and the 5G PKMF in the Key request procedure.

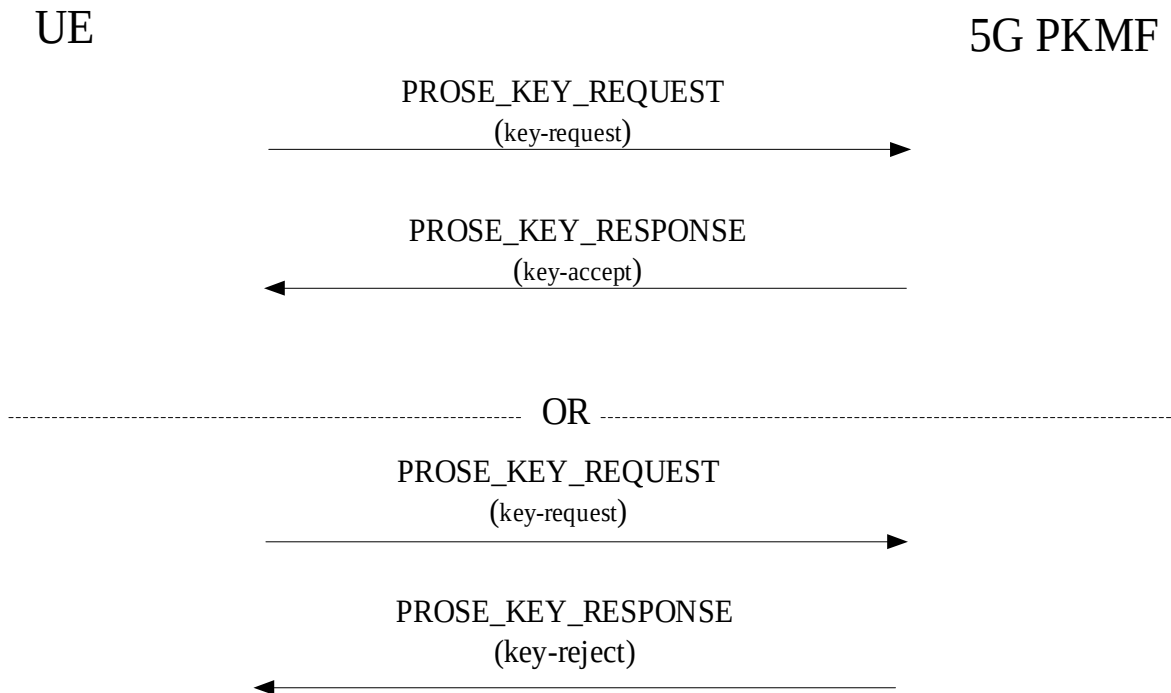


Figure 8.2.10.2.4.2.1: Key request procedure

8.2.10.2.4.3 Key request procedure accepted by the 5G PKMF

Upon receiving a PROSE_KEY_REQUEST message with the <key-request> element, if:

- the PROSE_KEY_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe UE-to-network relay for the relay service code indicated in the PROSE_KEY_REQUEST message; and
- the 5G ProSe remote UE identified by the SUCI, the UP-PRUK ID or the AUTS provided by the 5G ProSe remote UE and the PLMN identity of the HPLMN of the 5G ProSe remote UE, if any, indicated in the PROSE_KEY_REQUEST message is authorized to act as a 5G ProSe remote UE for the relay service code indicated in the PROSE_KEY_REQUEST message;

NOTE: In case of SNPN, the PLMN ID is the PLMN ID of the subscribed SNPN.

the 5G PKMF shall send a PROSE_KEY_RESPONSE message containing a <key-accept> element. In the <key-accept> element, the 5G PKMF:

- shall include the transaction ID set to the value of the transaction ID received in the PROSE_KEY_REQUEST message;
- shall include the UP-PRUK ID of the 5G ProSe remote UE;

- c) shall include the K_{NRP} ;
- d) shall include the K_{NRP} freshness parameter 2; and
- e) if the AUTS and the RAND are included in the PROSE_KEY_REQUEST message or a new UP-PRUK is required, then shall include the GBA push information (GPI).

If the 5G ProSe remote UE is served by another 5G PKMF, the 5G PKMF of the 5G ProSe UE-to-network relay requests the 5G PKMF of the 5G ProSe remote UE to check that the 5G ProSe remote UE identified by the SUCI, the UP-PRUK ID or the AUTS provided by the 5G ProSe remote UE and the PLMN identity of the HPLMN of the 5G ProSe remote UE, if any, indicated in the PROSE_KEY_REQUEST message, is authorized to act a 5G ProSe remote UE for the relay service code indicated in the PROSE_KEY_REQUEST message and to provide the UP-PRUK ID of the 5G ProSe remote UE, the K_{NRP} , the K_{NRP} freshness parameter 2, and optionally the GBA push information (GPI).

8.2.10.2.4.4 Key request procedure completion by the UE

Upon receipt of the PROSE_KEY_RESPONSE message with the <key-accept> element, if the transaction ID contained in the <key-accept> element matches the value sent by the UE in a PROSE_KEY_REQUEST message with the <key-request> element, the UE shall use the UP-PRUK ID of the 5G ProSe remote UE, the K_{NRP} , the K_{NRP} freshness parameter 2 and the GBA push information (GPI), if received, in the 5G ProSe direct link establishment.

8.2.10.2.4.5 Key request procedure not accepted by the 5G PKMF

If the PROSE_KEY_REQUEST message with <key-request> element cannot be accepted by the 5G PKMF, the 5G PKMF shall send a PROSE_KEY_RESPONSE message containing a <key-reject> element. In the <key-reject> element, the 5G PKMF shall include the transaction ID set to the value of the transaction ID received in the PROSE_KEY_REQUEST message and shall include an appropriate PC8 control protocol cause value.

NOTE: The 5G PKMF decides to reject the PROSE_KEY_REQUEST message when e.g. the UP-PRUK is not found in the network.

Upon receipt of the PROSE_KEY_RESPONSE message with the <key-reject> element, if the transaction ID contained in the <key-reject> element matches the value sent by the UE in a PROSE_KEY_REQUEST message with the <key-request> element, the UE shall consider the key request procedure as rejected.

8.2.10.2.4.6 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of PROSE_KEY_REQUEST message (e.g., after TCP retransmission timeout)

The UE shall close the existing secure connection to the 5G PKMF, establish a new secure connection and then restart the key request procedure.

- b) No response from the 5G PKMF after the PROSE_KEY_REQUEST message has been successfully delivered (e.g. TCP ACK has been received for the PROSE_KEY_REQUEST message)

The UE shall retransmit the PROSE_KEY_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

8.2.10.2.4.7 Abnormal cases in the 5G PKMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of PROSE_KEY_RESPONSE message

After receiving an indication from lower layer that the PROSE_KEY_RESPONSE message has not been successfully acknowledged (e.g., TCP ACK is not received), the 5G PKMF shall abort the procedure.

8.2.11 UE-to-network relay unicast direct communication over PC5 interface

The direct communication between 5G ProSe remote UE and 5G ProSe UE-to-network relay UE reuses the procedures for unicast mode 5G ProSe direct communication over PC5 described in clause 7.2.

NOTE: Any modifications needed to the procedures defined for unicast mode 5G ProSe direct communication over PC5 to support the direct communication between 5G ProSe remote UE and 5G ProSe UE-to-network relay UE are described within clause 7.2.

8.2.12 5G ProSe security procedures over PC3a interface

8.2.12.1 General

8.2.12.1.1 Transport protocol for PC3a messages

The UE and 5G DDNMF shall use HTTP/1.1 as specified in IETF RFC 9112 [3] and IETF RFC 9110 [4] as the transport protocol for PC3a messages over the PC3a interface. The PC3a messages described here shall be included in the body of either an HTTP request message or an HTTP response message.

8.2.12.1.2 Handling of UE-initiated procedures

8.2.12.1.2.1 General

The following rules apply for UE-initiated procedures:

- a) the UE initiates 5G ProSe transactions with an HTTP request message containing the PC3a request(s);
- b) the 5G DDNMF responds to the requests with an HTTP response message containing the PC3a response(s) for the PC3a request(s); and
- c) HTTP POST methods are used for 5G ProSe procedures over PC3a interface.

The UE may use UE local configuration or URSP, as defined in 3GPP TS 24.526 [5], to establish a PDU session for reaching the HPLMN 5G DDNMF:

- a) if a PDU session for reaching the HPLMN 5G DDNMF is not established yet, the UE shall establish the PDU session for reaching the HPLMN 5G DDNMF and shall send the HTTP request message via the PDU session for reaching the HPLMN 5G DDNMF; and
- b) if a PDU session for reaching the HPLMN 5G DDNMF is already established (e.g., either due to other 5G ProSe feature or due to other application), the UE shall send the HTTP request message via the PDU session for reaching the HPLMN 5G DDNMF.

8.2.12.1.2.2 5G DDNMF discovery

The 5G DDNMF discovery is the same as described in clause 6.1.2.2.

8.2.12.2 Procedures

8.2.12.2.1 Types of 5G ProSe security procedures over PC3a interface

The following procedures are defined:

- a) 5G ProSe UE-to-network relay discovery security material request procedure.

In the following descriptions of 5G procedures over PC3a interface, the terms "request" and "response" refer to the corresponding PC3a messages, not to the HTTP request or response. The following procedure descriptions use a single PC3a message for illustration purposes.

The PC3a control protocol procedures for 5G ProSe direct discovery shall be integrity protected and confidentiality protected using the security procedures defined in clause 5.2.3 in 3GPP TS 33.503 [34].

NOTE: A single HTTP request message can contain multiple PC3a control protocol requests and a single HTTP response message can contain multiple PC3a control protocol responses.

When the TLS tunnel between the UE and the 5G DDNMF for transport of PC3a messages is established by the UE according to 3GPP TS 33.503 [34], the 5G DDNMF shall obtain identity of the served UE using the procedures specified in 3GPP TS 33.220 [46] or 3GPP TS 33.535 [47].

8.2.12.2.2 5G ProSe UE-to-network relay discovery security material request procedure

8.2.12.2.2.1 General

The purpose of the 5G ProSe UE-to-network relay discovery security material request procedure is for the UE:

- a) to obtain the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE, applicable when the UE acts as a 5G ProSe remote UE and uses the security procedure over control plane as specified in 3GPP TS 33.503 [34]; and
- b) to obtain the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE, applicable when the UE acts as a 5G ProSe UE-to-network relay UE and uses the security procedure over control plane as specified in 3GPP TS 33.503 [34].

8.2.12.2.2.2 5G ProSe UE-to-network relay discovery security material request procedure initiation

The UE shall initiate the 5G ProSe UE-to-network relay discovery security material request procedure:

- a) if the UE is authorized to act as a 5G ProSe remote UE and uses the security procedure over control plane as specified in 3GPP TS 33.503 [34]:
 - 1) when the UE has no 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE and the UE is in NG-RAN coverage; or
 - 2) after expiration of timer T5078, when in NG-RAN coverage or when entering NG-RAN coverage; or
- b) if the UE is authorized to act as a 5G ProSe UE-to-network relay UE and uses the security procedure over control plane as specified in 3GPP TS 33.503 [34]:
 - 1) when the UE has no 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE and the UE is in NG-RAN coverage; or
 - 2) after expiration of timer T5079, when in NG-RAN coverage or when entering NG-RAN coverage.

The UE shall initiate the 5G ProSe UE-to-network relay discovery security material request procedure by sending a PROSE_SECURITY_MATERIAL_REQUEST message with the <UNR-discovery-security-parameters-request> element. In the <UNR-discovery-security-parameters-request> element, the UE:

- a) shall include a new transaction ID;
- b) shall indicate whether the UE requests the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE, the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE or both;
- c) shall include the PC5 UE security capabilities indicating ciphering algorithms supported by the UE;
- d) if the UE requests the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE, may include a list of PLMN identities of the visited PLMNs;

NOTE 1: In case of SNPN, the UE does not need to include the list of PLMN identities of the visited PLMNs since the requested security material is applicable only for the subscribed SNPN.

- e) may indicate the requested model indicating the model of the 5G ProSe UE-to-network relay discovery over PC5 interface for which security parameters are requested, set to "model A" or "model B"; and

f) shall include the relay service code indicating the connectivity service to be discovered.

NOTE 2: If the requested model is not included in the PROSE_SECURITY_MATERIAL_REQUEST message, security parameters are requested for both model A and model B of the 5G ProSe UE-to-network relay discovery over PC5 interface.

Figure 8.2.12.2.2.1 illustrates the interaction of the UE and the 5G DDNMF in the 5G ProSe UE-to-network relay discovery security material request procedure.

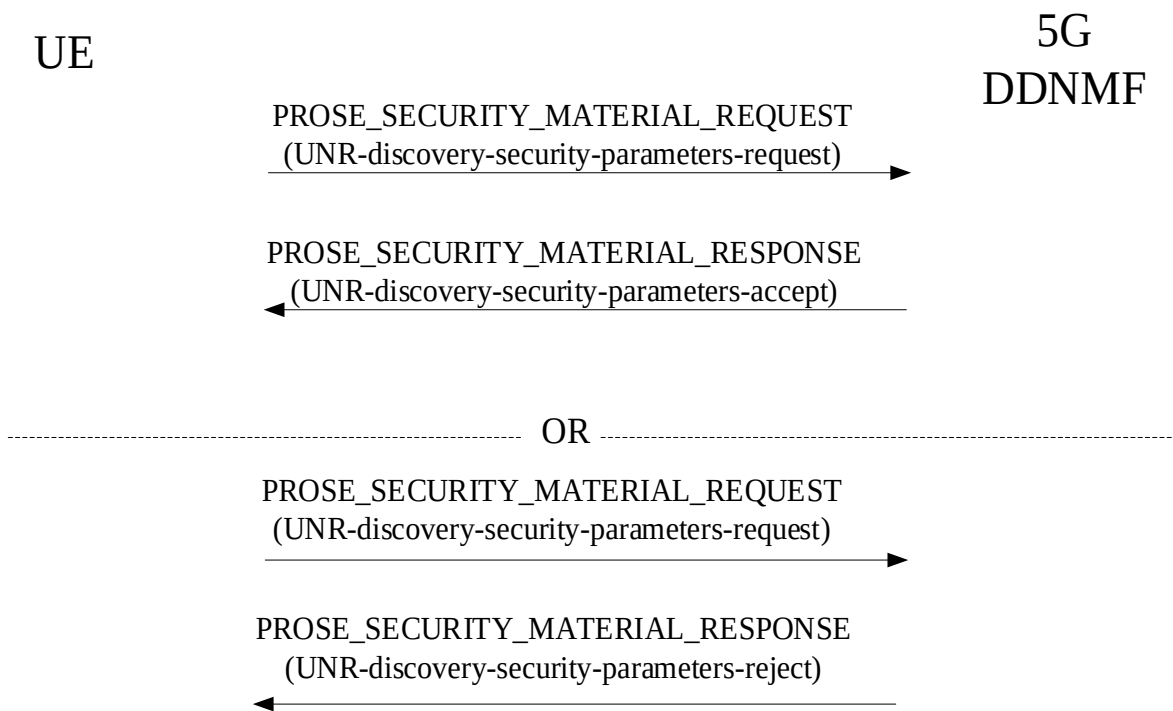


Figure 8.2.12.2.2.1: 5G ProSe UE-to-network relay discovery security material request procedure

8.2.12.2.2.3 5G ProSe UE-to-network relay discovery security material request procedure accepted by the 5G DDNMF

Upon receiving a PROSE_SECURITY_MATERIAL_REQUEST message with the <UNR-discovery-security-parameters-request> element, if:

- the UE requests the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE only and the PROSE_SECURITY_MATERIAL_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe remote UE;
- the UE requests the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE only and the PROSE_SECURITY_MATERIAL_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe UE-to-network relay UE; or
- the UE requests the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE and the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE and the PROSE_SECURITY_MATERIAL_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe UE-to-network relay UE and authorized to act as a 5G ProSe remote UE;

the 5G DDNMF shall send a PROSE_SECURITY_MATERIAL_RESPONSE message containing a <UNR-discovery-security-parameters-accept> element. In the <UNR-discovery-security-parameters-accept> element, the 5G DDNMF:

- shall include the transaction ID set to the value of the transaction ID received in the PROSE_SECURITY_MATERIAL_REQUEST message;

- b) if the UE requests the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE:
- 1) shall include zero or more 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE. In each of the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE, the 5G DDNMF:
 - A) shall include the expiration timer of the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE; and
 - B) for the received relay service code for which the UE is authorized to act as a 5G ProSe remote UE:
 - i) if the requested model is not indicated in the PROSE_SECURITY_MATERIAL_REQUEST message or is set to "model A", may include the code-receiving security parameters for model A containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - ii) if the requested model is not indicated in the PROSE_SECURITY_MATERIAL_REQUEST message or is set to "model B", may include the code-receiving security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask and the code-sending security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - iii) shall include the selected ciphering algorithm; and
 - iv) shall include the PLMN ID for which the security parameters are associated; and

NOTE: In case of SNPN, the PLMN ID is the PLMN ID of the subscribed SNPN.

- 2) may include the PC5 security policies for the received relay service code for 5G ProSe remote UE. In the PC5 security policies per relay service code for 5G ProSe remote UE, the 5G DDNMF:
 - A) for the received relay service code for which the UE is authorized to act as a 5G ProSe remote UE:
 - i) shall include the PC5 security policies;
- c) if the UE requests the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE:
 - 1) shall include the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE. In the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE, the 5G DDNMF:
 - A) shall include the expiration timer of the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE; and
 - B) for the received relay service code for which the UE is authorized to act as a 5G ProSe UE-to-network relay UE:
 - i) if the requested model is not indicated in the PROSE_SECURITY_MATERIAL_REQUEST message or is set to "model A", may include the code-sending security parameters for model A containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - ii) if the requested model is not indicated in the PROSE_SECURITY_MATERIAL_REQUEST message or is set to "model B", may include the code-receiving security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask and the code-sending security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask; and
 - iii) shall include the selected ciphering algorithm; and
 - 2) may include the PC5 security policies for the received relay service code for 5G ProSe UE-to-network relay UE. In the PC5 security policies for the received relay service code for 5G ProSe UE-to-network relay UE, the 5G DDNMF:
 - A) for the received relay service code for which the UE is authorized to act as a 5G ProSe UE-to-network relay UE:

- i) shall include the PC5 security policies; and
- d) shall include the current time set to the current UTC-based time at the 5G DDNMF and the max offset.

If the UE requests the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE, the UE identity in the PROSE_SECURITY_MATERIAL_REQUEST message indicates a UE authorized to act as a 5G ProSe remote UE and the PROSE_SECURITY_MATERIAL_REQUEST message contains a list of PLMN identities of the visited PLMNs, the 5G DDNMF shall include in the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE any information received from 5G DDNMFs that are discovered based on the provided list of PLMN identities of potential 5G ProSe UE-to-network relay UEs which can serve the UE. If the PROSE_SECURITY_MATERIAL_REQUEST message does not contain a list of PLMN identities of the visited PLMNs, the 5G DDNMF may get the PLMN identities of potential 5G ProSe UE-to-network relay UEs through different means such as local configurations. In case of SNPN, the PLMN ID is the PLMN ID of the subscribed SNPN of the potential 5G ProSe UE-to-network relay UEs.

8.2.12.2.2.4 5G ProSe UE-to-network relay discovery security material request procedure completion by the UE

Upon receipt of the PROSE_SECURITY_MATERIAL_RESPONSE message with the <UNR-discovery-security-parameters-accept>, if the transaction ID contained in the <UNR-discovery-security-parameters-accept> element matches the value sent by the UE in a PROSE_SECURITY_MATERIAL_REQUEST message with the <UNR-discovery-security-parameters-request> element, the UE:

- a) if the PROSE_SECURITY_MATERIAL_RESPONSE message contains one or more 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE:
 - 1) shall store the one or more 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE, each associated with its received PLMN ID, shall stop timer T5078, if running and shall start timer T5078 with the value of the expiration timer indicated in the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE; and

NOTE: In case of SNPN, the PLMN ID is the PLMN ID of the subscribed SNPN.

- 2) if the PC5 security policies for the relay service code for 5G ProSe remote UE are received, shall store the PC5 security policies for the relay service code for 5G ProSe remote UE;
- b) if the PROSE_SECURITY_MATERIAL_RESPONSE message contains the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE:
 - 1) shall store the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE, shall stop timer T5079, if running and shall start timer T5079 with the value of the expiration timer indicated in the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE; and
 - 2) if the PC5 security policies for the relay service code for 5G ProSe UE-to-network relay UE are received, shall store the PC5 security policies for the relay service code for 5G ProSe UE-to-network relay UE; and
- c) shall set a ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter and store the received max offset.

8.2.12.2.2.5 5G ProSe UE-to-network relay discovery security material request procedure not accepted by the 5G DDNMF

If the PROSE_SECURITY_MATERIAL_REQUEST message with the <UNR-discovery-security-parameters-request> element cannot be accepted by the 5G DDNMF, the 5G DDNMF shall send a PROSE_SECURITY_MATERIAL_RESPONSE message containing a <UNR-discovery-security-parameters-reject> element. In the <UNR-discovery-security-parameters-reject> element, the 5G DDNMF shall include the transaction ID set to the value of the transaction ID received in the PROSE_SECURITY_MATERIAL_REQUEST message and shall include an appropriate PC3a control protocol cause value.

Upon receipt of the PROSE_SECURITY_MATERIAL_RESPONSE message with the <UNR-discovery-security-parameters-reject> element, if the transaction ID contained in the <UNR-discovery-security-parameters-reject> element matches the value sent by the UE in a PROSE_SECURITY_MATERIAL_REQUEST message with the <UNR-

discovery-security-parameters-request> element, the UE shall consider the 5G ProSe UE-to-network relay discovery security material request procedure as rejected.

8.2.12.2.2.6 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of PROSE_SECURITY_MATERIAL_REQUEST message (e.g. after TCP retransmission timeout).

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the 5G ProSe UE-to-network relay discovery security material request procedure.

- b) No response from the 5G DDNMF after the PROSE_SECURITY_MATERIAL_REQUEST message has been successfully delivered (e.g. TCP ACK has been received for the PROSE_SECURITY_MATERIAL_REQUEST message)

The UE shall retransmit the PROSE_SECURITY_MATERIAL_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

8.2.12.2.2.7 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of PROSE_SECURITY_MATERIAL_RESPONSE message.

After receiving an indication from lower layer that the PROSE_SECURITY_MATERIAL_RESPONSE message has not been successfully acknowledged (e.g. TCP ACK is not received), the 5G DDNMF shall abort the procedure.

8.2.13 Communication path switching between 5G ProSe UE-to-network relays

8.2.13.1 General

For a 5G ProSe remote UE accessing the network via a 5G ProSe UE-to-network relay UE, if the related conditions specified in clause 8.2.3.2 are met, the 5G ProSe remote UE:

- a) may perform the procedure of target UE-to-network relay discovery and selection for communication path switching as specified in clause 8.2.13.2; and
 - 1) if a target 5G ProSe UE-to-network relay UE which can provide the same connectivity service (i.e. same relay service code) as the source 5G ProSe UE-to-network relay UE provides to the 5G ProSe remote UE is selected, shall perform procedures of communication path switching from the source 5G ProSe UE-to-network relay UE to the target 5G ProSe UE-to-network relay UE as specified in clause 8.2.13.3, clause 8.2.13.4 or clause 8.2.13.5,
 - 2) otherwise, may (re-)evaluate the URSP, if any, as specified clause 6.5.4 of 3GPP TS 23.304 [2].

8.2.13.2 Target UE-to-network relay discovery and selection for communication path switching

In order to discover a target 5G ProSe UE-to-network relay UE, the 5G ProSe remote UE shall initiate monitoring procedure for UE-to-network relay discovery as specified in clause 8.2.1.2.3, discoverer procedure for UE-to-network relay discovery as specified in clause 8.2.1.3.1 or both, depending on UE's configuration parameters for 5G ProSe UE-to-network relay as specified in clause 5.2.5, with following additions:

- a) for monitoring procedure for UE-to-network relay discovery, in the PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement received from the announcing UE, the 5G ProSe remote UE shall monitor the same relay service code as provided by the source 5G ProSe UE-to-network relay UE; and
- b) for discoverer procedure for UE-to-network relay discovery, in the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation, the 5G ProSe remote UE shall set the relay service code parameter to the same relay service code as provided by the source 5G ProSe UE-to-network relay UE.

NOTE 1: The connectivity service in a) and b) above refers to 5G ProSe layer-2 UE-to-network relay service, 5G ProSe layer-3 UE-to-network relay service with the set of PDU session parameters, or 5G ProSe layer-3 UE-to-network relay service using N3IWF access for the relayed traffic.

NOTE 2: In a) and b) above, specifying that the 5G ProSe remote UE use the same relay service code that was used with the source 5G ProSe UE-to-network relay UE ensures that the same security mechanism (i.e. either the security procedure over control plane or the security procedure over user plane as specified in 3GPP TS 33.503 [34]) is used with the target 5G ProSe UE-to-network relay UE.

NOTE 3: In a) and b) above, specifying that the 5G ProSe remote UE uses the same relay service code that was used with the source 5G ProSe UE-to-network relay UE ensures that the same type of the 5G ProSe UE-to-network relay (i.e. 5G ProSe layer-2 UE-to-network relay, 5G ProSe layer-3 UE-to-network relay without N3IWF or ProSe layer-3 UE-to-network relay with N3IWF) is selected.

If the target 5G ProSe UE-to-network relay UE with the same relay service code as provided by the source 5G ProSe UE-to-network relay UE is available after the execution of the above discovery procedure(s), the 5G ProSe remote UE shall perform the UE-to-network relay selection procedure as specified in clause 8.2.2 and shall perform the procedure of path switching as specified in clause 8.2.13.3, clause 8.2.13.4 or clause 8.2.13.5. Otherwise, the 5G ProSe remote UE may:

- a) (re-)evaluate the URSP, if any, as specified in in clause 6.5.4 of 3GPP TS 23.304 [2];
- b) perform the procedure of target UE-to-network relay discovery and selection for communication path switching as specified in this clause; and
- c) perform the procedure of path switching as specified in clause 8.2.13.3, clause 8.2.13.4 or clause 8.2.13.5.

8.2.13.3 Path switching to 5G ProSe layer-3 UE-to-network relay without N3IWF

If a 5G ProSe layer-3 UE-to-network relay without N3IWF is selected as the target 5G ProSe UE-to-network relay UE, the 5G ProSe remote UE shall perform the procedure of 5G ProSe communication via 5G ProSe layer-3 UE-to-network relay without N3IWF as specified in clause 6.5.1.1 of 3GPP TS 23.304 [2]. In this case, the service continuity support is used by the application layer procedures which is out of scope of the present specification.

8.2.13.4 Path switching to 5G ProSe layer-3 UE-to-network relay with N3IWF

If a 5G ProSe layer-3 UE-to-network relay with N3IWF is selected as the target 5G ProSe UE-to-network relay UE, the 5G ProSe remote UE shall perform the procedure as specified in clause 8.2.7 with following additions:

- a) if the source 5G ProSe UE-to-network relay UE is a 5G ProSe layer-3 UE-to-network relay with N3IWF, the 5G ProSe remote UE shall select the same N3IWF which is connected with the source 5G ProSe layer-3 UE-to-network relay UE and use MOBIKE as specified in IETF RFC 4555 [52] if the 5G ProSe remote UE supports IETF RFC 4555 [52];
- b) if the source 5G ProSe UE-to-network relay UE is a 5G ProSe layer-3 UE-to-network relay without N3IWF, the service continuity support is used by the application layer procedures which is out of scope of the present specification; and
- c) if the source 5G ProSe UE-to-network relay UE is a 5G ProSe layer-2 UE-to-network relay, the 5G ProSe remote UE shall perform handover of a PDU session procedure from 3GPP to untrusted non-3GPP access as specified in clause 4.9.2.2 of 3GPP TS 23.502 [51].

8.2.13.5 Path switching to 5G ProSe layer-2 UE-to-network relay

If a 5G ProSe layer-2 UE-to-network relay is selected as the target 5G ProSe UE-to-network relay UE, the 5G ProSe remote UE shall perform the procedure of 5G ProSe communication via 5G ProSe layer-2 UE-to-network relay as specified in clause 6.5.2 of 3GPP TS 23.304 [2] with following additions:

- a) if the source 5G ProSe UE-to-network relay UE is a 5G ProSe layer-3 UE-to-network relay with N3IWF, the 5G ProSe remote UE shall perform handover of a PDU session procedure from untrusted non-3GPP to 3GPP access as specified in clause 4.9.2.1 of 3GPP TS 23.502 [51];
- b) if the source 5G ProSe UE-to-network relay UE is a 5G ProSe layer-3 UE-to-network relay without N3IWF, the service continuity support is used by the application layer procedures which is out of scope of the present specification; or
- c) if the source 5G ProSe UE-to-network relay UE is a 5G ProSe layer-2 UE-to-network relay, the procedure for path switching is specified in 3GPP TS 38.300 [21].

8.2.14 5G ProSe public warning notification relay procedure

8.2.14.1 General

The purpose of the 5G ProSe public warning notification relay procedure is for the 5G ProSe UE-to-network relay UE to broadcast the warning message specified in 3GPP TS 23.041 [54] received from the network to the 5G ProSe remote UE(s) nearby. Broadcast mode 5G ProSe direct communication over PC5 is used for broadcasting the warning message. A 5G ProSe remote UE can receive the broadcasted warning message without establishing a connection to the 5G ProSe UE-to-network Relay for the relay service code based on the configuration as specified in clause 5.2.5.

NOTE: If the 5G ProSe layer-2 UE-to-network relay UE is not configured with the destination layer-2 ID for broadcasting warning messages, 5G ProSe layer-2 UE-to-network relay UE forwards the SIB messages (i.e. SIB 6/7/8) for public warning system to a connected 5G ProSe layer-2 remote UE over the unicast link as specified in 3GPP TS 38 300 [21].

8.2.14.2 5G ProSe public warning notification relay procedure initiation for 5G ProSe layer-3 UE-to-network relay

The 5G ProSe UE-to-network relay UE broadcasts the public warning notification messages if the 5G ProSe UE-to-network relay UE receives the public warning notification message from the network as specified in 3GPP TS 23.041 [54].

NOTE: The 5G ProSe UE-to-network relay UE can perform the duplication detection function as specified in 3GPP TS 23.041 [54] to suppress received duplicated warning messages over Uu in order to avoid broadcasting the duplicated warning message over PC5.

The 5G ProSe UE-to-network relay UE shall start broadcasting the received public warning notification message if:

- a) the 5G ProSe UE-to-network relay UE is served by NG-RAN for 5G ProSe communication;
- b) the 5G ProSe UE-to-network relay UE is authorised to act as a 5G ProSe UE-to-network relay UE;
- c) either the registered PLMN is in the list of PLMNs in which the UE is authorized to use 5G ProSe communication over PC5, or the registered SNPN is the subscribed SNPN in which the UE is authorized to use 5G ProSe communication over PC5, when the UE is served by NG-RAN for 5G ProSe communication over PC5 as specified in clause 5.2.4; and
- d) the 5G ProSe UE-to-network relay UE is configured with the default destination layer-2 ID for broadcasting warning messages and the PC5 QoS parameters for broadcasting warning messages.

The UE shall include 5G ProSe public warning notification relay message in a protocol data unit with following parameters:

- a) data unit(s) includes the public warning notification message received from the network;
- b) a layer-3 protocol data unit type (see 3GPP TS 38.323 [16]) set to unstructured;

- c) the source layer-2 ID set to the layer-2 ID self-assigned by the UE for 5G ProSe communication over PC5 as specified in clause 7.3.2.1.2;
- d) the destination layer-2 ID set to the destination layer-2 ID configured for broadcasting warning message over PC5 as specified in clause 5.2.5;
- e) the PQFI set to the value corresponding to the configured PC5 QoS parameters for broadcasting warning messages as specified in clause 5.2.5; and
- f) the NR Tx profile based on the configuration for broadcasting warning message over PC5 as specified in clause 5.2.5.

Then the UE shall request radio resources for 5G ProSe communication over PC5 as specified in 3GPP TS 38.300 [21] and pass the data unit(s) on the PC5 QoS flow identified by the PQFI to lower layers for transmission.

If the UE is camped on a serving cell indicating that 5G ProSe communication over PC5 is supported by the network, but not broadcasting any carrier frequencies and radio resources for 5G ProSe communication over PC5 as specified in 3GPP TS 38.331 [13], the UE shall request radio resources for 5G ProSe communication over PC5 as specified in 3GPP TS 24.501 [11].

8.2.14.3 Reception of 5G ProSe public warning notification relay message

The 5G ProSe remote UE is configured with a destination layer-2 ID(s) for reception of data unit(s) over PC5 carrying 5G ProSe public warning notification relay message. The 5G ProSe remote UE is a receiving UE for this procedure.

The receiving UE shall determine the PC5 QoS parameter and the NR Tx profile for the 5G ProSe public warning notification relay based on the configuration as specified in clause 5.2.5, and shall provide the PC5 QoS parameters, the NR Tx profile, and the destination layer-2 ID for the 5G ProSe public warning notification relay to lower layers.

For each received protocol data unit over PC5, the receiving UE shall check if the destination layer-2 ID of the received protocol data unit matches one of the configured destination layer-2 ID for the 5G ProSe public warning notification relay. If yes, the UE shall then check whether the protocol data unit type as defined 3GPP TS 38.323 [16] provided by the lower layers for the received packet is set to Unstructured and pass the protocol data unit to the corresponding upper layer entity for public warning system.

NOTE: The 5G ProSe remote UE can perform the duplication detection function as specified in 3GPP TS 23.041 [54] to detect duplicated warning messages received over PC5 and/or Uu, for example, if there are multiple 5G ProSe UE-to-network relay UE broadcasting the warning messages.

8.2.15 Multi-path communication via a PDU session and via 5G ProSe UE-to-network relay

8.2.15.1 General

This clause describes the procedures to support multi-path communication via a PDU session (direct path) and via 5G ProSe UE-to-network relay (indirect path).

8.2.15.2 Multi-path communication via a PDU session and via 5G ProSe layer-3 UE-to-network relay

Based on the URSP as specified in 3GPP TS 24.526 [5], the UE may access the network through multi-path communication, i.e., via a PDU session (direct path) and via a 5G ProSe layer-3 UE-to-network relay UE (indirect path).

For the 5G ProSe remote UE, to access the network via a 5G ProSe layer-3 UE-to-network relay UE (the indirect path), the 5G ProSe remote UE:

- a) if there is no existing connection with a 5G ProSe layer-3 UE-to-network relay UE for the needed RSC;
 - 1) shall perform the procedures of UE-to-network relay discovery and UE-to-network relay selection as specified in clause 8.2.1 and clause 8.2.2 in order to select a 5G ProSe layer-3 UE-to-network relay UE; and

- 2) shall establish a connection with the selected 5G ProSe layer-3 UE-to-network relay UE by performing the procedure of 5G ProSe direct link establishment procedure as specified in clause 7.2.2; or
- b) if there is an existing connection with a 5G ProSe layer-3 UE-to-network relay UE for the needed RSC:
 - 1) may modify the existing connection with a 5G ProSe layer-3 UE-to-network relay UE by performing the procedure of 5G ProSe direct link modification procedure as specified in clause 7.2.3.

For the 5G ProSe remote UE, to access the network via a PDU session (the direct path), the UE establishes a new PDU session or, if needed, modifies an existing PDU session as specified in 3GPP TS 24.501 [11]. If the indirect path consists of a 5G ProSe layer-3 UE-to-network relay with N3IWF support, the 5G ProSe remote UE, if needed, establishes the direct path by establishing a new MA PDU session or modifying an existing MA PDU session as specified in 3GPP TS 24.501 [11].

8.2.15.3 Multi-path communication via a PDU session and via 5G ProSe layer-2 UE-to-network relay

The procedure of multi-path communication via a PDU session and via 5G ProSe layer-2 UE-to-network relay is specified in 3GPP TS 38.300 [21].

8a 5G ProSe UE-to-UE relay

8a.1 Overview

This clause describes the procedures for 5G ProSe UE-to-UE relay.

8a.2 Procedures

8a.2.1 5G ProSe UE-to-UE relay discovery over PC5 interface

8a.2.1.1 General

This clause describes the procedures for both 5G ProSe layer-3 and layer-2 UE-to-UE relay discovery for public safety use and commercial services at a ProSe-enabled UE over the PC5 interface. The purpose of the 5G ProSe UE-to-UE relay discovery procedure over PC5 interface is to enable a ProSe-enabled UE to detect and identify another ProSe-enabled UE over PC5 interface for 5G ProSe UE-to-UE relay communication between two UEs with the assistance of a 5G ProSe UE-to-UE relay UE.

A 5G ProSe UE-to-UE relay supporting multiple relay service codes can advertise the relay service codes using multiple discovery messages, with one relay service code per discovery message.

To perform 5G ProSe UE-to-UE relay discovery over PC5 interface, the UE is configured with the related information as described in clause 5.2.7. The following models for 5G ProSe UE-to-UE relay discovery procedure over PC5 interface as specified in 3GPP TS 23.304 [2] are supported:

- a) Model A uses a single discovery protocol message (Announcement); and
- b) Model B uses two discovery protocol messages (Solicitation and Response).

NOTE: If the UE is authorized to perform both 5G ProSe UE-to-UE relay discovery Model A and 5G ProSe UE-to-UE relay discovery Model B, it is up to UE implementation to select which model to perform or perform both models simultaneously.

The 5G ProSe end UEs shall use the security materials provisioned by PC3a control protocol procedures for 5G ProSe direct discovery as specified in clause 6.2 to protect a direct discovery set so that the direct discovery set is transparent to the 5G ProSe UE-to-UE relay UE. The 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE shall use the security materials provisioned by 5G ProSe security procedure for 5G ProSe UE-to-UE relay as specified in clause 8a.2.11 or clause 8a.2.12 to protect the 5G ProSe UE-to-UE relay discovery messages.

The 5G ProSe UE-to-UE relay UE and 5G ProSe end UE may use the PC5 DRX mechanism to perform 5G ProSe UE-to-UE relay discovery over PC5 interface when the UE is not served by NG-RAN as specified in clause 5.2.7.

The following procedures are defined for 5G ProSe UE-to-UE relay discovery procedure over PC5 interface:

- a) 5G ProSe UE-to-UE relay discovery over PC5 interface with Model A:
 - 1) Announcing UE procedure for 5G ProSe UE-to-UE relay discovery initiation;
 - 2) Announcing UE procedure for 5G ProSe UE-to-UE relay discovery completion;
 - 3) Monitoring UE procedure for 5G ProSe UE-to-UE relay discovery initiation; and
 - 4) Monitoring UE procedure for 5G ProSe UE-to-UE relay discovery completion; and
- b) 5G ProSe UE-to-UE relay discovery over PC5 interface with Model B:
 - 1) Discoverer end UE procedure for 5G ProSe UE-to-UE relay discovery initiation;
 - 2) Discoverer end UE procedure for 5G ProSe UE-to-UE relay discovery completion;
 - 3) Relay UE procedure for UE-to-UE relay discovery initiation;
 - 4) Relay UE procedure for UE-to-UE relay discovery completion;
 - 5) Discoveree end UE procedure for 5G ProSe UE-to-UE relay discovery initiation; and
 - 6) Discoveree end UE procedure for 5G ProSe UE-to-UE relay discovery completion.

8a.2.1.2 UE-to-UE relay discovery over PC5 interface with model A

8a.2.1.2.1 General

In this procedure, the 5G ProSe end UE and 5G ProSe UE-to-UE relay UE may act as an "announcing UE" and the "monitoring UE".

8a.2.1.2.2 Announcing UE relay discovery for UE-to-UE relay discovery

8a.2.1.2.2.1 General

The purpose of the announcing UE procedure for UE-to-UE relay discovery is:

- a) to enable a ProSe-enabled UE to announce availability of a connectivity service provided by a UE-to-UE relay of the ProSe-enabled UE to other ProSe-enabled UEs, upon a request from upper layers as defined in 3GPP TS 23.304 [2]; or
- b) to enable a ProSe-enabled UE to measure the PROSE PC5 DISCOVERY message signal strength between the ProSe-enabled UE and the 5G ProSe UE-to-UE relay UE(s) for UE-to-UE relay selection/reselection.

8a.2.1.2.2.2 Announcing UE procedure for UE-to-UE relay discovery initiation

The UE is authorised to perform the announcing UE procedure for UE-to-UE relay discovery if:

- a) the UE is authorised to act as a 5G ProSe UE-to-UE relay UE in the PLMN or subscribed SNPN indicated by the serving cell as specified in clause 5.2.7, and
 - 1) the UE is served by NG-RAN and the UE is authorised to perform 5G ProSe UE-to-UE relay discovery in the PLMN or subscribed SNPN as specified in clause 5; or
 - 2) the UE is authorised to perform 5G ProSe UE-to-UE relay discovery when not served by NG-RAN as specified in clause 5 and intends to use the provisioned radio resources for 5G ProSe UE-to-UE relay discovery;

- b) the UE is authorised to act as a 5G ProSe source end UE in the PLMN or subscribed SNPN indicated by the serving cell as specified in clause 5.2.7, and
 - 1) the UE is served by NG-RAN and the UE is authorised to perform 5G ProSe UE-to-UE relay discovery in the PLMN or subscribed SNPN as specified in clause 5; or
 - 2) the UE is authorised to perform 5G ProSe UE-to-UE relay discovery when not served by NG-RAN as specified in clause 5 and intends to use the provisioned radio resources for 5G ProSe UE-to-UE relay discovery; and
- c) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be announced as specified in clause 5.2.7 and the indicated security procedure for 5G ProSe UE-to-UE relay for the relay service code is supported by the UE as per 3GPP TS 33.503 [34]; and
 - 2) the user info ID for the 5G ProSe UE-to-UE relay discovery as specified in clause 5.2.7, if the UE is acting as 5G ProSe UE-to-UE relay UE;

otherwise, the UE is not authorised to perform the announcing UE procedure for UE-to-UE relay discovery.

The protected user info of 5G ProSe end UE(s) shall be available in the announcing UE to perform the announcing UE procedure for UE-to-UE relay discovery. The protected user info of 5G ProSe end UE(s) may be retrieved from a previous 5G ProSe UE-to-UE relay discovery response message, or from a previous 5G ProSe UE-to-UE relay communication. The announcing UE shall store the list of the protected user info of 5G ProSe end UE(s) based on the validity timer(s) derived from the bit length of UTC-based counter LSB contents of the UTC-based counter LSB IE associated with the protected user info of 5G ProSe end UE as specified in clause 6.1.3.3 of 3GPP TS 33.503 [34]. If the validity timer associated with a protected user info of 5G ProSe end UE expires, the announcing UE shall remove the protected user info of 5G ProSe end UE from the stored list of protected user info of 5G ProSe end UE(s).

Figure 8a.2.1.2.2.2.1 illustrates the interaction of the UEs in the announcing UE procedure for UE-to-UE relay discovery.



Figure 8a.2.1.2.2.2.1: Announcing UE procedure for UE-to-UE relay discovery

When the UE is triggered by the upper layers to announce availability of a connectivity service provided by a 5G ProSe UE-to-UE relay, if the UE is authorised to perform the announcing UE procedure for UE-to-UE relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages for 5G ProSe UE-to-UE relay discovery as specified in 3GPP TS 38.331 [13], shall perform a service request procedure or mobility registration procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time as specified in clause 11.2.5;
- c) shall generate a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement according to clause 10.2.1. In the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement, the UE:
 - 1) shall set the UE-to-UE relay UE info parameter to the User info ID configured for the 5G ProSe UE-to-UE relay discovery, if the 5G ProSe UE-to-UE relay UE is acting as announcing UE, as specified in clause 5.2.7;
 - 2) shall set the relay service code parameter to the relay service code configured for the connectivity service to be announced, as specified in clause 5.2.7. If the UE is served by the NG-RAN, the security procedures selection is based on the relay service codes configured at the UE. Otherwise, the selected relay service code

configured at the UE shall be associated with the network assistance security indication indicating the security procedure without network assistance is to be used;

- 3) shall set the direct discovery set parameter to a list of stored protected user info of 5G ProSe end UE(s) of which the associated relay service code is the same as the relay service code to be announced, if the 5G ProSe UE-to-UE relay UE is acting as announcing UE;

NOTE 0: The 5G ProSe UE-to-UE relay UE announces protected user info of 5G ProSe end UEs in proximity only if the PC5 signal strength of the UEs in proximity measured by the 5G ProSe UE-to-UE relay is above the configured signal strength threshold as specified in 3GPP TS 38.331 [16]

- 3a) shall set the direct discovery set parameter to the user info of the source 5G ProSe end UE, if the source 5G end UE is acting as announcing UE;
- 4) shall include the MIC field computed as described in 3GPP TS 33.503 [34];
- 5) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
- 6) shall set the Resource status indicator bit of the status indicator parameter to indicate whether or not the UE has resources available to provide a connectivity service for 5G ProSe UE-to-UE relay for additional ProSe-enabled UEs, if the 5G ProSe UE-to-UE relay UE is acting as announcing UE;
- 7) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.12; and
- 8) shall include the PLMN ID set to its HPLMN ID and in cleartext;

NOTE 1: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 1A: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- d) shall apply the DUIK, DUSK or DUCK with the associated encrypted bitmask for the relay service code for 5G ProSe UE-to-UE relay discovery, along with the UTC-based counter, to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the destination layer-2 ID to the default destination layer-2 ID as specified in clause 5.2.7 and self-assign a source layer-2 ID for sending the 5G ProSe UE-to-UE relay discovery announcement; and

NOTE 1B: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.2.2, clause 6.2.15.2.2.2, clause 8.2.1.3.1.2 and clause 8a.2.1.3.1.2.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement to the lower layers for transmission over the PC5 interface with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery.

Until the UE is triggered by the upper layers to stop announcing availability of a connectivity service provided by a 5G ProSe UE-to-UE relay UE, or until the UE stops being authorised to perform the announcing UE procedure for UE-to-UE relay discovery,

- a) if the list of protected user info of 5G ProSe end UE(s) of which the associated relay service code is the same as the relay service code to be announced remains the same, the UE shall ensure that it keeps on passing the same PROSE PC5 DISCOVERY message along with the same source layer-2 ID, destination layer-2 ID, and an indication that the message is for 5G ProSe direct discovery to the lower layer for transmission,
- b) if the list of protected user info of 5G ProSe end UE(s) of which the associated relay service code is the same as the relay service code to be announced in the UE is updated, for example, new protected user info of 5G ProSe end UE(s) are available, or one or more protected user info of 5G ProSe end UE(s) are removed due to the associated validity timer(s) have expired, the UE shall generate and protect a new PROSE PC5 DISCOVERY message containing the updated list of protected user info of 5G ProSe end UE(s) of which the associated relay

service code are the same as the relay service code to be announced and pass the PROSE PC5 DISCOVERY message along with the source layer-2 ID, destination layer-2 ID, and an indication that the message is for 5G ProSe direct discovery to the lower layer for transmission, and

- c) if the protected user info of the source 5G ProSe end UE is updated, for example, new protected user info of the source 5G ProSe end UE is available, the UE shall generate and protect a new PROSE PC5 DISCOVERY message containing the updated protected user info of the source 5G ProSe end UE and pass the PROSE PC5 DISCOVERY message along with the source layer-2 ID, destination layer-2 ID, and an indication that the message is for 5G ProSe direct discovery to the lower layer for transmission.

NOTE 2: The announcing UE can stop announcing UE procedure for UE-to-UE relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

8a.2.1.2.2.3 Announcing UE procedure for UE-to-UE relay discovery completion

When the announcing UE is triggered by the upper layers to stop announcing availability for 5G ProSe UE-to-UE relay, when the announcing UE stops being authorised to perform the announcing UE procedure for UE-to-UE relay discovery, or none of the direct discovery set to be announced is available, the UE shall instruct the lower layers to stop announcing.

NOTE: The announcing UE can stop announcing UE procedure for UE-to-UE relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops announcing, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8a.2.1.2.3 Monitoring UE relay discovery for UE-to-UE relay discovery

8a.2.1.2.3.1 General

The purpose of the monitoring UE procedure for UE-to-UE relay discovery is:

- a) to enable a ProSe-enabled UE to become aware of proximity of a connectivity service provided by a 5G ProSe UE-to-UE relay UE, upon a request from upper layers as defined in 3GPP TS 23.304 [2]; or
- b) to enable a ProSe-enabled UE to perform measurements of signal strength of PROSE PC5 DISCOVERY messages from 5G ProSe UE-to-UE relay UE(s) for UE-to-UE relay selection/reselection.

8a.2.1.2.3.2 Monitoring UE procedure for UE-to-UE relay discovery initiation

The UE is authorised to perform the monitoring UE procedure for UE-to-UE relay discovery if:

- a) the following is true:
 - 1) the UE is not served by NG-RAN, is authorised to perform 5G ProSe UE-to-UE relay discovery using monitoring when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe UE-to-UE relay discovery when not served by NG-RAN;
 - 2) the UE is served by NG-RAN and is authorised to perform 5G ProSe UE-to-UE relay discovery monitoring in at least one PLMN or the subscribed SNPN; or
 - 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or

- C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
- ii) authorised to perform 5G ProSe UE-to-UE relay discovery using monitoring when the UE is not served by NG-RAN, and:
 - A) configured with the radio parameters to be used for 5G ProSe UE-to-UE relay discovery when not served by NG-RAN; and
- b) the UE is configured with the relay service code parameter identifying the connectivity service to be monitored, as specified in clause 5.2.7;

otherwise, the UE is not authorised to perform the monitoring UE procedure for UE-to-UE relay discovery.

Figure 8a.2.1.2.3.2.1 illustrates the interaction of the UEs in the monitoring UE procedure for UE-to-UE relay discovery.



Figure 8a.2.1.2.3.2.1: Monitoring UE procedure for UE-to-UE relay discovery

When the UE acting as 5G ProSe end UE is triggered by the upper layers to monitor proximity of a connectivity service provided by a 5G ProSe UE-to-UE relay UE or when the UE decides to perform 5G ProSe UE-to-UE relay reselection as specified in clause 8a.2.3, and if the UE is authorised to perform the monitoring UE procedure for UE-to-UE relay discovery, then the UE shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages with the default destination layer-2 ID as specified in clause 5.2.7.

Upon reception of a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to discover, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to discover, the UE shall obtain a valid UTC time from the lower layers and generate a UTC-based counter corresponding to this UTC time, and use it to recover the UTC-based counter associated with the PROSE PC5 DISCOVERY message and the UTC-based counter associated with the direct discovery set. The UE shall use the associated DUSK, if received from the 5G DDNMF (if security procedure over control plane for 5G ProSe UE-to-UE relay is used) or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used) and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF (if security procedure over control plane for 5G ProSe UE-to-UE relay is used) or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUCK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF (if security procedure over control plane for 5G ProSe UE-to-UE relay is used) or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUIK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement.

If a DUSK is included in the code-receiving security parameter for the ProSe service which the UE is authorized to discover (see clause 6.2.6), the UE shall use DUSK and the UTC-based counter associated with the direct discovery set, in order to unscramble the direct discovery set IE as described in 3GPP TS 33.503 [34]. Then if a DUCK is included in the code-receiving security parameter, the UE shall use the DUCK and the UTC-based counter associated with the direct discovery set, in order to decrypt the direct discovery set IE, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is included in the code-receiving security parameter, the UE shall use the DUIK and the UTC-based counter associated with the direct discovery set, in order to verify the MIC for the direct discovery set IE.

NOTE: The UE can determine the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement is for 5G ProSe direct discovery based on an indication from the lower layer.

Then if:

- a) the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement is the same as the relay service code parameter configured as specified in clause 5 for the connectivity service being monitored; and
- b) at least one of the protected user info of 5G ProSe end UE(s) from the direct discovery set IE included in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement contains the application layer ID of the target end UE provided by upper layers for the connectivity service being monitored,

then the UE shall consider that the connectivity service the UE seeks to monitor has been discovered. In addition, the UE can measure the signal strength of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement for 5G ProSe UE-to-UE relay selection or reselection.

The 5G ProSe UE-to-UE relay UE acting as monitoring UE upon receiving the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement from the 5G ProSe source end UE acting as an announcing UE, may include the received protected user info of the 5G ProSe source end UE as received, in the Direct Discovery Set included in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement.

8a.2.1.2.3.3 Monitoring UE procedure for UE-to-UE relay discovery completion

When the UE is triggered by the upper layers to stop monitoring proximity of other UEs for 5G ProSe UE-to-UE relay, or when the UE stops being authorised to perform the monitoring UE procedure for UE-to-UE relay discovery, the UE shall instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8a.2.1.3 UE-to-UE relay discovery over PC5 interface with model B

8a.2.1.3.1 General

In the following procedures, the 5G ProSe end UE sending the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation is called the "discoverer end UE" and the other 5G ProSe end UE is called the "discoveree end UE".

8a.2.1.3.2 Discoverer end UE procedure for UE-to-UE Relay discovery

8a.2.1.3.2.1 General

The purpose of the discoverer end UE procedure for UE-to-UE Relay discovery is:

- a) to enable a ProSe-enabled UE to solicit proximity of a connectivity service provided by a 5G ProSe UE-to-UE relay UE, upon a request from upper layers; or
- b) to enable a ProSe-enabled UE to measure the PROSE PC5 DISCOVERY message signal strength between the ProSe-enabled UE and the 5G ProSe UE-to-UE relay UE(s) for UE-to-UE relay selection/reselection.

8a.2.1.3.2.2 Discoverer end UE procedure for UE-to-UE relay discovery initiation

The UE is authorised to perform the discoverer end UE procedure for UE-to-UE relay discovery if:

- a) one of the following is true:
 - 1) the UE is not served by NG-RAN, is authorised to act as a 5G ProSe end UE towards a 5G ProSe UE-to-UE relay UE and is configured with the radio parameters to be used for ProSe UE-to-UE relay discovery when not served by NG-RAN;
 - 2) the UE is served by NG-RAN, is authorised to act as a 5G ProSe end UE towards a 5G ProSe UE-to-UE relay UE; or
 - 3) the UE is:

- i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to act as a 5G ProSe end UE towards a 5G ProSe UE-to-UE relay UE when the UE is not served by NG-RAN and configured with the radio parameters to be used for ProSe UE-to-UE relay discovery use when not served by NG-RAN; and
- b) the UE is configured with:
- 1) the relay service code parameter identifying the connectivity service provided by a 5G ProSe UE-to-UE relay to be solicited as specified in clause 5.2.7 and the indicated security procedure for the relay service code is supported by the UE;

otherwise, the UE is not authorised to perform the discoverer end UE procedure for UE-to-UE relay discovery.

Figure 8a.2.1.3.2.2.1 illustrates the interaction of the UEs in the discoverer end UE procedure for UE-to-UE relay discovery.

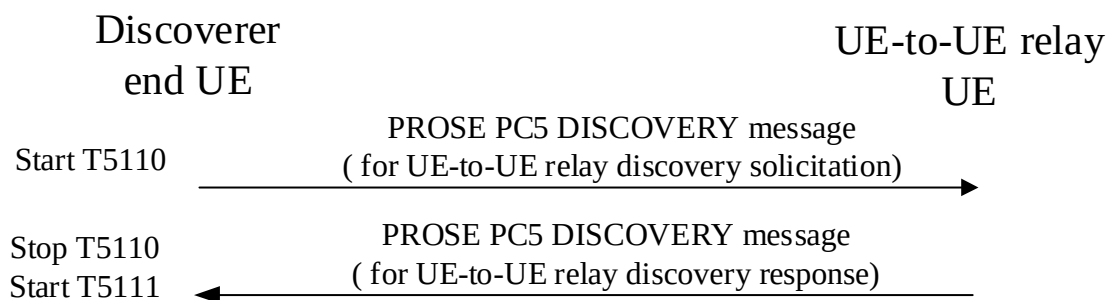


Figure 8a.2.1.3.2.2.1: Discoverer end UE procedure for UE-to-UE Relay discovery

For PROSE PC5 DISCOVERY message signal strength measurement, the UE manages a periodic measurement timer T5111, which is used to trigger the periodic PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe UE-to-UE relay UE with which the UE has a link established. It is started whenever the UE has established a direct link with a 5G ProSe UE-to-UE relay UE and restarted whenever the UE receives the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response from the 5G ProSe UE-to-UE relay UE with which the UE has a link established.

When the UE is triggered by the upper layers to solicit proximity of a connectivity service provided by a 5G ProSe UE-to-UE relay UE to communicate with a target discoveree end UE, or when the periodic measurement timer T5111 expires and if the UE is authorised to perform the discoverer end UE procedure for UE-to-UE relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages for relay discovery as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- c) shall generate a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation. In the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, the UE:

NOTE 0: If the UE has received more than one set of the <security-parameters-for-end-UE> each associated with different PLMN ID in the PROSE_SECURITY_PARAM_RESPONSE message or the PROSE_SECURITY_MATERIAL_RESPONSE message, the UE can generate multiple PROSE PC5 DISCOVERY messages for UE-to-UE relay discovery solicitation, where each message uses the parameters of different set of <security-parameters-for-end-UE> associated with each PLMN ID to form that message.

- 1) shall include the direct discovery set IE which contains the list of protected user infos as follows:
 - i) set the "protected user info 1" field to the protected user info of the discoveree end UE as described in table 11.2.17.1: the user info parameter set to the application layer ID of the discoveree end UE as provided by the upper layers, the corresponding MIC field computed as described in 3GPP TS 33.503 [34] for the discoveree user info, and the corresponding UTC-based counter LSB parameter set to the 4 least significant bits of the UTC-based counter; and
 - ii) set the "protected user info 2" field to the protected user info of the discoverer end UE as described in table 11.2.17.1: the user info parameter set to the application layer ID of the discoverer end UE as provided by the upper layers, the corresponding MIC field computed as described in 3GPP TS 33.503 [34] for the discoverer user info, and the corresponding UTC-based counter LSB parameter set to the 4 least significant bits of the UTC-based counter;and shall apply the DUSK or DUCK, along with the UTC-based counter, and the associated encrypted bitmask in the code-sending security parameter for the ProSe service received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used) as described in clause 6.2, to each of the application layer ID of the end UE as specified in 3GPP TS 33.503 [34];
- 2) void;
- 3) shall set the relay service code parameter to the relay service code parameter identifying the connectivity service to be solicited, configured in clause 5.2.7. The security procedure selection is based on the relay service codes configured at the UE.
- 4) shall include the MIC field computed as described in 3GPP TS 33.503 [34];
- 5) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
- 6) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.13;
- 7) may set the UE-to-UE relay UE info parameter to user info ID for the 5G ProSe UE-to-UE relay UE, if known e.g. during previous 5G ProSe UE-to-UE relay discovery or 5G ProSe UE-to-UE relay communication procedure(s);
- 8) shall include the announce prohibited indication with its value set as "It is prohibited to broadcast the user info " in the PC5 DISCOVERY message for UE-to-UE relay discovery solicitation if the discoverer UE needs to indicate to a 5G ProSe UE-to-UE relay UE that it is prohibited from broadcasting the user info of the discoverer end UE included in the direct discovery set during the procedure of 5G ProSe UE-to-UE relay discovery over PC5 interface with model A; and
- 9) shall include the PLMN ID set to the PLMN ID for which the used security parameters are associated and in cleartext;

NOTE 0A: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- d) shall apply the DUIK, DUSK or DUCK with the associated encrypted bitmask for the relay service code for 5G ProSe UE-to-UE relay discovery, along with the UTC-based counter, to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more of the above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the destination layer-2 ID to the default destination layer-2 ID as specified in clause 5.2.7 and self-assign a source layer-2 ID for sending the UE-to-UE relay discovery solicitation message; and

NOTE 1: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.1.2, clause 6.2.15.2.1.2, clause 8.2.1.2.2.2, clause 8.2.1.2.4.2 and clause 8a.2.1.2.2.2.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

If the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation is used to solicit proximity of a connectivity service provided by a 5G ProSe UE-to-UE relay UE, the UE shall ensure that it keeps on passing the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation for transmission until the UE is triggered by the upper layers to stop soliciting proximity of a connectivity service provided by a 5G ProSe UE-to-UE relay UE, or until the UE stops being authorised to perform the discoverer end UE procedure for UE-to-UE relay discovery. How this is achieved is left up to UE implementation.

NOTE 2: The discoverer end UE can stop discoverer end UE procedure for UE-to-UE relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

If the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation is used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe UE-to-UE relay UE with which the UE has a link established, the UE shall start the retransmission timer T5110. If retransmission timer T5110 expires, the UE shall retransmit the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation and restart timer T5110. If no response is received from the 5G ProSe UE-to-UE relay UE with which the UE has a link established after reaching the maximum number of allowed retransmissions, the UE shall trigger UE-to-UE relay reselection procedure.

NOTE 3: The maximum number of allowed retransmissions is UE implementation specific.

Upon reception of a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to discover, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to discover, the UE shall obtain a valid UTC time from the lower layers and generate a UTC-based counter corresponding to this UTC time and use it to recover the UTC-based counter associated with the PROSE PC5 DISCOVERY message and the UTC-based counter associated with the direct discovery set. The UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used) and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUCK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUIK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response.

The UE shall further use the DUSK in code-receiving security parameter for the ProSe service which the UE is authorized to discover (see clause 6.2.7) and the UTC-based counter associated with the direct discovery set to unscramble the direct discovery set IE in the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then if a DUCK is included in the code-receiving security parameter, the UE shall use the DUCK and the UTC-based counter associated with the direct discovery set to decrypt the direct discovery set IE, as described in 3GPP TS 33.503 [34]. The UE shall verify whether the application layer ID of the discoveree end UE in the decrypted direct discovery set matches the application layer ID of target discoveree end UE provided by the upper layers; if not, the UE shall discard the PROSE PC5 DISCOVERY message. Finally, if the application layer IDs match and a DUIK is included in the code-receiving security parameter, the UE shall use the DUIK and the UTC-based counter associated with the direct discovery set to verify the MIC for the direct discovery set IE in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response.

NOTE 4: The UE can determine the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response is for 5G ProSe direct discovery based on an indication from the lower layer.

Then if:

- a) the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response is the same as the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation; and
- b) the application layer ID of the discoverer end UE received in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response is the same as the application layer ID of targeted discoverer end UE provided by upper layers for the connectivity service being solicited,

then the UE shall consider that the connectivity service the UE seeks to discover has been discovered. In addition, the UE can measure the signal strength of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response for relay selection or reselection. If the UE has received the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response from the 5G ProSe UE-to-UE relay UE with which the UE has a link established, the UE shall stop the retransmission timer T5110 and start the periodic measurement timer T5111.

8a.2.1.3.2.3 Discoverer end UE procedure for UE-to-UE relay discovery completion

When the UE is triggered by the upper layers to stop soliciting for proximity of a connectivity service provided by a 5G ProSe UE-to-UE relay UE, or when the UE stops being authorised to perform the discoverer end UE procedure for UE-to-UE relay discovery, the UE shall instruct the lower layers to stop the discoverer operation.

NOTE: The discoverer end UE can stop discoverer end UE procedure for UE-to-UE relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops discoverer operation, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8a.2.1.3.3 Relay UE procedure for UE-to-UE Relay discovery

8a.2.1.3.3.1 General

The purpose of the relay UE procedure for UE-to-UE relay discovery is to enable a ProSe-enabled UE with a UE-to-UE relay to respond to solicitation from other ProSe-enabled UEs on proximity of a connectivity service provided by the 5G ProSe UE-to-UE relay UE, upon a request from upper layers.

8a.2.1.3.3.2 Relay UE procedure for UE-to-UE relay discovery initiation

The UE is authorised to perform the relay UE procedure for UE-to-UE relay discovery if:

- a) the UE is authorised to act as a 5G ProSe UE-to-UE relay UE in the PLMN or the subscribed SNPN indicated by the serving cell, and
 - 1) the UE is served by NG-RAN; or
 - 2) the UE is not served by NG-RAN and intends to use the provisioned radio resources for 5G ProSe UE-to-UE relay discovery;
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be responded to as specified in clause 5.2.7 and the indicated security procedure for the relay service code is supported by the UE; and
 - 2) the user info ID for the 5G ProSe UE-to-UE relay discovery, as specified in clause 5.2.7. Otherwise, the UE is not authorised to perform the relay UE procedure for UE-to-UE relay discovery.

Figure 8a.2.1.3.3.2.1 illustrates the interactions between the 5G ProSe UE-to-UE relay UE and discoverer end UE in the relay UE procedure for UE-to-UE relay discovery.

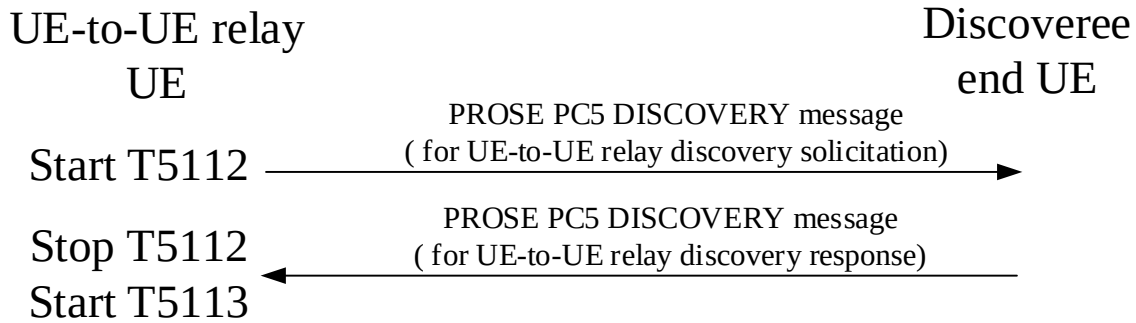


Figure 8a.2.1.3.3.2.1: Relay UE procedure for UE-to-UE Relay discovery with the discoverer end UE

When the UE is triggered by the upper layers to start responding to solicitation on proximity of a connectivity service provided by the UE-to-UE relay and if the UE is authorised to perform the relay UE procedure for UE-to-UE relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11]; and
- b) shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages.

Upon reception of a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, for the relay service code of the connectivity service which the UE is authorized to respond, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used) and the UTC-based counter obtained during the reception operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation.

NOTE 1: The UE can determine the received PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery solicitation is for 5G ProSe direct discovery based on an indication from the lower layer.

If the UE receives a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation which includes a relay service code associated with the network assistance security indication indicating the security procedure with network assistance is to be used and the UE is not served by NG-RAN, the UE shall ignore the PROSE PC5 DISCOVERY message.

If:

- a) the UE receives a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, and in this message:
 - 1) the relay service code parameter is the same as the relay service code parameter configured for the connectivity service as specified in clause 5.2.7; and
 - i) the UE is served by NG-RAN; or
 - ii) the UE is not served by NG-RAN and the relay service code is associated with the network assistance security indication indicating the security procedure without network assistance is to be used; or
 - 2) the UE-to-UE relay UE info parameter is not included, or the UE-to-UE relay UE info parameter is included and the same as the configured user info ID for the UE-to-UE relay discovery as specified in clause 5.2.7; or
- b) the periodic measurement timer T5113 expires,

then the UE:

- a) shall store the protected user info of the discoverer end UE, its validity time and the relay service code, if the announce prohibited indication is not included in the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, or if the announce prohibited indication is included therein and its value is set to "It is not prohibited to broadcast the user info".
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- c) shall generate a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation to the discoveree end UE. In the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, the UE:
 - 1) shall set the direct discovery set IE to the direct discovery set as included in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation received from the discoverer end UE;
 - 2) shall set the UE-to-UE relay UE info parameter to the configured user info ID for the 5G ProSe UE-to-UE relay discovery, as specified in clause 5.2.7;
 - 3) shall set the relay service code parameter to the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation received from the discoverer end UE;
 - 4) shall set the Resource status indicator bit of the status indicator parameter to indicate whether or not the UE has resources available to provide a connectivity service for additional ProSe-enabled UEs;
 - 5) shall include the MIC field computed as described in 3GPP TS 33.503 [34];
 - 6) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 7) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.14; and
 - 8) shall include the PLMN ID set to its HPLMN ID and in cleartext;

NOTE 1A: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 1B: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- d) shall apply the DUIK, DUSK, or DUCK with the associated encrypted bitmask for the relay service code for 5G ProSe UE-to-UE relay discovery, along with the UTC-based counter, to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more of the above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the destination layer-2 ID to the default destination layer-2 ID as specified in clause 5.2.7 and self-assign a source layer-2 ID for sending the UE-to-UE relay discovery solicitation message; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2, and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe discovery procedure over PC5 with a different discovery model e.g. as specified in clause 6.2.14.2.1.2, clause 6.2.15.2.1.2, clause 8.2.1.2.2.2, clause 8.2.1.2.4.2 and clause 8a.2.1.2.2.2.

NOTE 3: The UE implementation ensures that the value of the self-assigned source layer-2 ID is also different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe UE-to-UE relay discovery over PC5 with Model B. The source layer-2 ID is used to correlate the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response with the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, so that the UE can correctly send the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response to the discoverer end UE which initiated the Model B PROSE PC5 DISCOVERY procedure.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

For PROSE PC5 DISCOVERY message signal strength measurement, the UE manages a periodic measurement timer T5113, which is used to trigger the periodic PROSE PC5 DISCOVERY message signal strength measurement between

the UE and the discoveree end UE with which the UE has a link established. It is started whenever the UE has established a direct link with a discoveree end UE and restarted whenever the UE receives the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response from the discoveree end UE with which the UE has a link established.

If the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation is used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the discoveree end UE with which the UE has a link established, the UE shall start the retransmission timer T5112. If retransmission timer T5112 expires, the UE shall retransmit the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation and restart timer T5112. If no response is received from the discoveree end UE with which the UE has a link established after reaching the maximum number of allowed retransmissions, the UE shall trigger the 5G ProSe direct link release procedure.

NOTE 4: The maximum number of allowed retransmissions is UE implementation specific.

The UE shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages for UE-to-UE relay discovery response from the discoveree end UE.

Upon reception of a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response, for the target relay service code of the connectivity service which the UE is authorized to respond, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used) and the UTC-based counter obtained during the reception operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response.

NOTE 5: The UE can determine the received PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery response is for 5G ProSe direct discovery based on an indication from the lower layer.

If the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response is the same as the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation,

then the UE:

- a) shall store the protected user info of the discoveree end UE, its validity time, and the relay service code, if the announce prohibited indication is not included in the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response, or if the announce prohibited indication is included with the value set to "It is not prohibited to broadcast user info".
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- c) shall generate a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response. In the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response, the UE:
 - 1) shall set the direct discovery set IE to the direct discovery set as included in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response received from the discoveree end UE;
 - 2) shall set the UE-to-UE relay UE info parameter to the configured user info ID for the 5G ProSe UE-to-UE relay discovery, as specified in clause 5.2.7;
 - 3) shall set the relay service code parameter to the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response received from the discoveree end UE;
 - 4) shall set the Resource status indicator bit of the status indicator parameter to indicate whether or not the UE has resources available to provide a connectivity service for 5G ProSe UE-to-UE relay for additional ProSe-enabled UEs;
 - 5) shall include the MIC field computed as described in 3GPP TS 33.503 [34];
 - 6) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;

- 7) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.14; and
- 8) shall include the PLMN ID set to its HPLMN ID and in cleartext;

NOTE 5A: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 5B: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- d) shall apply the DUIK, DUSK, or DUCK with the associated encrypted bitmask for the relay service code for 5G ProSe UE-to-UE relay discovery, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more of the above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the destination layer-2 ID to the source layer-2 ID from the discoverer end UE used in the transportation of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation and self-assign a source layer-2 ID for sending the UE-to-UE relay discovery response message; and

NOTE 6: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

NOTE 7: If the UE is processing a PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the same source layer-2 ID of the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, it depends on UE implementation to avoid the conflict of destination layer-2 ID (e.g. send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #3 "conflict of layer-2 ID for unicast communication is detected", or ignore the PROSE DIRECT DISCOVERY message for UE-to-UE relay discovery solicitation).

Figure 8a.2.1.3.3.2.2 illustrates the interactions between the 5G ProSe UE-to-UE relay UE and discoverer end UE in the relay UE procedure for UE-to-UE relay discovery.

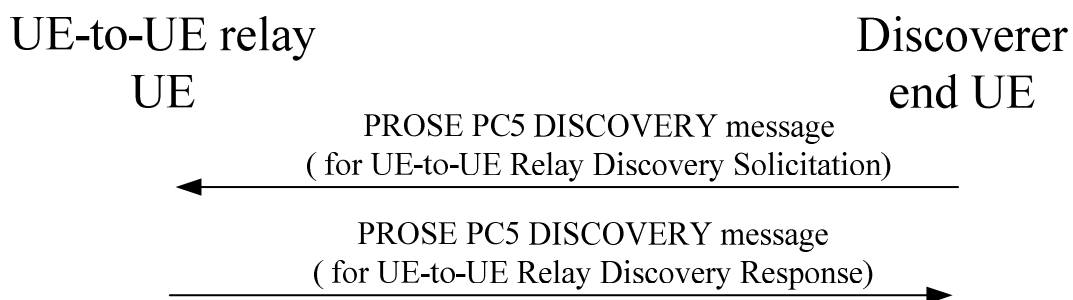


Figure 8a.2.1.3.3.2.2: Relay UE procedure for UE-to-UE relay discovery with the discoverer end UE

8a.2.1.3.3.3 Relay UE procedure for UE-to-UE relay discovery completion

When the UE is triggered by the upper layers to stop responding to solicitation on proximity of a connectivity service provided by a 5G ProSe UE-to-UE relay UE, or when the UE stops being authorised to perform the relay UE procedure for UE-to-UE relay discovery, the UE shall instruct the lower layers to stop monitoring.

NOTE: The 5G ProSe UE-to-UE relay UE can stop Relay UE procedure for UE-to-UE relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8a.2.1.3.4 Discoveree end UE procedure for UE-to-UE Relay discovery

8a.2.1.3.4.1 General

The purpose of the discoveree end UE procedure for UE-to-UE relay discovery is to enable a ProSe-enabled UE to respond to solicitation from other ProSe-enabled UEs on proximity of a connectivity service via a 5G ProSe UE-to-UE relay UE, upon a request from upper layers.

8a.2.1.3.4.2 Discoveree end UE procedure for UE-to-UE relay discovery initiation

The UE is authorised to perform the discoveree end UE procedure for UE-to-UE relay discovery if:

- a) the UE is authorised to act as a 5G ProSe end UE in the PLMN or the subscribed SNPN indicated by the serving cell, and
 - 1) the UE is served by NG-RAN; or
 - 2) the UE is not served by NG-RAN and intends to use the provisioned radio resources for 5G ProSe UE-to-UE relay discovery; and
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be responded to as specified in clause 5.2.7 and the indicated security procedure for the relay service code is supported by the UE;

otherwise, the UE is not authorised to perform the discoveree end UE procedure for UE-to-UE relay discovery.

Figure 8a.2.1.3.4.2.1 illustrates the interaction of the UEs in the discoveree end UE procedure for UE-to-UE relay discovery.

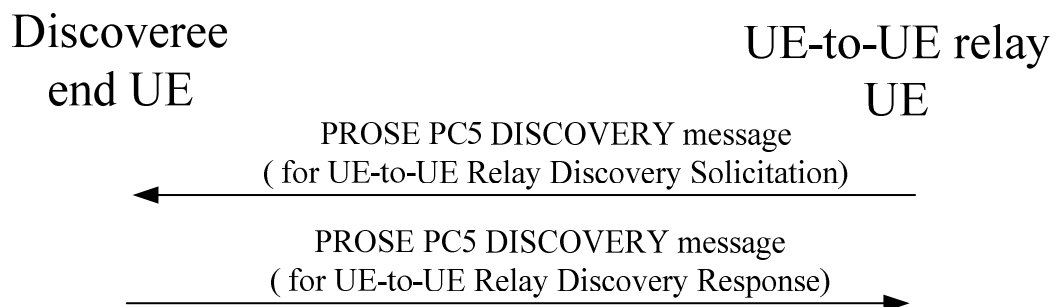


Figure 8a.2.1.3.4.2.1: Discoveree end UE procedure for UE-to-UE relay discovery

When the UE is triggered by the upper layers to start responding to solicitation on proximity of a connectivity service provided by a 5G ProSe UE-to-UE relay UE and if the UE is authorised to perform the discoveree end UE procedure for UE-to-UE relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11]; and
- b) shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages.

Upon reception of a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to respond, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to respond, the UE shall obtain a valid UTC time from the lower layers and generate a UTC-based counter corresponding to this UTC time, and use it to recover the UTC-based counter associated with the PROSE PC5 DISCOVERY message and the UTC-based counter associated with the direct discovery set. The UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used) and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security

procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUCK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUIK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation.

The UE shall further use the DUSK in code-receiving security parameter for the ProSe service which the UE is authorized for discovery (see clause 6.2.6) and the UTC-based counter associated with the direct discovery set to unscramble the direct discovery set IE in the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then if a DUCK is included in the code-receiving security parameter, the UE shall use the DUCK and the UTC-based counter associated with the direct discovery set to decrypt the direct discovery set IE, as described in 3GPP TS 33.503 [34]. The UE shall verify whether the application layer ID of the discoveree end UE in the decrypted direct discovery set matches the application layer ID of the UE as provided by the upper layers; if not, the UE shall discard the PROSE PC5 DISCOVERY message. Finally, if the application layer IDs match and a DUIK is included in the code-receiving security parameter, the UE shall use the DUIK and the UTC-based counter associated with the direct discovery set to verify the MIC for the direct discovery set IE in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation.

NOTE 1: The UE can determine the received PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery solicitation is for 5G ProSe direct discovery based on an indication from the lower layer.

Then, if:

- a) the relay service code parameter of the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation is the same as the relay service code parameter configured as specified in clause 5.2.7 for the connectivity service; and
- b) the application layer ID of discoveree end UE in the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation is the same as the application layer ID of the UE provided by upper layers ;

then the UE:

- a) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- b) shall generate a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response. In the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response, the UE:

1) shall include the direct discovery set IE which contains:

- i) the discoveree user info parameter set to the application layer ID of the UE provided by the upper layers, which is the same as the application layer ID of the discoveree end UE received in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, the corresponding MIC field computed as described in 3GPP TS 33.503 [34] for the discoveree user info, and the corresponding UTC-based counter LSB parameter set to the 4 least significant bits of the UTC-based counter; and
- ii) the discoverer user info parameter set to the application layer ID of the discoverer end UE received in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation from the 5G ProSe UE-to-UE relay UE, the corresponding MIC field computed as described in 3GPP TS 33.503 [34] for the discoverer user info, and the corresponding UTC-based counter LSB parameter set to the 4 least significant bits of the UTC-based counter;

and shall apply the DUSK or DUCK, along with the UTC-based counter, and the associated encrypted bitmask in the code-sending security parameter for the ProSe service received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used) as described in clause 6.2, to each of the application layer ID of the end UE as specified in 3GPP TS 33.503 [34];

- 2) void;
- 3) shall set the relay service code parameter to the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation;
- 4) shall include the MIC field computed as described in 3GPP TS 33.503 [34];

- 5) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter; and
- 6) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.14;
- 7) shall include the announce prohibited indication with its value set as "It is prohibited to broadcast the user info" in the PC5 DISCOVERY message for UE-to-UE relay discovery response if the discoveree UE needs to indicate to the 5G ProSe UE-to-UE relay UE that it is prohibited from broadcasting user info of the discoveree end UE included in the direct discovery set during the procedure of 5G ProSe UE-to-UE relay discovery over PC5 interface with model A; and
- 8) shall include the PLMN ID set to the PLMN ID for which the used security parameters are associated and in cleartext;

NOTE 1A: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- c) shall apply the DUIK, DUSK, or DUCK with the associated encrypted bitmask for the relay service code for 5G ProSe UE-to-UE relay discovery, along with the UTC-based counter, to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more of the above parameters, as specified in 3GPP TS 33.503 [34];
- d) shall set the destination layer-2 ID to the source layer-2 ID from the 5G ProSe UE-to-UE relay UE used in the transportation of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation and self-assign a source layer-2 ID for sending the UE-to-UE relay discovery response message; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

- e) shall pass the resulting PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

NOTE 3: If the UE is processing a PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the same source layer-2 ID of the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, it depends on UE implementation to avoid the conflict of destination layer-2 ID (e.g. send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #3 "conflict of layer-2 ID for unicast communication is detected", or ignore the PROSE DIRECT DISCOVERY message for UE-to-UE relay discovery solicitation).

8a.2.1.3.4.3 Discoveree end UE procedure for UE-to-UE relay discovery completion

When the UE is triggered by the upper layers to stop responding to solicitation on proximity of a connectivity service via a 5G ProSe UE-to-UE relay UE, or when the UE stops being authorised to perform the discoveree end UE procedure for UE-to-UE relay discovery, the UE shall instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8a.2.2 5G ProSe UE-to-UE relay selection procedure

8a.2.2.1 General

The purpose of the UE-to-network relay selection procedure is to enable a 5G ProSe end UE to select a suitable 5G ProSe UE-to-UE relay UE to obtain a connectivity service to another 5G ProSe end UE.

8a.2.2.2 UE-to-UE relay selection procedure initiation

The 5G ProSe end UE shall trigger the UE-to-UE relay selection procedure if the following conditions are met:

- a) the UE is authorised to act as a 5G ProSe end UE towards a 5G ProSe UE-to-UE relay UE as specified in clause 5.2.7;

- 1) if the 5G ProSe end UE is expected to use 5G ProSe layer-3 UE-to-UE relay, the indication that the UE is authorized to use a 5G ProSe layer-3 UE-to-UE relay UE shall be set; and
- 2) if the 5G ProSe end UE is expected to use 5G ProSe layer-2 UE-to-UE relay, the indication that the UE is authorized to use a 5G ProSe layer-2 UE-to-UE relay UE shall be set;
- b) the UE has obtained a list of 5G ProSe UE-to-UE relay UE candidate(s) fulfilling ProSe layer criteria with the monitoring UE relay discovery for UE-to-UE relay discovery as specified in clause 8a.2.1.2.3 or the discoverer end UE procedure for UE-to-UE relay discovery as specified in clause 8a.2.1.3.2;
- c) the UE has obtained a list of 5G ProSe UE-to-UE relay UE candidate(s) fulfilling lower layers criteria as specified in 3GPP TS 38.300 [21]; and
- d) the user info of the target 5G ProSe end UE that the UE is interested in is included in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement (for discovery model A) or in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response (for discovery model B).

8a.2.2.3 UE-to-UE relay selection procedure completion

If there exists only one 5G ProSe UE-to-UE relay UE candidate satisfying the conditions in clause 8a.2.2.2, then that 5G ProSe UE-to-UE relay UE is selected. If there exist more than one 5G ProSe UE-to-UE relay UE candidate satisfying the conditions in clause 8a.2.2.2, any relay candidates not satisfying the non-radio related ProSe layer criteria shall be discarded and out of the remaining relay candidates, the relay candidate with the highest ranking of the lower layer criteria shall be selected. The UE may take the value of the resource status indicator bit of the status indicator parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement or PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response into account when deciding which 5G ProSe UE-to-UE relay UE to select. It is up to the UE implementation whether the ProSe layer or the lower layers takes the final selection on which 5G ProSe UE-to-UE relay UE to select.

8a.2.3 5G ProSe UE-to-UE relay reselection procedure

8a.2.3.1 General

The purpose of the 5G ProSe UE-to-UE relay reselection procedure is to enable a 5G ProSe end UE to reselect a 5G ProSe UE-to-UE relay UE to obtain a connectivity service to another 5G ProSe end UE when the serving 5G ProSe UE-to-UE relay UE is no longer suitable.

8a.2.3.2 UE-to-UE relay reselection procedure initiation

The 5G ProSe end UE shall trigger the UE-to-UE relay reselection procedure if one of the following conditions is met:

- a) the UE has received an indication from lower layers that the serving 5G ProSe UE-to-UE relay UE no longer fulfills the lower layers criteria as specified in 3GPP TS 38.300 [21];
- b) the parameters related to 5G ProSe UE-to-UE relay in the configuration parameters for 5G ProSe UE-to-UE relay as specified in clause 5.2.7 (e.g., relay service code, etc.) have been updated and the serving 5G ProSe UE-to-UE relay UE no longer fulfills the conditions specified in clause 8a.2.2.2;
- c) the UE has received a PROSE DIRECT LINK ESTABLISHMENT REJECT message from the 5G ProSe UE-to-UE relay UE with the PC5 signalling protocol cause value #1 "direct communication to the target UE not allowed";
- d) the UE has received a PROSE DIRECT LINK RELEASE REQUEST message from the 5G ProSe UE-to-UE relay UE with the PC5 signalling protocol cause value #1 "direct communication to the target UE not allowed";
- e) the UE has received a PROSE DIRECT LINK RELEASE REQUEST message from the 5G ProSe UE-to-UE relay UE with the PC5 signalling protocol cause value #4 "direct connection is not available anymore";
- f) the UE has not received any response from the 5G ProSe UE-to-UE relay UE after M consecutive retransmissions of PROSE DIRECT LINK ESTABLISHMENT REQUEST or PROSE DIRECT LINK KEEPALIVE REQUEST messages;

- g) the UE has not received any response from the 5G ProSe UE-to-UE relay UE after M consecutive retransmissions of PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe UE-to-UE relay UE with which the UE has a link established;

NOTE 1: The value of M is implementation specific and is less than or equal to the maximum number of retransmissions allowed for PC5 signalling protocol.

- h) the UE has received a PROSE DIRECT LINK ESTABLISHMENT REJECT message from the 5G ProSe UE-to-UE relay UE with the PC5 signalling protocol cause value #13 "congestion situation";
- i) the UE has received a PROSE DIRECT LINK RELEASE REQUEST message from the 5G ProSe UE-to-UE relay UE with the PC5 signalling protocol cause value #13 "congestion situation"; or
- j) the UE has received a PROSE DIRECT LINK ESTABLISHMENT REJECT message from the 5G ProSe UE-to-UE relay UE with the PC5 signalling protocol cause value #22 "security procedure failure of 5G ProSe UE-to-UE relay".

In cases c), d), h), i) and j), the 5G ProSe end UE shall exclude the 5G ProSe UE-to-UE relay UE which sent the message specified in cases c), d), h), i) or j) from the UE-to-UE relay reselection process described below (at least for the indicated back-off time period if provided from the ProSe UE-to-UE relay UE in cases h) and i)).

To conduct UE-to-UE relay reselection process, the UE shall first initiate one of the following procedures or both:

- a) monitoring UE relay discovery for UE-to-UE relay discovery as specified in clause 8a.2.1.2.3; or
- b) discoverer end UE procedure for UE-to-UE relay discovery as specified in clause 8a.2.1.3.2.

After the execution of the above discovery procedure(s), the 5G ProSe end UE, based on UE implementation, may perform the 5G ProSe direct link modification procedure for the negotiated 5G ProSe UE-to-UE relay reselection or may perform the 5G ProSe direct link establishment procedure with the selected 5G ProSe UE-to-UE relay UE.

8a.2.3.3 Candidate 5G ProSe UE-to-UE relay discovery procedure

The purpose of the candidate 5G ProSe UE-to-UE relay discovery procedure is to support the target 5G ProSe end UE to discover the candidate 5G ProSe UE-to-UE relay UE when the target 5G ProSe end UE needs to discover the candidate 5G ProSe UE-to-UE relay UE for the negotiated 5G ProSe UE-to-UE relay reselection, as specified in clause 6.7.4 of 3GPP TS 23.304 [2]. This procedure is based on UE-to-UE relay discovery over PC5 interface with model B procedure as specified in clause 8a.2.1.3 with the following modifications:

- a) when the target 5G ProSe end UE as a discoverer UE generates a PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, the UE shall:
 - 1) set the relay service code parameter to the relay service code parameter currently being used with the serving 5G UE-to-UE relay UE for which the UE-to-UE relay reselection is needed;
 - 2) set the UE-to-UE relay UE info parameter to user info ID for the candidate 5G ProSe UE-to-UE relay UE; and
 - 3) set the direct discovery set parameter to include one protected user info as specified in clause 11.2.17,

and shall set the destination layer-2 ID to the destination layer-2 ID of the candidate 5G ProSe UE-to-UE relay UE as received in the PROSE DIRECT LINK MODIFICATION REQUEST message during the negotiated 5G ProSe UE-to-UE relay reselection procedure. If there is no layer-2 ID of the candidate 5G ProSe UE-to-UE relay UE received in the PROSE DIRECT LINK MODIFICATION REQUEST message during the negotiated 5G ProSe UE-to-UE relay reselection procedure, the UE shall set the destination layer-2 ID to the default layer-2 ID for discovery as specified in clause 5.2.7;

- b) when the 5G ProSe UE-to-UE relay UE receives the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation, the 5G ProSe UE-to-UE relay does not perform the Relay UE procedure for UE-to-UE relay discovery if :
 - 1) the direct discovery set parameter in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation includes one protected user info with application layer ID coded as zero; and

- 2) the UE-to-UE relay UE info parameter in the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation matches with the user info ID for 5G ProSe UE-to-UE relay UE;
- c) after b), the 5G ProSe UE-to-UE relay UE shall send the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response to the discoverer UE. In the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response, the UE shall:
 - 1) set the relay service code parameter to the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation received from the target 5G ProSe end UE; and
 - 2) set the direct discovery set parameter to include one protected user info as specified in clause 11.2.17; and
- d) after c), when the target 5G ProSe end UE receives the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response and if
 - 1) the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response is the same as the relay service code parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation;
 - 2) the direct discover set parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response includes one protected user info with application layer ID coded as zero; and
 - 3) the UE-to-UE relay UE info parameter of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response is the same as the user info ID for the candidate 5G ProSe UE-to-UE relay UE of the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation,

then the 5G ProSe end UE shall consider the candidate 5G ProSe UE-to-UE relay UE is discovered, and proceed the 5G ProSe direct link modification procedure for UE-to-UE relay UE reselection.

8a.2.4 5G ProSe UE-to-UE relay unicast direct communication over PC5 interface

The direct communication between 5G ProSe end UEs and 5G ProSe UE-to-UE relay UE reuses the procedures for unicast mode 5G ProSe direct communication over PC5 described in clause 7.2.

NOTE: Any modifications needed to the procedures defined for unicast mode 5G ProSe direct communication over PC5 to support the direct communication between 5G ProSe end UEs and 5G ProSe UE-to-UE relay UE are described within clause 7.2.

For 5G ProSe layer-2 UE-to-UE relay, the source 5G ProSe layer-2 end UE shall initiate the end-to-end 5G ProSe direct link establishment procedure with the target 5G ProSe layer-2 end UE only after the 5G ProSe direct link for the first hop and the 5G ProSe direct link for the second hop are established. The end-to-end 5G ProSe direct link establishment procedure follows the 5G ProSe direct link establishment procedure between the initiating UE and the target UE described in clause 7.2.2.

8a.2.5 IP address allocation for 5G ProSe layer-3 end UE in 5G ProSe layer-3 UE-to-UE relay procedure

During 5G ProSe direct link establishment for 5G ProSe direct communication between the source or target 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE, and for IP traffic, the source or target 5G ProSe layer-3 end UE and 5G ProSe UE-to-UE layer-3 relay UE shall determine the IP version (IPv4 or IPv6) and IP address to be used based on the following rules:

- a) IP address allocation mechanisms of unicast mode of 5G ProSe direct communication over PC5 as described in clause 7.2.2.3 and clause 7.2.10.3 can be reused between each 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE; and
- b) the 5G ProSe layer-3 UE-to-UE relay UE may act as a DNS server and store an association of user info, RSC and the IP address of target 5G ProSe layer-3 end UE into its DNS entries. If the IP address of the target 5G ProSe layer-3 end UE is not received in the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message from the 5G ProSe layer-3 UE-to-UE relay, the source 5G ProSe layer-3 end UE may send the DNS query as

specified in IETF RFC 1035 [53] to the 5G ProSe layer-3 UE-to-UE relay UE to obtain the IP address (in the DNS entry that is associated with the used RSC) of the target 5G ProSe layer-3 end UE.

NOTE: 5G ProSe layer-3 UE-to-UE relay UE may convert the IP versions between the first hop PC5 interface (between the source 5G ProSe layer-3 end UE and 5G ProSe layer-3 UE-to-UE relay UE) and second hop PC5 interface (between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE).

8a.2.6 Security procedures for 5G ProSe layer-2 end UEs

The security establishment between the source 5G ProSe layer-2 end UE and the target 5G ProSe layer-2 end UE via a 5G ProSe layer-2 UE-to-UE relay UE reuses the 5G ProSe direct link authentication procedure described in clause 7.2.12 and the 5G ProSe direct link security mode control procedure described in clause 7.2.10. The security establishment between the source 5G ProSe layer-2 end UE and the target 5G ProSe layer-2 end UE via a 5G ProSe layer-2 UE-to-UE relay UE happens after the 5G ProSe direct link establishment between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link establishment between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE.

8a.2.7 QoS handling for 5G ProSe UE-to-UE relay

8a.2.7.1 General

This clause describes the QoS handling between a 5G ProSe UE-to-UE relay UE and two 5G ProSe end UEs. The purpose of QoS handling for 5G ProSe UE-to-UE relay is to meet the end-to-end QoS requirement between two 5G ProSe end UEs.

The QoS handling for 5G ProSe UE-to-UE relay can be classified with the following two cases according to the type of 5G ProSe UE-to-UE relay:

- a) QoS handling for two 5G ProSe end UEs via a 5G ProSe layer-2 UE-to-UE relay; and
- b) QoS handling for two 5G ProSe end UEs via a 5G ProSe layer-3 UE-to-UE relay.

8a.2.7.2 QoS handling for 5G ProSe layer-3 UE-to-UE relay

8a.2.7.2.1 General

The QoS handling by a 5G ProSe layer-3 UE-to-UE relay UE to achieve an end-to-end QoS between two 5G ProSe layer-3 end UEs as specified in clause 5.6.3.1 of 3GPP TS 23.304 [2].

For a source 5G ProSe layer-3 end UE, the end-to-end QoS requirement between the source 5G ProSe layer-3 end UE and the target 5G ProSe layer-3 end UE can be satisfied by the corresponding QoS control:

- a) QoS control between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE (first hop PC5 QoS control); and
- b) QoS control between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE (second hop PC5 QoS control).

8a.2.7.2.2 PC5 QoS flows handling initiated by the source 5G ProSe layer-3 end UE

For PC5 QoS flows setup or modification initiated by the source 5G ProSe layer-3 end UE, the source 5G ProSe layer-3 end UE shall provide the PC5 QoS flow context as defined in clause 7.2.7 to the 5G ProSe layer-3 UE-to-UE relay UE to indicate the end-to-end QoS requirements for the traffic transmission between the source 5G ProSe layer-3 end UE and the target 5G ProSe layer-3 end UE, using 5G ProSe direct link security mode control procedure as specified in clause 7.2.10 or 5G ProSe direct link modification procedure as specified in clause 7.2.3.

In addition, if the source 5G ProSe layer-3 end UE wants to add new PC5 QoS flow(s) or modify the existing PC5 QoS flow(s) for IP traffic or Ethernet traffic, the source 5G ProSe layer-3 end UE may also provide the PC5 QoS rule(s) for the PC5 QoS flow(s) to be added or modified to the 5G ProSe layer-3 UE-to-UE relay UE, using 5G ProSe direct link

establishment procedure as specified in clause 7.2.2 or 5G ProSe direct link modification procedure as specified in clause 7.2.3.

Upon reception of the PC5 QoS flow context from the source 5G ProSe layer-3 end UE, the 5G ProSe layer-3 UE-to-UE relay UE:

- a) shall determine the PQI for the first hop PC5 QoS control and PQI for the second hop PC5 QoS control based on its implementation;
- b) may derive the packet filter(s) used over the second hop PC5 interface if the 5G ProSe layer-3 UE-to-UE relay UE received the PC5 QoS rule(s) from the source 5G ProSe layer-3 end UE;
- c) if a new QoS flow needs to be established or the existing QoS flow(s) needs to be modified, shall perform 5G ProSe direct link establishment procedure as specified in clause 7.2.2 or 5G ProSe direct link modification procedure as specified in clause 7.2.3 providing:
 - 1) the QoS flow descriptions IE with the PQI value for the second hop PC5 QoS control determined in bullet a) to the target 5G ProSe layer-3 end UE; and
 - 2) the QoS rules IE with the packet filter(s) if packet filter(s) are derived in bullet b) to the target 5G ProSe layer-3 end UE;
- d) may derive the packet filter(s) used over the first hop PC5 interface if the 5G ProSe layer-3 UE-to-UE relay UE determines the PC5 QoS rule(s) over the first hop PC5 based on bullet a) and the QoS flow descriptions IE and the QoS rules IE that the target UE accepts; and
- e) shall provide the source 5G ProSe layer-3 end UE with the PQI determined in bullet a) or the PQI updated in bullet d), the corresponding PC5 QoS parameters and the corresponding ProSe identifier(s) as specified in clause 7.2.2.3 (if 5G ProSe direct link establishment procedure was initiated by the source 5G ProSe layer-3 end UE) or clause 7.2.3.3 (if 5G ProSe direct link modification procedure was initiated by the source 5G ProSe layer-3 end UE).

8a.2.7.3 QoS handling for 5G ProSe layer-2 UE-to-UE relay

For a 5G ProSe layer-2 end UE connecting with another 5G ProSe layer-2 end UE(s) via a 5G ProSe layer-2 UE-to-UE relay UE, the source 5G ProSe layer-2 end UE and the target 5G ProSe layer-2 end UE negotiate the end-to-end QoS for the traffic transmission between the source 5G ProSe layer-2 end UE and the target 5G ProSe layer-2 end UE. The 5G ProSe layer-2 UE-to-UE relay UE performs QoS splitting as described in 3GPP TS 38.300 [21].

8a.2.8 Support for Ethernet traffic via 5G ProSe layer-3 UE-to-UE relay

When a 5G ProSe direct link is being established or modified between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE (called source 5G ProSe direct link) and another 5G ProSe direct link is being established or modified between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE (called target 5G ProSe direct link), for Ethernet traffic:

- a) if the source 5G ProSe direct link is being established, MAC address of the source 5G ProSe layer-3 end UE is indicated in the PROSE DIRECT LINK SECURITY MODE COMPLETE message of the source 5G ProSe direct link and MAC address of the target 5G ProSe layer-3 end UE is indicated in the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message of the source 5G ProSe direct link;
- b) if the source 5G ProSe direct link is being modified:
 - 1) MAC address of the target 5G ProSe layer-3 end UE shall be indicated in the PROSE DIRECT LINK MODIFICATION ACCEPT message of the source 5G ProSe direct link; or
 - 2) MAC address of the source 5G ProSe layer-3 end UE shall be indicated in the PROSE DIRECT LINK MODIFICATION REQUEST message of the source 5G ProSe direct link if the MAC address of the source 5G ProSe layer-3 end UE changed;
- c) if the target 5G ProSe direct link is being established, MAC address of the source 5G ProSe layer-3 end UE is indicated in PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT message of the target 5G ProSe direct link and MAC address of the target 5G ProSe layer-3 end UE is indicated in the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message of the target 5G ProSe direct link; and

d) if the target 5G ProSe direct link is being modified:

- 1) MAC address of the source 5G ProSe layer-3 end UE shall be indicated in the PROSE DIRECT LINK MODIFICATION REQUEST message of the target 5G ProSe direct link; or
- 2) MAC address of the target 5G ProSe layer-3 end UE may be indicated in the PROSE DIRECT LINK MODIFICATION ACCEPT message of the target 5G ProSe direct link if the MAC address of the target 5G ProSe layer-3 end UE changed.

The 5G ProSe layer-3 UE-to-UE relay UE maintains associations between the 5G ProSe direct links and Ethernet MAC addresses provided by the 5G ProSe layer-3 end UEs of the 5G ProSe direct links, shall ensure that each 5G ProSe layer-3 end UE uses a different MAC address, and shall use the association for forwarding of the user data packets.

The 5G ProSe layer-3 end UE maintains associations between the 5G ProSe direct link and Ethernet MAC address provided by the other 5G ProSe layer-3 end UE, and shall use the Ethernet MAC address provided by the other 5G ProSe layer-3 end UE as destination address of the user data packets.

8a.2.9 5G ProSe AA message reliable transport procedure

The 5G ProSe AA message reliable transport procedure as described in clause 8.2.9 is used for exchanging the EAP messages between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE when the security procedure over control plane is used, with the following modifications:

- a) the 5G ProSe remote UE is replaced by the 5G ProSe end UE; and
- b) the 5G ProSe UE-to-network relay UE is replaced by the 5G ProSe UE-to-UE relay UE.

8a.2.10 5G ProSe UE-to-UE relay direct link security establishment procedure

8a.2.10.1 General

The purpose of the 5G ProSe UE-to-UE relay direct link security establishment procedure is for the target 5G ProSe end UE to establish the security between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE.

This procedure is triggered when the target 5G ProSe end UE receives the PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the 5G ProSe UE-to-UE relay UE and the Network Assistance Security Indicator associated with the received relay service code indicates the security procedures with network assistance are required.

8a.2.10.2 5G ProSe UE-to-UE relay direct link security establishment procedure initiation by initiating UE

The initiating UE shall meet the following pre-conditions before initiating this procedure:

- a) the PROSE DIRECT LINK ESTABLISHMENT REQUEST message is received;
- b) the initiating UE acting as the target 5G ProSe end UE is authorized to use a 5G ProSe UE-to-UE relay UE in the registered PLMN or local PLMN, or in case of SNPN, in the RSNPN; and
- c) the network assistance security indicator associated with the received relay service code indicates the security procedures with network assistance are required.

The UE shall initiate the 5G ProSe UE-to-UE relay direct link security establishment procedure by sending the PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message. The initiating UE:

- a) shall include:
 - 1) a Nonce₁, if the security procedure over control plane is used as specified in 3GPP TS 33.503 [34]; or
 - 2) a K_{NRP} freshness parameter 1, if the security procedure over user plane is used as specified in 3GPP TS 33.503 [34];

set to the 128-bit nonce value generated by the initiating UE for the purpose of session key establishment over this 5G ProSe direct link if the UE PC5 unicast signalling integrity protection policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred";

NOTE 1: The Nonce_1 IE in the PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message is used to hold the value of Nonce_1 or KNRP freshness parameter 1.

- b) shall include its UE security capabilities indicating the list of algorithms that the initiating UE supports for the security establishment of this 5G ProSe direct link;
- c) shall include the MSB of $K_{\text{NRP-secs}}$ ID chosen by the initiating UE as specified in 3GPP TS 33.503 [34] if the UE PC5 unicast signalling integrity protection policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred";
- d) shall include its UE PC5 unicast signalling security policy. The Signalling integrity protection policy shall be set to "Signalling integrity protection required";
- e) shall include the Relay service code IE set to the relay service code indicating the connectivity service requested by the source 5G ProSe end UE;
- f) shall include the UTC-based counter LSB set to the four least significant bits of the UTC-based counter;
- g) shall include the UE identity IE set to the SUCI of the initiating UE if:
 - 1) the 5G ProSe direct link establishment procedure is for direct communication between the target 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE; and
 - 2) the security for 5G ProSe UE-to-UE relay uses the security procedure over control plane and the initiating UE does not have a valid CP-PRUK as specified in 3GPP TS 33.503 [34], or, the security for 5G ProSe UE-to-UE relay uses the security procedure over user plane and the initiating UE does not have a valid UP-PRUK as specified in 3GPP TS 33.503 [34];
- h) shall include the User security key ID IE set to:
 - 1) UP-PRUK ID of the initiating UE if:
 - i) the 5G ProSe direct link establishment procedure is for direct communication between the target 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;
 - ii) the initiating UE has a valid UP-PRUK; and
 - iii) the security for 5G ProSe UE-to-UE relay uses the security procedure over user plane as specified in 3GPP TS 33.503 [34]; or
 - 2) CP-PRUK ID of the initiating UE that is associated with the relay service code of the target UE if:
 - i) the 5G ProSe direct link establishment procedure is for direct communication between the target 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;
 - ii) the initiating UE has a valid CP-PRUK is associated with the relay service code of the target UE; and
 - iii) the security for 5G ProSe UE-to-UE relay uses the security procedure over control plane as specified in 3GPP TS 33.503 [34];
- i) shall include the HPLMN ID of the initiating UE, if the UP-PRUK ID of the initiating UE is included and is not in NAI format (see 3GPP TS 33.503 [34]); and
- j) shall include the MIC IE set to the calculated MIC value as specified in 3GPP TS 33.503 [34] if the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE has the DUIK.

NOTE 2: In case of SNPN, the HPLMN ID includes the PLMN ID of the subscribed SNPN.

After the PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID (e.g. the source layer-2 ID in the received PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the 5G ProSe UE-to-UE relay UE) and start timer T5201. The UE shall

not send a new PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message to the same target UE while timer T5201 is running.

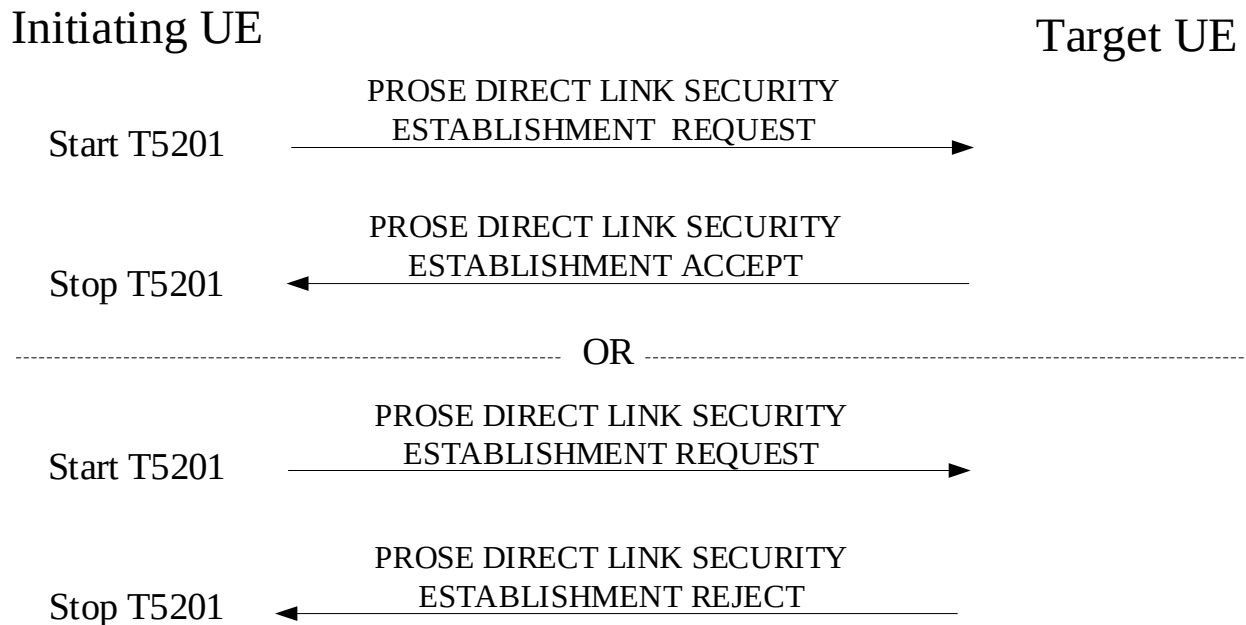


Figure 8a.2.10.2.1: 5G ProSe direct link security establishment procedure

8a.2.10.3 5G ProSe UE-to-UE relay direct link security establishment procedure accepted by the target UE

Upon receipt of a PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message, the target UE shall verify the MIC field in the received PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message with the DUK, if any, and decrypts the encrypted:

- a) relay service code; and
- b) UP-PRUK ID or CP-PRUK ID, if received,

using the DUCK, or DUSK with the associated encrypted bitmask used for 5G ProSe UE-to-UE relay discovery (see clause 6.6.3.1 of 3GPP TS 33.503 [34]) and verifies if the relay service code matches with the one that the target UE has sent in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message.

NOTE 1: If the UE is neither configured with DUCK nor DUSK, the relay service code and the UP-PRUK ID or CP-PRUK ID are not encrypted.

If the target UE is authorized to act as the 5G ProSe UE-to-UE relay UE and is in NG-RAN coverage, the target UE shall proceed with either:

- a) the authentication and key agreement procedure as specified in clause 5.5.4 of 3GPP TS 24.501 [11] if the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used; or
- b) the key request procedure as specified in clause 8.2.10.2.4 if the security procedure over user plane as specified in 3GPP TS 33.503 [34] is used;

and shall initiate 5G ProSe direct link security mode control procedure as specified in clause 7.2.10.

The target UE shall:

- a) if the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used, request a new K_{NR_ProSe} according to the security procedure over control plane as specified in 3GPP TS 33.503 [34]; or

- b) if the security procedure over user plane as specified in 3GPP TS 33.503 [34] is used, request a new K_{NRP} according to the security procedure over user plane.

NOTE 2: How many times the 5G ProSe direct link authentication procedure needs to be performed to derive a new K_{NRP} depends on the authentication method used.

After a new K_{NRP} was derived or after a new K_{NRP} or $K_{\text{NRP\_ProSe}}$ is received, the target UE shall initiate a 5G ProSe direct link security mode control procedure as specified in clause 7.2.10. The target UE determines whether the PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message can be accepted or not based on the result of the 5G ProSe direct link security mode control procedure.

If the target UE accepts the 5G ProSe direct link security establishment procedure, the target UE shall create a PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT message.

In the PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT message, the target UE:

- a) shall include the PQFI and the corresponding PC5 QoS parameters if received from the source 5G ProSe layer-3 end UE;
- b) shall include the PC5 QoS rule(s) if received from the source 5G ProSe layer-3 end UE;
- c) if IP communication is used, shall include an IP address configuration IE set to one of the following values:
 - 1) "IPv6 router" if only IPv6 address allocation mechanism is supported by the target UE, i.e., acting as an IPv6 router;
 - 2) "DHCPv4 server" if only IPv4 address allocation mechanism is supported by the target UE, i.e., acting as a DHCPv4 server;
 - 3) "DHCPv4 server & IPv6 Router" if both IPv4 and IPv6 address allocation mechanism are supported by the target UE; or
 - 4) "address allocation not supported" if neither IPv4 nor IPv6 address allocation mechanism is supported by the target UE;
- d) if IP communication is used, the IP address configuration IE is set to "address allocation not supported" and the received PROSE DIRECT LINK SECURITY MODE COMPLETE message included a link local IPv6 address IE, shall include a link local IPv6 address IE formed locally based on IETF RFC 4862 [25]; and
- e) if Ethernet communication is used, shall include the MAC address of the source 5G ProSe layer-3 end UE.

After the PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT message is created, the target UE shall pass the message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication.

8a.2.10.4 5G ProSe UE-to-UE relay direct link security establishment procedure completion by the initiating UE

Upon receipt of a PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT message, the initiating UE shall stop timer T5201. For each of the PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT message received, the initiating UE shall create a PROSE DIRECT LINK ESTABLISHMENT ACCEPT message as specified in clause 7.2.2.4.

8a.2.10.5 5G ProSe UE-to-UE relay direct link security establishment procedure not accepted by the target UE

If the PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message cannot be accepted, the target UE shall send a PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message. The PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message contains a PC5 signalling protocol cause IE set to one of the following cause values:

- #7 Integrity failure
- #13 congestion situation;

- #22 security procedure failure of 5G ProSe UE-to-UE relay;
- #25 triggering security procedure not possible; or
- #111 protocol error, unspecified.

If the target UE acting as the 5G ProSe UE-to-UE relay UE is under congestion, the target UE shall send a PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #13 "congestion situation". The target UE may provide a back-off timer value to the initiating UE in the PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message.

If the 5G ProSe direct link security establishment procedure fails due to a failure in the security procedure over control plane or security procedure over user plane as specified in 3GPP TS 33.503 [34], the target UE shall send a PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #22 "security procedure failure of 5G ProSe UE-to-UE relay". The target UE shall provide the EAP message if received from the network according to the security procedure over control plane as specified in 3GPP TS 33.503 [34]. The target UE acting as the 5G ProSe UE-to-UE relay UE shall further abort the ongoing direct link establishment procedure with the target 5G ProSe end UE, and then send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #22 "security procedure failure of 5G ProSe UE-to-UE relay" to the source 5G ProSe end UE.

Upon receipt of the PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message from the target UE, the initiating UE shall stop timer T5201 and abort the ongoing procedure that triggered the initiation of the 5G ProSe direct link security establishment procedure.

If the 5G ProSe direct link security establishment procedure fails due to a failure in verification of the MIC IE in the received PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message, if any, the target UE shall send a PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #7 "Integrity failure".

If the target UE is acting as the 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link security establishment procedure is between the target 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and is using the security procedure with network assistance and the 5G ProSe UE-to-UE relay UE is not in NG-RAN coverage; the 5G ProSe UE-to-UE relay UE shall send a PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #25 "triggering security procedure not possible" to the target 5G ProSe end UE and shall send PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #25 "triggering security procedure not possible" to the source 5G ProSe end UE.

If the 5G ProSe direct link security establishment procedure fails due to other reasons, the target UE shall send a PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #111 "protocol error, unspecified".

If the target UE is acting as a target 5G ProSe end UE and the 5G ProSe direct link security establishment procedure is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE, and:

- a) the indicated security procedure is without network assistance; and
- b) the target 5G ProSe end UE does not have valid long-term credentials, as specified in 3GPP TS 33.536 [37];

the target 5G ProSe end UE shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #25 "triggering security procedure not possible" to the 5G ProSe UE-to-UE relay UE. The 5G ProSe UE-to-UE relay UE, upon receiving the PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #25 "triggering security procedure not possible" from the target 5G ProSe end UE, shall send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #20 "Failure from 5G ProSe end UE" and optionally the PC5 end UE failure cause IE set to #25 "triggering security procedure not possible".

After sending the PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message, the target UE shall provide the following information along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication to the lower layer:

- a) an indication of deactivation of the PC5 unicast security protection and deletion of security context for the 5G ProSe direct link, if applicable.

After receiving the PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message, the initiating UE shall provide the following information along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication to the lower layer:

- a) an indication of deactivation of the PC5 unicast security protection and deletion of security context for the 5G ProSe direct link, if applicable.

8a.2.10.6 Abnormal cases

8a.2.10.6.1 Abnormal cases at the initiating UE

The following abnormal cases can be identified:

- a) Timer T5201 expires.

The initiating UE shall retransmit the PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message and restart timer T5201. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct link security establishment procedure and abort the ongoing 5G ProSe direct link establishment procedure.

NOTE: The maximum number of allowed retransmissions is UE implementation specific.

- b) The need to establish a link no longer exists before the procedure is completed, the initiating UE shall abort the procedure.

When the initiating UE aborts the 5G ProSe direct link security establishment procedure, the initiating UE shall provide the following information along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication to the lower layer:

- a) an indication of deactivation of the PC5 unicast security protection and deletion of security context for the 5G ProSe direct link, if applicable.

8a.2.10.6.2 Abnormal cases at the target UE

After the target UE decrypts the encrypted relay service code using the DUIK, DUSK, or DUCK with the associated encrypted bitmask used for 5G ProSe UE-to-UE relay discovery, if the relay service code does not match with the one that the target UE has sent during 5G ProSe UE-to-UE relay discovery procedure, then the target UE shall abort the 5G ProSe direct link security establishment procedure.

8a.2.11 5G ProSe security procedures over PC3a interface for 5G ProSe UE-to-UE relay

8a.2.11.1 General

8a.2.11.1.1 Transport protocol for PC3a messages

The transport protocol for PC3a messages is the same as described in clause 8.2.12.1.1.

8a.2.11.1.2 Handling of UE-initiated procedures

The handling of UE-initiated procedures is the same as described in clause 8.2.12.1.2.

8a.2.11.2 Procedures

8a.2.11.2.1 Types of 5G ProSe security procedures over PC3a interface for 5G ProSe UE-to-UE relay

The following procedures are defined:

- a) 5G ProSe UE-to-UE relay discovery security material request procedure.

In the following descriptions of 5G procedures over PC3a interface, the terms "request" and "response" refer to the corresponding PC3a messages, not to the HTTP request or response. The following procedure descriptions use a single PC3a message for illustration purposes.

The PC3a control protocol procedures for 5G ProSe UE-to-UE relay discovery shall be integrity protected and confidentiality protected using the security procedures defined in clause 5.2.3 in 3GPP TS 33.503 [34].

NOTE: A single HTTP request message can contain multiple PC3a control protocol requests and a single HTTP response message can contain multiple PC3a control protocol responses.

When the TLS tunnel between the UE and the 5G DDNMF for transport of PC3a messages is established by the UE according to 3GPP TS 33.503 [34], the 5G DDNMF shall obtain identity of the served UE using the procedures specified in 3GPP TS 33.220 [46] or 3GPP TS 33.535 [47].

8a.2.11.2.2 5G ProSe UE-to-UE relay discovery security material request procedure

8a.2.11.2.2.1 General

The purpose of the 5G ProSe UE-to-UE relay discovery security material request procedure is for the UE:

- a) to obtain the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE, applicable when the UE acts as a 5G ProSe end UE and uses the security procedure over control plane as specified in 3GPP TS 33.503 [34]; and
- b) to obtain the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE, applicable when the UE acts as a 5G ProSe UE-to-UE relay UE and uses the security procedure over control plane as specified in 3GPP TS 33.503 [34].

8a.2.11.2.2.2 5G ProSe UE-to-UE relay discovery security material request procedure initiation

The UE shall initiate the 5G ProSe UE-to-UE relay discovery security material request procedure:

- a) if the UE is authorized to act as a 5G ProSe end UE and uses the security procedure over control plane as specified in 3GPP TS 33.503 [34]:
 - 1) when the UE has no 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE and the UE is in NG-RAN coverage; or
 - 2) after expiration of timer T5103, when in NG-RAN coverage or when entering NG-RAN coverage; or
- b) if the UE is authorized to act as a 5G ProSe UE-to-UE relay UE and uses the security procedure over control plane as specified in 3GPP TS 33.503 [34]:
 - 1) when the UE has no 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE and the UE is in NG-RAN coverage; or
 - 2) after expiration of timer T5104, when in NG-RAN coverage or when entering NG-RAN coverage.

The UE shall initiate the 5G ProSe UE-to-UE relay discovery security material request procedure by sending a PROSE_SECURITY_MATERIAL_REQUEST message with the <UUR-discovery-security-parameters-request> element. In the <UUR-discovery-security-parameters-request> element, the UE:

- a) shall include a new transaction ID;
- b) shall indicate whether the UE requests the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE, the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE or both;
- c) shall include the PC5 UE security capabilities indicating ciphering algorithms supported by the UE;
- d) if the UE requests the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE, may include a list of PLMN identities of the visited PLMNs;
- e) may indicate the requested model indicating the model of the 5G ProSe UE-to-UE relay discovery over PC5 interface for which security parameters are requested, set to "model A" or "model B"; and

NOTE: If the requested model is not included in the PROSE_SECURITY_MATERIAL_REQUEST message, security parameters are requested for both model A and model B of the 5G ProSe UE-to-UE relay discovery over PC5 interface.

f) shall include the relay service code indicating the connectivity service to be discovered.

Figure 8a.2.11.2.2.1 illustrates the interaction of the UE and the 5G DDNMF in the 5G ProSe UE-to-UE relay discovery security material request procedure.

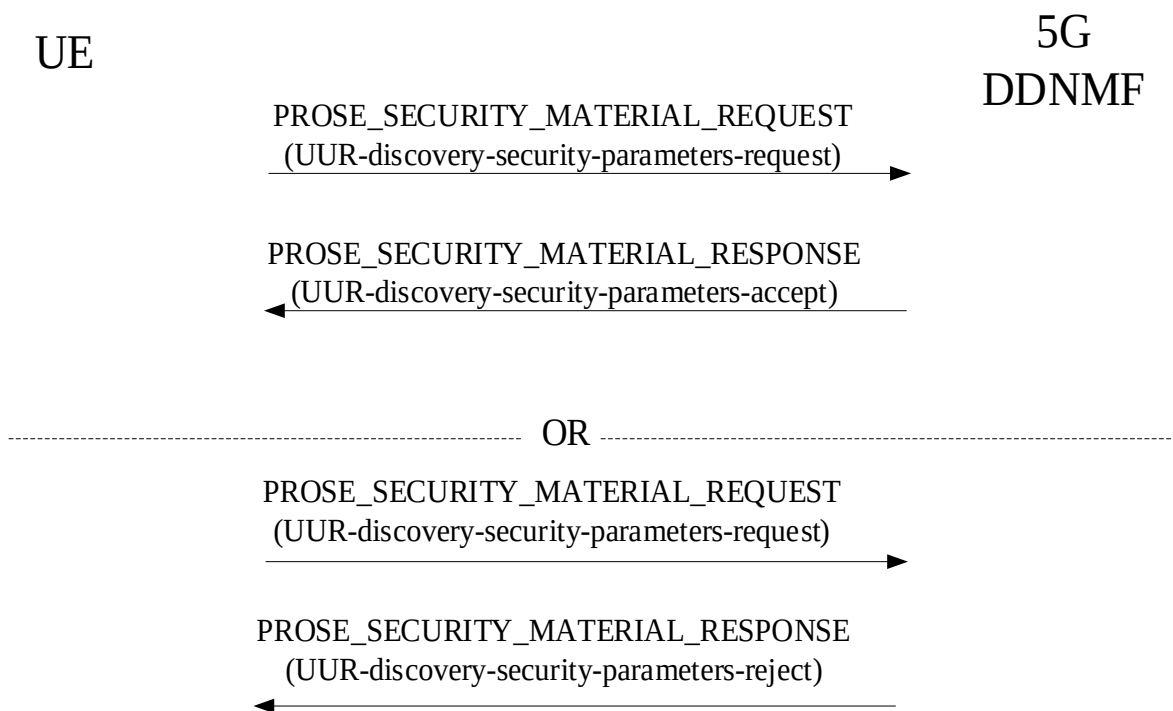


Figure 8a.2.11.2.2.1: 5G ProSe UE-to-UE relay discovery security material request procedure

8a.2.11.2.2.3 5G ProSe UE-to-UE relay discovery security material request procedure accepted by the 5G DDNMF

Upon receiving a PROSE_SECURITY_MATERIAL_REQUEST message with the <UUR-discovery-security-parameters-request> element, if:

- the UE requests the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE only and the PROSE_SECURITY_MATERIAL_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe end UE;
- the UE requests the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE only and the PROSE_SECURITY_MATERIAL_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe UE-to-UE relay UE; or
- the UE requests the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE and the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE and the PROSE_SECURITY_MATERIAL_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe UE-to-UE relay UE and authorized to act as a 5G ProSe end UE;

the 5G DDNMF shall send a PROSE_SECURITY_MATERIAL_RESPONSE message containing a <UUR-discovery-security-parameters-accept> element. In the <UUR-discovery-security-parameters-accept> element, the 5G DDNMF:

- shall include the transaction ID set to the value of the transaction ID received in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_MATERIAL_REQUEST message;

- b) if the UE requests the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE:
- 1) shall include one or more 5G ProSe UE-to-UE relay discovery security materials for 5G ProSe end UE. In each of the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE, the 5G DDNMF:
 - A) shall include the expiration timer of the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE; and
 - B) for the received relay service code for which the UE is authorized to act as a 5G ProSe end UE:
 - i) if the requested model is not indicated in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_MATERIAL_REQUEST message or is set to "model A", may include the code-receiving security parameters for model A containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - ii) if the requested model is not indicated in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_MATERIAL_REQUEST message or is set to "model B", may include the code-receiving security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask and the code-sending security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - iii) shall include the selected ciphering algorithm; and
 - iv) shall include the PLMN ID for which the security parameters are associated; and
 - 2) may include the PC5 security policies for the received relay service code for 5G ProSe end UE. In the PC5 security policies for the received relay service code for 5G ProSe end UE, the 5G DDNMF:
 - A) for the received relay service code for which the UE is authorized to act as a 5G ProSe end UE:
 - i) shall include the PC5 security policies;
- c) if the UE requests the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE:
- 1) shall include the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE. In the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE, the 5G DDNMF:
 - A) shall include the expiration timer of the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE; and
 - B) for the received relay service code for which the UE is authorized to act as a 5G ProSe UE-to-UE relay UE:
 - i) if the requested model is not indicated in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_MATERIAL_REQUEST message or is set to "model A", may include the code-sending security parameters for model A containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - ii) if the requested model is not indicated in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_MATERIAL_REQUEST message or is set to "model B", may include the code-receiving security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask and the code-sending security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask; and
 - iii) shall include the selected ciphering algorithm; and
 - 2) may include the PC5 security policies for the received relay service code for 5G ProSe UE-to-UE relay UE. In the PC5 security policies for the received relay service code for 5G ProSe UE-to-UE relay UE, the 5G DDNMF:
 - A) for the received relay service code for which the UE is authorized to act as a 5G ProSe UE-to-UE relay UE:
 - i) shall include the PC5 security policies; and

- d) shall include the current time set to the current UTC-based time at the 5G DDNMF and the max offset.

If the UE requests the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE, the UE identity in the PROSE_SECURITY_MATERIAL_REQUEST message indicates a UE authorized to act as a 5G ProSe end UE and the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_MATERIAL_REQUEST message contains a list of PLMN identities of the visited PLMNs, the 5G DDNMF shall include in the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE any information received from 5G DDNMFs of potential 5G ProSe UE-to-UE relay UEs which can serve the UE.

8a.2.11.2.2.4 5G ProSe UE-to-UE relay discovery security material request procedure completion by the UE

Upon receipt of the PROSE_SECURITY_MATERIAL_RESPONSE message with the <UUR-discovery-security-parameters-accept>, if the transaction ID contained in the <UUR-discovery-security-parameters-accept> element matches the value sent by the UE in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_MATERIAL_REQUEST message, the UE:

- a) if the <UUR-discovery-security-parameters-accept> element contains one or more 5G ProSe UE-to-UE relay discovery security materials for 5G ProSe end UE:
 - 1) shall store the one or more 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE, each associated with its received PLMN ID, shall stop timer T5103, if running and shall start timer T5103 with the value of the expiration timer indicated in the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE; and
 - 2) if the PC5 security policies for the relay service code for 5G ProSe end UE are received, shall store the PC5 security policies for the relay service code for 5G ProSe end UE;
- b) if the <UUR-discovery-security-parameters-accept> element contains the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE:
 - 1) shall store the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE, shall stop timer T5104, if running and shall start timer T5104 with the value of the expiration timer indicated in the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE; and
 - 2) if the PC5 security policies for the relay service code for 5G ProSe UE-to-UE relay UE are received, shall store the PC5 security policies for the relay service code for 5G ProSe UE-to-UE relay UE; and
- c) shall set a ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter and store the received max offset.

8a.2.11.2.2.5 5G ProSe UE-to-UE relay discovery security material request procedure not accepted by the 5G DDNMF

If the PROSE_SECURITY_MATERIAL_REQUEST message with the <UUR-discovery-security-parameters-request> element cannot be accepted by the 5G DDNMF, the 5G DDNMF shall send a PROSE_SECURITY_MATERIAL_RESPONSE message containing a <UUR-discovery-security-parameters-reject> element. In the <UUR-discovery-security-parameters-reject> element, the 5G DDNMF shall include the transaction ID set to the value of the transaction ID received in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_MATERIAL_REQUEST message and shall include an appropriate PC3a control protocol cause value.

Upon receipt of the PROSE_SECURITY_MATERIAL_RESPONSE message with the <UUR-discovery-security-parameters-reject> element, if the transaction ID contained in the <UUR-discovery-security-parameters-reject> element matches the value sent by the UE in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_MATERIAL_REQUEST message, the UE shall consider the 5G ProSe UE-to-UE relay discovery security material request procedure as rejected.

8a.2.11.2.2.6 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of PROSE_SECURITY_MATERIAL_REQUEST message (e.g. after TCP retransmission timeout).

The UE shall close the existing secure connection to the 5G DDNMF, establish a new secure connection and then restart the 5G ProSe UE-to-UE relay discovery security material request procedure.

- b) No response from the 5G DDNMF after the PROSE_SECURITY_MATERIAL_REQUEST message has been successfully delivered (e.g. TCP ACK has been received for the PROSE_SECURITY_MATERIAL_REQUEST message)

The UE shall retransmit the PROSE_SECURITY_MATERIAL_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

8a.2.11.2.2.7 Abnormal cases in the 5G DDNMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of PROSE_SECURITY_MATERIAL_RESPONSE message.

After receiving an indication from lower layer that the PROSE_SECURITY_MATERIAL_RESPONSE message has not been successfully acknowledged (e.g. TCP ACK is not received), the 5G DDNMF shall abort the procedure.

8a.2.12 5G ProSe security procedures over PC8 interface for 5G ProSe UE-to-UE relay

8a.2.12.1 General

8a.2.12.1.1 Transport protocol for PC8 messages

The transport protocol for PC3a messages is the same as described in clause 8.2.10.1.1.

8a.2.12.1.2 Handling of UE-initiated procedures

The handling of UE-initiated procedures is the same as described in clause 8.2.10.1.2.

8a.2.12.2 Procedures

8a.2.12.2.1 Types of 5G ProSe security procedures over PC8 interface for 5G ProSe UE-to-UE relay

The following procedures are defined:

- a) 5G ProSe UE-to-UE relay discovery security parameters request procedure;
- b) 5G ProSe end UE key request procedure; and
- c) 5G ProSe UE-to-UE relay UE key request procedure.

In the following descriptions of 5G procedures over PC8 interface, the terms "request" and "response" refer to the corresponding PC8 messages, not to the HTTP request or response. The following procedure descriptions use a single PC8 message for illustration purposes.

The 5G ProSe procedures over PC8 interface shall be integrity protected and confidentiality protected using the security procedures using GBA or AKMA, see clause 5.2.5.3 and clause 5.2.5.4 in 3GPP TS 33.503 [34].

NOTE 1: A single HTTP request message can contain multiple PC8 requests and a single HTTP response message can contain multiple PC8 responses.

NOTE 2: The privacy of the UE identity included in the PC8 messages of 5G ProSe procedures over PC8 interface is ensured by the confidentiality protection of those procedures.

8a.2.12.2.2 5G ProSe UE-to-UE relay discovery security parameters request procedure

8a.2.12.2.2.1 General

The purpose of the 5G ProSe UE-to-UE relay discovery security parameters request procedure is for the UE:

- a) to obtain the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE, applicable when the UE acts as a 5G ProSe end UE and uses the security procedure over user plane as specified in 3GPP TS 33.503 [34]; and
- b) to obtain the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE, applicable when the UE acts as a 5G ProSe UE-to-UE relay UE and uses the security procedure over user plane as specified in 3GPP TS 33.503 [34].

8a.2.12.2.2.2 5G ProSe UE-to-UE relay discovery security parameters request procedure initiation

The UE shall initiate the 5G ProSe UE-to-UE relay discovery security parameters request procedure:

- a) if the UE is authorized to act as a 5G ProSe end UE and uses the security procedure over user plane as specified in 3GPP TS 33.503 [34]:
 - 1) when the UE has no 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE and the UE is in NG-RAN coverage; or
 - 2) after expiration of timer T5105, when in NG-RAN coverage or when entering NG-RAN coverage; or
- b) if the UE is authorized to act as a 5G ProSe UE-to-UE relay UE and uses the security procedure over user plane as specified in 3GPP TS 33.503 [34]:
 - 1) when the UE has no 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE and the UE is in NG-RAN coverage; or
 - 2) after expiration of timer T5016, when in NG-RAN coverage or when entering NG-RAN coverage.

The UE shall initiate the 5G ProSe UE-to-UE relay discovery security parameters request procedure by sending a PROSE_SECURITY_PARAM_REQUEST message with the <UUR-discovery-security-parameters-request> element. In the <UUR-discovery-security-parameters-request> element, the UE:

- a) shall include a new transaction ID;
- b) shall indicate whether the UE requests the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE, the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE or both;
- c) shall include the PC5 UE security capabilities indicating ciphering algorithms supported by the UE;
- d) if the UE requests the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE, may include a list of PLMN identities of the visited PLMNs;
- e) may indicate the requested model indicating the model of the 5G ProSe UE-to-UE relay discovery over PC5 interface for which security parameters are requested, set to "model A" or "model B"; and

NOTE: If the requested model is not included in the PROSE_SECURITY_PARAM_REQUEST message, security parameters are requested for both model A and model B of the 5G ProSe UE-to-UE relay discovery over PC5 interface.

- f) shall include the relay service code indicating the connectivity service to be discovered.

Figure 8a.2.12.2.2.1 illustrates the interaction of the UE and the 5G PKMF in the 5G ProSe UE-to-UE relay discovery security parameters request procedure.

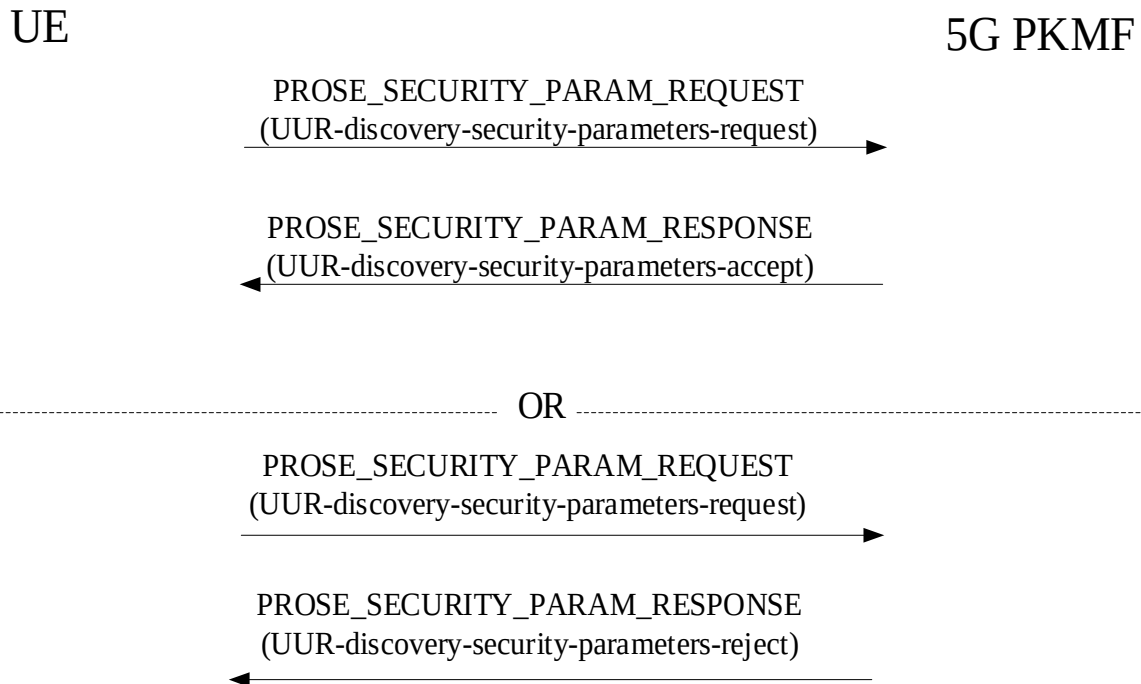


Figure 8a.2.12.2.2.1: 5G ProSe UE-to-UE relay discovery security material request procedure

8a.2.12.2.2.3 5G ProSe UE-to-UE relay discovery security parameters request procedure accepted by the 5G PKMF

Upon receiving a PROSE_SECURITY_PARAM_REQUEST message with the <UUR-discovery-security-parameters-request> element, if:

- a) the UE requests the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE only and the PROSE_SECURITY_PARAM_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe end UE;
- b) the UE requests the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE only and the PROSE_SECURITY_PARAM_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe UE-to-UE relay UE; or
- c) the UE requests the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE and the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE and the PROSE_SECURITY_PARAM_REQUEST message is received over a TLS tunnel established by a UE authorized to act as a 5G ProSe UE-to-UE relay UE and authorized to act as a 5G ProSe end UE;

the 5G PKMF shall send a PROSE_SECURITY_PARAM_RESPONSE message containing a <UUR-discovery-security-parameters-accept> element. In the <UUR-discovery-security-parameters-accept> element, the 5G PKMF:

- a) shall include the transaction ID set to the value of the transaction ID received in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_PARAM_REQUEST message;
- b) if the UE requests the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE:
 - 1) shall include one or more 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE. In each of the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE, the 5G PKMF:
 - A) shall include the expiration timer of the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE; and

- B) for the received relay service code for which the UE is authorized to act as a 5G ProSe end UE:
 - i) if the requested model is not indicated in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_PARAM_REQUEST message or is set to "model A", may include the code-receiving security parameters for model A containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - ii) if the requested model is not indicated in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_PARAM_REQUEST message or is set to "model B", may include the code-receiving security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask and the code-sending security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - iii) shall include the selected ciphering algorithm; and
 - iv) shall include the PLMN ID for which the security parameters are associated; and
- 2) may include the PC5 security policies for the received relay service code for 5G ProSe end UE. In the PC5 security policies for the received relay service code for 5G ProSe end UE, the 5G PKMF:
 - A) for the received relay service code for which the UE is authorized to act as a 5G ProSe end UE:
 - i) shall include the PC5 security policies;
- c) if the UE requests the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE:
 - 1) shall include the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE. In the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE, the 5G PKMF:
 - A) shall include the expiration timer of the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE; and
 - B) for the received relay service code for which the UE is authorized to act as a 5G ProSe UE-to-UE relay UE:
 - i) if the requested model is not indicated in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_PARAM_REQUEST message or is set to "model A", may include the code-sending security parameters for model A containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask;
 - ii) if the requested model is not indicated in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_PARAM_REQUEST message or is set to "model B", may include the code-receiving security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask and the code-sending security parameters for model B containing one or more of DUSK, DUIK and DUCK with associated encrypted bitmask; and
 - iii) shall include the selected ciphering algorithm; and
 - 2) may include the PC5 security policies for the received relay service code for 5G ProSe UE-to-UE relay UE. In the PC5 security policies for the received relay service code for 5G ProSe UE-to-UE relay UE, the 5G PKMF:
 - A) for the received relay service code for which the UE is authorized to act as a 5G ProSe UE-to-UE relay UE:
 - i) shall include the PC5 security policies; and
 - d) shall include the current time set to the current UTC-based time at the 5G PKMF and the max offset.

If the UE requests the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE, the UE identity in the PROSE_SECURITY_PARAM_REQUEST message indicates a UE authorized to act as a 5G ProSe end UE and the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_PARAM_REQUEST message contains a list of PLMN identities of the visited PLMNs, the 5G PKMF shall include in the 5G ProSe UE-to-UE relay

discovery security parameters for 5G ProSe end UE any information received from 5G PKMFs of potential 5G ProSe UE-to-UE relay UEs which can serve the UE.

8a.2.12.2.2.4 5G ProSe UE-to-UE relay discovery security parameters request procedure completion by the UE

Upon receipt of the PROSE_SECURITY_PARAM_RESPONSE message with the <UUR-discovery-security-parameters-accept>, if the transaction ID contained in the <UUR-discovery-security-parameters-accept> element matches the value sent by the UE in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_PARAM_REQUEST message, the UE:

- a) if the <UUR-discovery-security-parameters-accept> element contains one or more 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE:
 - 1) shall store the one or more 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE, each associated with its received PLMN ID, shall stop timer T5105, if running and shall start timer T5105 with the value of the expiration timer indicated in the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE; and
 - 2) if the PC5 security policies for the relay service code for 5G ProSe end UE are received, shall store the PC5 security policies for the relay service code for 5G ProSe end UE;
- b) if the <UUR-discovery-security-parameters-accept> element contains the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE:
 - 1) shall store the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE, shall stop timer T5016, if running and shall start timer T5016 with the value of the expiration timer indicated in the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE; and
 - 2) if the PC5 security policies for the relay service code for 5G ProSe UE-to-UE relay UE are received, shall store the PC5 security policies for the relay service code for 5G ProSe UE-to-UE relay UE; and
- c) shall set a ProSe clock (see 3GPP TS 33.503 [34]) to the value of the received current time parameter and store the received max offset.

8a.2.12.2.2.5 5G ProSe UE-to-UE relay discovery security parameters request procedure not accepted by the 5G PKMF

If the PROSE_SECURITY_PARAM_REQUEST message with the <UUR-discovery-security-parameters-request> element cannot be accepted by the 5G PKMF, the 5G PKMF shall send a PROSE_SECURITY_PARAM_RESPONSE message containing a <UUR-discovery-security-parameters-reject> element. In the <UUR-discovery-security-parameters-reject> element, the 5G PKMF shall include the transaction ID set to the value of the transaction ID received in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_PARAM_REQUEST message and shall include an appropriate PC8 control protocol cause value.

Upon receipt of the PROSE_SECURITY_PARAM_RESPONSE message with the <UUR-discovery-security-parameters-reject> element, if the transaction ID contained in the <UUR-discovery-security-parameters-reject> element matches the value sent by the UE in the <UUR-discovery-security-parameters-request> element in the PROSE_SECURITY_PARAM_REQUEST message, the UE shall consider the 5G ProSe UE-to-UE relay discovery security parameters request procedure as rejected.

8a.2.12.2.2.6 Abnormal cases in the UE

The following abnormal cases can be identified:

- a) Indication from the transport layer of transmission failure of PROSE_SECURITY_PARAM_REQUEST message (e.g. after TCP retransmission timeout).

The UE shall close the existing secure connection to the 5G PKMF, establish a new secure connection and then restart the 5G ProSe UE-to-UE relay discovery security parameters request procedure.

- b) No response from the 5G PKMF after the PROSE_SECURITY_PARAM_REQUEST message has been successfully delivered (e.g. TCP ACK has been received for the PROSE_SECURITY_PARAM_REQUEST message)

The UE shall retransmit the PROSE_SECURITY_PARAM_REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

8a.2.12.2.2.7 Abnormal cases in the 5G PKMF

The following abnormal cases can be identified:

- a) Indication from the lower layer of transmission failure of PROSE_SECURITY_PARAM_RESPONSE message.

After receiving an indication from lower layer that the PROSE_SECURITY_PARAM_RESPONSE message has not been successfully acknowledged (e.g. TCP ACK is not received), the 5G PKMF shall abort the procedure.

8a.2.12.2.3 5G ProSe end UE key request procedure

The 5G ProSe end UE key request procedure is the same as described in clause 8.2.10.2.3 with replacing the 5G ProSe remote UE to 5G ProSe end UE and the 5G ProSe UE-to-network relay UE to 5G ProSe UE-to-UE relay UE.

8a.2.12.2.4 5G ProSe UE-to-UE relay UE key request procedure

The 5G ProSe UE-to-UE relay UE key request procedure is the same as described in clause 8.2.10.2.4 with replacing the 5G ProSe remote UE to 5G ProSe end UE and the 5G ProSe UE-to-network relay UE to 5G ProSe UE-to-UE relay UE.

8a.2.13 5G ProSe direct discovery set transfer procedure

8a.2.13.1 General

The purpose of the 5G ProSe UE-to-UE relay direct discovery set transfer procedure is for the source 5G ProSe end UE to send the protected user info to the 5G ProSe UE-to-UE relay UE.

This procedure is triggered when the source 5G ProSe end UE has a direct link established with the 5G ProSe UE-to-UE relay UE and the source 5G ProSe end UE would like the 5G ProSe UE-to-UE relay UE to perform the announcing UE procedure for UE-to-UE relay discovery on behalf of the source 5G ProSe end UE.

8a.2.13.2 5G ProSe direct discovery set transfer procedure initiation by initiating UE

The initiating UE shall meet the following pre-conditions before initiating this procedure:

- a) the 5G ProSe direct link is established between the source 5G ProSe end UE and 5G ProSe UE-to-UE relay UE;
- b) the initiating UE determines to use the 5G ProSe UE-to-UE relay UE to perform the announcing UE procedure for UE-to-UE relay discovery.

The UE shall initiate the 5G ProSe direct discovery set transfer procedure by sending the PROSE DIRECT DISCOVERY SET TRANSFER IND message. The initiating UE:

- a) shall include the protected user info of the source 5G ProSe end UE; and
- b) shall include the relay service code parameter set to the relay service code configured for the connectivity service to be announced, as specified in clause 5.2.7. If the UE served by the NG-RAN, the security procedures selection is based on the relay service codes configured at the UE. Otherwise, the selected relay service code configured at the UE shall be associated with the network assistance security indication indicating the security procedure without network assistance is to be used.

After the PROSE DIRECT DISCOVERY SET TRANSFER IND message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for 5G ProSe direct communication and the target UE's layer-2 ID of the 5G ProSe UE-to-UE relay UE and start timer T5202. The UE shall not send a new PROSE DIRECT DISCOVERY SET TRANSFER IND message to the same target UE while timer T5202 is running.

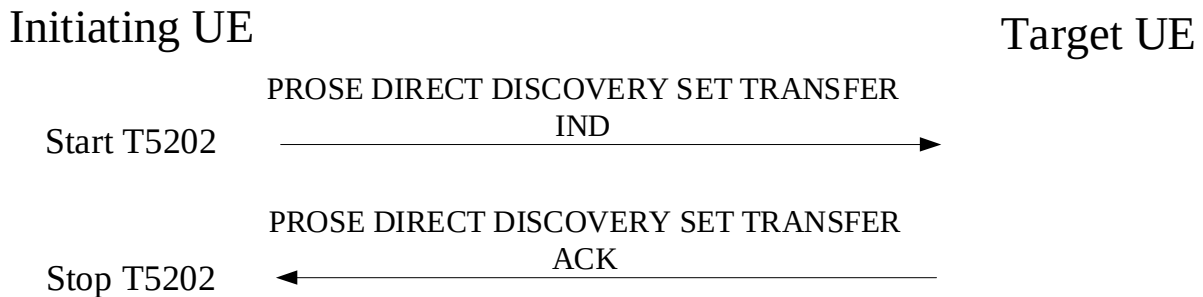


Figure 8a.2.13.2.1: 5G ProSe direct discovery set transfer procedure

8a.2.13.3 5G ProSe direct discovery set procedure ack by the target UE

Upon reception of PROSE DIRECT DISCOVERY SET TRANSFER IND message, the target UE shall store the protected user info of the source 5G ProSe end UE based on the validity timer derived from the bit length of UTC-based counter LSB contents of the UTC-based counter LSB IE associated with the protected user info of the source 5G ProSe end UE as specified in clause 6.1.3.3 of 3GPP TS 33.503 [34]. The target UE schedules the next announcement for the source 5G ProSe end UE according to its next scheduled announcement opportunity that can be implementation specific and considering the received validity time.

If the validity timer associated with a protected user info of 5G ProSe end UE is valid, the target UE shall create a PROSE DIRECT DISCOVERY SET TRANSFER ACK message.

After the PROSE DIRECT DISCOVERY SET TRANSFER ACK message is generated, the target UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication.

8a.2.13.4 5G ProSe direct discovery set transfer procedure completion by the initiating UE

Upon receipt of a PROSE DIRECT DISCOVERY SET TRANSFER ACK message, the initiating UE shall stop timer T5202.

8a.2.13.5 Abnormal cases

8a.2.13.5.1 Abnormal cases at the initiating UE

The following abnormal cases can be identified:

- a) If timer T5202 expires, the initiating UE shall retransmit the PROSE DIRECT DISCOVERY SET TRANSFER IND message and restart timer T5202. After reaching the maximum number of allowed retransmissions, the initiating UE shall abort the 5G ProSe direct discovery set transfer procedure and may notify the upper layer that the target UE is unreachable.

NOTE 1: The maximum number of allowed retransmissions is UE implementation specific.

NOTE 2: After reaching the maximum number of allowed retransmissions, whether the initiating UE releases this 5G ProSe direct link depends on its implementation.

- b) For the same 5G ProSe direct link, if the initiating UE receives a PROSE DIRECT LINK RELEASE REQUEST message after the initiation of 5G ProSe direct discovery set transfer procedure, the initiating UE shall stop the timer T5202 and abort the 5G ProSe direct discovery set transfer procedure and proceed with the 5G ProSe direct link release procedure.

NOTE 3: The implementation dependent timer value needs to be set to avoid further collisions (e.g., random timer value).

8a.2.13.5.2 Abnormal cases at the target UE

The following abnormal cases can be identified:

- a) For the same 5G ProSe direct link, if the target UE receives a PROSE DIRECT LINK RELEASE REQUEST message during the 5G ProSe direct discovery set transfer procedure, the target UE shall stop all running timers for this 5G ProSe direct link, abort the 5G ProSe direct discovery set transfer procedure and proceed with the 5G ProSe direct link release procedure.

8b 5G ProSe multi-hop UE-to-network relay

8b.1 Overview

This clause describes the procedures for 5G ProSe multi-hop UE-to-network relay. The UE is configured with the related information as described in clause 5.2.8.

8b.2 Procedures

8b.2.1 5G ProSe multi-hop UE-to-network relay discovery over PC5 interface

8b.2.1.1 General

This clause describes the procedures for both multi-hop layer-3 and layer-2 UE-to-network relay discovery for public safety use and commercial services at a ProSe-enabled UE over the PC5 interface. The purpose of the multi-hop UE-to-network relay discovery procedure over PC5 interface is to enable a ProSe-enabled UE to detect and identify another ProSe-enabled UE over PC5 interface for multi-hop UE-to-network relay communication between a UE and 5GC.

A 5G ProSe multi-hop UE-to-network relay UE or a 5G ProSe intermediate UE-to-network relay UE supporting multiple relay service codes can advertise the relay service codes using multiple discovery messages, with one relay service code per discovery message.

Due to local regulations or implementation specific requirements and if the 5G ProSe multi-hop layer-3 UE-to-network relay UE or the 5G ProSe layer-3 intermediate UE-to-network relay UE:

- a) is using its own emergency service;
- b) is relaying the emergency service from one 5G ProSe multi-hop layer-3 remote UE; or
- c) received the emergency service support indicator for 3GPP access set to "emergency services not supported" in the latest REGISTRATION ACCEPT message from the AMF as specified in 3GPP TS 24.501 [11],

the 5G ProSe multi-hop layer-3 UE-to-network relay UE or the 5G ProSe layer-3 intermediate UE-to-network relay UE shall not announce or respond to the 5G ProSe multi-hop UE-to-network relay discovery message including the RSC specific for emergency service.

NOTE 1: The prioritisation between the emergency calls of the 5G ProSe multi-hop layer-3 UE-to-network relay UE or the 5G ProSe layer-3 intermediate UE-to-network relay UE itself and of the 5G ProSe multi-hop layer-3 remote UE is determined by the local regulations, if available, otherwise it is left to the 5G ProSe multi-hop layer-3 UE-to-network relay UE or 5G ProSe layer-3 intermediate UE-to-network relay UE implementation.

The following principles for 5G ProSe multi-hop UE-to-network relay apply when the 5G ProSe multi-hop UE-to-network relay UE, 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop remote UE is in service area restriction as defined in clause 5.3.5 of 3GPP TS 24.501 [11], except the case when the 5G ProSe multi-hop UE-to-network relay UE or 5G ProSe intermediate UE-to-network relay UE is relaying the emergency service for the 5G ProSe multi-hop remote UE:

- a) in non-allowed area of its serving PLMN, the 5G ProSe multi-hop layer-3 UE-to-network relay UE or 5G ProSe layer-3 intermediate UE-to-network relay UE is not allowed to perform relay operations except for e.g. high priority access as defined in clause 5.3.5 of 3GPP TS 24.501 [11] based on relay service codes as specified in clause 5.2.8;
- b) service area restriction is not applicable to the 5G ProSe multi-hop layer-3 remote UE;
- c) in non-allowed area of its serving PLMN, the 5G ProSe multi-hop layer-2 UE-to-network relay UE or the 5G ProSe layer-2 intermediate UE-to-network relay UE is not allowed to perform relay operations;
- d) in non-allowed area of its serving PLMN, the 5G ProSe multi-hop layer-2 remote UE follows the same principles of service area restrictions as specified in clause 5.3.5 of 3GPP TS 24.501 [11] for communication with the network via the 5G ProSe multi-hop layer-2 UE-to-network relay UE or the 5G ProSe layer-2 intermediate UE-to-network relay UE; and
- e) when the 5G ProSe multi-hop layer-2 remote UE is out of NG-RAN coverage, or is in allowed area of 5G ProSe multi-hop layer-2 remote UE's serving PLMN, the 5G ProSe multi-hop layer-2 remote UE follows the same principles of service area restrictions as specified in clause 5.3.5 of 3GPP TS 24.501 [11] for communication with the network via the 5G ProSe multi-hop layer-2 UE-to-network relay UE or the 5G ProSe layer-2 intermediate UE-to-network relay UE if the 5G ProSe multi-hop layer-2 remote UE determines that the 5G ProSe multi-hop layer-2 UE-to-network relay UE or the 5G ProSe layer-2 intermediate UE-to-network relay UE is in the non-allowed area of the 5G ProSe multi-hop layer-2 remote UE based on the TAI in the RRC container received from the 5G ProSe multi-hop layer-2 UE-to-network relay UE or the 5G ProSe layer-2 intermediate UE-to-network relay UE.

The following principles for 5G ProSe multi-hop UE-to-network relay apply when 5G ProSe multi-hop UE-to-network relay UE, 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop remote UE is in 5GS forbidden tracking areas as defined in clause 5.3.13 of 3GPP TS 24.501 [11]:

- a) in a 5GS forbidden tracking area of its serving PLMN, the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE is not allowed to perform relay operations;
- b) in a 5GS forbidden tracking area of its serving PLMN, the 5G ProSe multi-hop remote UE is not allowed to access the network via the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE unless the 5G ProSe multi-hop remote UE is attempting for emergency service; and
- c) when the 5G ProSe multi-hop layer-2 remote UE is out of NG-RAN coverage, or is in NG-RAN coverage and not in a 5GS forbidden tracking area of its serving PLMN, the 5G ProSe multi-hop layer-2 remote UE shall not access the network via this 5G ProSe multi-hop layer-2 UE-to-network relay or 5G ProSe layer-2 intermediate UE-to-network relay except for emergency service, if the 5G ProSe multi-hop layer-2 remote UE determines that the 5G ProSe multi-hop layer-2 UE-to-network relay UE or the 5G ProSe layer-2 intermediate UE-to-network relay UE is in the forbidden tracking area of the 5G ProSe multi-hop layer-2 remote UE based on the TAI in the RRC container received from the 5G ProSe multi-hop layer-2 UE-to-network relay UE or the 5G ProSe layer-2 intermediate UE-to-network relay.

To perform multi-hop UE-to-network relay discovery over PC5 interface, the UE is configured with the related information as described in clause 5.2.8. The following models for multi-hop UE-to-network relay discovery procedure over PC5 interface as specified in 3GPP TS 23.304 [2] are supported:

- a) Model A uses a single discovery protocol message (Announcement); and
- b) Model B uses two discovery protocol messages (Solicitation and Response).

NOTE 2: If the UE is authorized to perform both 5G ProSe multi-hop UE-to-network relay discovery Model A and 5G ProSe multi-hop UE-to-network relay discovery Model B, it is up to UE implementation to select which model to perform or perform both models simultaneously.

The 5G ProSe multi-hop UE-to-network relay UE, the 5G ProSe intermediate UE-to-network relay UE and 5G ProSe multi-hop remote UE may use the PC5 DRX mechanism to perform 5G ProSe multi-hop UE-to-network relay discovery over PC5 interface when the UE is not served by NG-RAN as specified in clause 5.2.8.

8b.2.1.2 Multi-hop UE-to-network relay discovery over PC5 interface with model A

8b.2.1.2.1 General

In this procedure, the 5G ProSe multi-hop UE-to-network relay UE acts as an "announcing UE", 5G ProSe intermediate UE-to-network relay UE acts both as an "announcing UE" and a "monitoring UE", and the 5G ProSe multi-hop remote UE acts as a "monitoring UE".

8b.2.1.2.2 Announcing multi-hop UE-to-network relay discovery

8b.2.1.2.2.1 General

The purpose of the announcing UE procedure for multi-hop UE-to-network relay discovery is:

- a) to enable a ProSe-enabled UE to announce availability of a connectivity service provided by a multi-hop UE-to-network relay of the ProSe-enabled UE to other ProSe-enabled UEs, upon a request from upper layers as defined in 3GPP TS 23.304 [2];
- b) to enable a ProSe-enabled UE to announce availability of a connectivity service provided by a 5G ProSe intermediate UE-to-network relay of the ProSe-enabled UE to other ProSe-enabled UEs, upon a request from upper layers as defined in 3GPP TS 23.304 [2]; or
- c) to enable a ProSe-enabled UE to measure the PROSE PC5 DISCOVERY message signal strength between the ProSe-enabled UE, and the 5G ProSe multi-hop UE-to-network relay UE(s) or the 5G ProSe intermediate UE-to-network relay UE(s) for relay selection/reselection.

8b.2.1.2.2.2 ProSe multi-hop UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation

This procedure is performed by:

- a) a 5G ProSe multi-hop UE-to-network relay UE towards a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop remote UE.

The UE is authorised to perform the ProSe multi-hop UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation if:

- a) the UE is authorised to act as a multi-hop UE-to-network relay in the PLMN or the subscribed SNPN indicated by the serving cell as specified in clause 5.2.8, and
 - 1) the UE is served by NG-RAN and the UE is authorised to perform 5G ProSe direct discovery in the PLMN or the subscribed SNPN as specified in clause 5; or
 - 2) the UE is authorised to perform 5G ProSe direct discovery when not served by NG-RAN as specified in clause 5 and intends to use the provisioned radio resources for multi-hop UE-to-network relay discovery;
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be announced as specified in clause 5.2.8 and the indicated security procedure for the relay service code is supported by the UE. For 5G ProSe multi-hop layer-3 UE-to-network relay UE,
 - i) an indication that multi-hop relay is allowed for the relay service code and the maximum number of allowed hops as specified in clause 5.2.8;
 - ii) the S-NSSAI associated with that relay service code shall belong to the allowed NSSAI of the UE; and
 - iii) if the UE is camped on a cell whose TAI is in the list of "non-allowed tracking areas" or is camped on a cell whose TAI is not in the list of "allowed tracking areas", then the relay service code shall be associated with high priority access as defined in clause 5.3.5 of 3GPP TS 24.501 [11]; and
 - 2) the User info ID for the multi-hop UE-to-network relay discovery parameter as specified in clause 5.2.8;
 - 3) the PDU Session parameters to be used for relayed traffic, as specified in clause 5.2.8; and

- c) the back-off timer T3346 used for NAS mobility management congestion control as specified in clause 5.3.9 of 3GPP TS 24.501 [11] is not running at the UE;

otherwise, the UE is not authorised to perform the ProSe multi-hop UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation.

Figure 8b.2.1.2.2.2-1 illustrates the interaction of the UEs in the ProSe multi-hop UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation.



Figure 8b.2.1.2.2.2-1: ProSe multi-hop UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation

When the UE is triggered by an upper layer application to announce availability of a connectivity service provided by a multi-hop UE-to-network relay, if the UE is authorised to perform the ProSe multi-hop UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages for relay discovery as specified in 3GPP TS 38.331 [13], shall perform a service request procedure or mobility registration procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time as specified in clause 11.2.5;
- c) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement according to clause 10.2.1. In the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement, the UE:
 - 1) shall set the announcer info parameter to the User info ID configured for the multi-hop UE-to-network relay discovery, as specified in clause 5.2.8;
 - 2) shall set the hop count parameter to '1';
 - 3) may set the hop limit parameter to the value provided by the upper layer, if the value is smaller than the maximum number of allowed hops as specified in clause 5.2.8;
 - 4) shall set the relay service code parameter to the relay service code configured for the connectivity service to be announced, as specified in clause 5.2.8. The relay service code parameter is set to relay service code specific for emergency service if the UE is triggered by an upper layer application to announce availability of an emergency connectivity service provided by a UE-to-network relay; and
 - i) for 5G ProSe multi-hop layer-2 UE-to-network relay UE, the UE received an indication from the lower layers that the cell supports IMS emergency bearer services for UEs in limited service mode as specified in 3GPP TS 38.331 [13]; or
 - ii) for 5G ProSe multi-hop UE-to-network relay UE, the EMC bit in the 5GS network feature support IE of the REGISTRATION ACCEPT message is not set to "Emergency services not supported" as specified in 3GPP TS 24.501 [11] and the UE is neither using its own emergency service nor relaying the emergency services from one 5G ProSe multi-hop remote UE;
- 4a) shall include the MIC field computed as described in 3GPP TS 33.503 [34], by using the UTC-based counter and the DUIK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe multi-hop UE-to-network relay is used;

- 5) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
- 6) shall set the Resource Status Indicator bit of the status indicator parameter to indicate whether or not the UE has resources available to provide a connectivity service for additional ProSe-enabled UEs;
- 7) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.15;
- 8) if acting as 5G ProSe multi-hop layer-2 UE-to-network relay UE, shall set the NCGI parameter to the NCGI of its serving cell;
- 9) if acting as 5G ProSe multi-hop layer-2 UE-to-network relay UE, shall set the RRC container to the RRC container if provided by the lower layers;
- 10) may set the root relay parameter to the User info ID configured for the multi-hop UE-to-network relay discovery; and
- 11) shall include the PLMN ID set to its HPLMN ID and in cleartext;

NOTE 0: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 0A: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- d) shall apply the DUK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the destination layer-2 ID to the default destination layer-2 ID as specified in clause 5.2.8 and self-assign a source layer-2 ID for sending the multi-hop UE-to-network relay discovery announcement; and

NOTE 1: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.2.2, clause 6.2.15.2.2.2 and clause 8b.2.1.3.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement to the lower layers for transmission over the PC5 interface with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery.

The UE shall maintain the association(s) between the self-assigned source layer-2 ID and relay service code once the PROSE PC5 DISCOVERY message is generated. Each self-assigned source layer-2 ID can be associated with only one relay service code.

The UE shall ensure that it keeps on passing the same PROSE PC5 DISCOVERY message along with the same source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission until the UE is triggered by an upper layer application to stop announcing availability of a connectivity service provided by a multi-hop UE-to-network relay, or until the UE stops being authorised to perform the ProSe multi-hop UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation. How this is achieved is left up to UE implementation.

NOTE 2: The announcing UE can stop ProSe multi-hop UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

8b.2.1.2.2.3 ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation

This procedure is performed by:

- a) a 5G ProSe multi-hop parent UE-to-network relay UE towards a 5G ProSe multi-hop child UE-to-network relay UE; or
- b) a 5G ProSe intermediate UE-to-network relay UE towards a 5G ProSe multi-hop remote UE.

The UE is authorised to perform the 5G ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation if:

- a) the UE is authorised to act as a 5G ProSe intermediate UE-to-network relay in the PLMN or the subscribed SNPN indicated by the serving cell as specified in clause 5.2.8; and
 - 1) the UE is served by NG-RAN and the UE is authorised to perform 5G ProSe direct discovery in the PLMN or the subscribed SNPN as specified in clause 5; or
 - 2) the UE is authorised to perform 5G ProSe direct discovery when not served by NG-RAN as specified in clause 5 and intends to use the provisioned radio resources for UE-to-network relay discovery;
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be announced as specified in clause 5.2.8 and the indicated security procedure for the relay service code is supported by the UE. For 5G ProSe intermediate UE-to-network relay UE;
 - i) an indication that multi-hop relay is allowed for the relay service code and the maximum number of allowed hops as specified in clause 5.2.8; and
 - 2) the User info ID for the multi-hop UE-to-network relay discovery parameter as specified in clause 5.2.8; and
 - 3) the traffic type (IP, Ethernet, Unstructured) to be used for the relayed traffic; and
- c) the UE has established PC5 direct link with its 5G ProSe multi-hop parent UE-to-network relay UE identified by the Announcer Info in the 5G ProSe UE-to-Network relay discovery entry;

otherwise, the UE is not authorised to perform the 5G ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation.

Figure 8b.2.1.2.2.3-1 illustrates the interaction of the UEs in the 5G ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation.



Figure 8b.2.1.2.2.3-1: ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation

When the UE is triggered by an upper layer application to announce availability of a connectivity service provided by an intermediate UE-to-network relay using the 5G ProSe UE-to-Network relay discovery entry as described in clause 8b.2.1.2.3.2, and if the UE is authorised to perform the 5G ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation, then upon monitoring and processing a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement as described in clause 8b.2.1.2.3.2, the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages for relay discovery as specified in 3GPP TS 38.331 [13], shall perform a service request procedure or mobility registration procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time as specified in clause 11.2.5;

- c) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement according to clause 10.2.1. In the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement, the UE shall use the 5G ProSe UE-to-Network relay discovery entry and:
- 1) shall set the announcer info parameter to the User info ID configured for the multi-hop UE-to-network relay discovery, as specified in clause 5.2.8;
 - 2) shall increment the Hop Count Info stored in the 5G ProSe UE-to-Network relay discovery entry by 1 and set it as the hop count parameter;
 - 3) shall set the relay service code parameter to the RSC Info stored in the 5G ProSe UE-to-Network relay discovery entry;
 - 4) may set the root relay info parameter to the Root Relay Info stored in the 5G ProSe UE-to-Network relay discovery entry;
 - 5) may set the accumulated QoS parameter to the Accumulated QoS for PC5 link Info stored in the 5G ProSe UE-to-Network relay discovery entry;
 - 5a) shall set the hop limit parameter to the Hop Limit Info stored in the 5G ProSe UE-to-network relay discovery entry, if available;
 - 5b) shall include the MIC field computed as described in 3GPP TS 33.503 [34], by using the UTC-based counter and the DUIK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe multi-hop UE-to-network relay is used;
 - 6) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 7) shall set the Resource Status Indicator bit of the status indicator parameter to indicate whether or not the UE has resources available to provide a connectivity service for additional ProSe-enabled UEs;
 - 8) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.15;
 - 9) if acting as 5G ProSe layer-2 intermediate UE-to-network relay UE, shall set the NCGI parameter to the NCGI of its serving cell;
 - 10) if acting as 5G ProSe layer-2 intermediate UE-to-network relay UE, shall set the RRC container to the RRC container if provided by the lower layers;
 - 11) shall include the PLMN ID set to the PLMN ID value obtained from the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement, and in cleartext;

NOTE 0: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 0A: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- d) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the destination layer-2 ID to the default destination layer-2 ID as specified in clause 5.2.8 and self-assign a source layer-2 ID for sending the intermediate UE-to-network relay discovery announcement; and

NOTE 1: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.2.2, clause 6.2.15.2.2.2 and clause 8b.2.1.3.1.2.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement to the lower layers for transmission over the PC5 interface with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery.

The UE shall maintain the association(s) between the self-assigned source layer-2 ID and relay service code once the PROSE PC5 DISCOVERY message is generated. Each self-assigned source layer-2 ID can be associated with only one relay service code.

The UE shall ensure that it keeps on passing the same PROSE PC5 DISCOVERY message along with the same source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission until the UE is triggered by an upper layer application to stop announcing availability of a connectivity service provided by an intermediate UE-to-network relay, or until the UE stops being authorised to perform the 5G ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation. How this is achieved is left up to UE implementation.

NOTE 2: The announcing UE can stop 5G ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

8b.2.1.2.2.4 Announcing UE procedure for multi-hop UE-to-network relay discovery completion

When the announcing UE, ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE, is triggered by an upper layer application to stop announcing availability in a discovery group, or when the announcing UE stops being authorised to perform the announcing UE procedure, the UE shall instruct the lower layers to stop announcing.

NOTE: The announcing UE can stop announcing UE procedure for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops announcing, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8b.2.1.2.3 Monitoring multi-hop UE-to-network relay discovery

8b.2.1.2.3.1 General

The purpose of the monitoring UE procedure for multi-hop UE-to-network relay discovery is:

- a) to enable a ProSe-enabled UE to become aware of proximity of a connectivity service provided by a multi-hop UE-to-network relay or a intermediate UE-to-network relay, upon a request from upper layers as defined in 3GPP TS 23.304 [2]; or
- b) to enable a ProSe-enabled UE to measure the PROSE PC5 DISCOVERY message signal strength between the ProSe-enabled UE, and the 5G ProSe multi-hop UE-to-network relay UE(s) or the 5G ProSe intermediate UE-to-network relay UE(s) for relay selection/reselection.

8b.2.1.2.3.2 ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery monitoring

This procedure is performed by:

- a) a 5G ProSe intermediate UE-to-network relay UE to monitor a 5G ProSe multi-hop UE-to-network relay UE; or
- b) a 5G ProSe multi-hop child UE-to-network relay UE to monitor a 5G ProSe multi-hop parent UE-to-network relay UE.

The UE is authorised to perform the ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery monitoring if:

- a) the following is true:

- 1) if the UE is not served by NG-RAN, the UE is authorised to perform 5G ProSe direct discovery monitoring when the UE is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN; or
 - 2) if the UE is served by NG-RAN, the UE is authorised to perform 5G ProSe direct discovery monitoring in at least one PLMN or the subscribed SNPN; and
- b) the UE is configured with the relay service code parameter identifying the connectivity service to be monitored, as specified in clause 5.2.8 and the indicated security procedure for the relay service code is supported by the UE.

otherwise, the UE is not authorised to perform the ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery monitoring.

Figure 8b.2.1.2.3.2-1 illustrates the interaction of the UEs in the ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery monitoring.

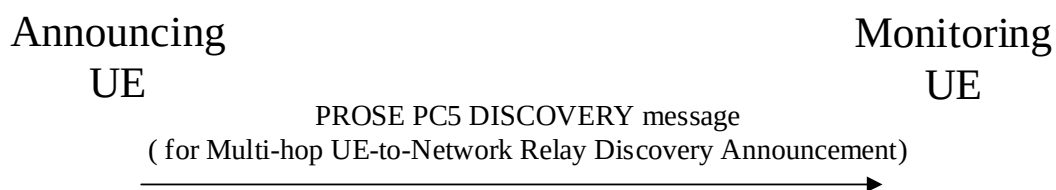


Figure 8b.2.1.2.3.2-1: ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery monitoring

When the UE is triggered by the upper layers to monitor proximity of a connectivity service provided by a multi-hop UE-to-network relay or an intermediate UE-to-network relay or when the UE decides to perform 5G ProSe multi-hop UE-to-network relay reselection as specified in clause 8b.2.3, and if the UE is authorised to perform the ProSe intermediate UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery monitoring, then the UE shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages with the default destination layer-2 ID as specified in clause 5.2.8.

Upon reception of a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement according to clause 10.2.1, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to monitor, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to monitor, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used) and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement.

NOTE 1: The use of an erroneous UTC-based counter for processing received PROSE PC5 DISCOVERY messages at the ProSe-enabled UE can cause MIC check failure after DUK is used for integrity check and malformed contents after DUSK is used for unscrambling or DUCK is used for deciphering. How a ProSe-enabled UE ensures the accuracy of the UTC-based counter is left to UE implementation.

NOTE 2: The UE can determine the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement is for 5G ProSe direct discovery based on an indication from the lower layer.

Then, if:

- a) the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement is the same as the relay service code parameter configured as specified in clause 5 for the connectivity service being monitored;
- b) the target announcer info is not provided by upper layers for the connectivity service being monitored, or the announcer info parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement is the same as the target announcer info if the target announcer info is provided by upper layers for the connectivity service being monitored;
- c) the hop count parameter of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement is less than the configured maximum number of allowed hops, as specified in clause 5.2.8; and
- d) the hop count parameter of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement is less than the hop limit parameter of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement (if available),

then

- a) the UE may measure the signal strength of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement for relay selection or reselection;
- b) if a 5G ProSe UE-to-Network relay discovery entry corresponding to the relay service code parameter and the root relay info parameter of the received PROSE PC5 DISCOVERY message is not stored at the UE:
 - 1) the UE shall create and store a 5G ProSe UE-to-Network relay discovery entry corresponding to the received PROSE PC5 DISCOVERY message. The 5G ProSe UE-to-Network relay discovery entry:
 - i) shall include RSC Info, set to the relay service code parameter of the received PROSE PC5 DISCOVERY message;
 - ii) shall include the Announcer Info, set to the Announcer Info parameter of the received PROSE PC5 DISCOVERY message;
 - iii) shall include Hop Count Info, set to the hop count parameter of the received PROSE PC5 DISCOVERY message;
 - iv) may include Root Relay Info, set to the root relay info parameter of the received PROSE PC5 DISCOVERY message;
 - v) may include the Accumulated QoS for PC5 link Info, based on the Accumulated QoS for PC5 link information parameter of the received PROSE PC5 DISCOVERY message and the QoS of the PC5 link between the UE and the sender of the message;
 - vi) may include the NCGI Info, set to the NCGI parameter of the received PROSE PC5 DISCOVERY message;
 - vii) may include the RRC Container Info if provided by the lower layers; and
 - viii) shall include the hop limit, set to the hop limit parameter of the received PROSE PC5 DISCOVERY message, if available; and
- c) if a 5G ProSe UE-to-Network relay discovery entry corresponding to the relay service code parameter and the root relay info parameter of the received PROSE PC5 DISCOVERY message is already stored, then the UE shall:
 - 1) check if the hop count parameter of the received PROSE PC5 DISCOVERY message is less than the Hop Count Info of the stored 5G ProSe UE-to-Network relay discovery entry. If yes, the UE:
 - i) shall update the Announcer Info of the stored 5G ProSe UE-to-network relay discovery entry to the Announcer Info parameter of the received PROSE PC5 DISCOVERY message;
 - ii) shall update the Hop Count Info of the stored 5G ProSe UE-to-network relay discovery entry to the hop count parameter of the received PROSE PC5 DISCOVERY message; and

- iii) may update the Accumulated QoS for PC5 link Info, based on the Accumulated QoS for PC5 link information parameter of the received PROSE PC5 DISCOVERY message and the QoS of the PC5 link between the UE and the sender of the message; and
- 2) check if the hop limit parameter of the received PROSE PC5 DISCOVERY message (if available) is different with the Hop Limit Info of the stored 5G ProSe UE-to-network relay discovery entry. If yes, the UE shall update the Hop Limit Info of the stored 5G ProSe-UE-to-network relay discovery entry to the hop limit parameter of the received PROSE PC5 DISCOVERY message.

If the hop count parameter of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement is the same as the configured maximum number of allowed hops as specified in clause 5.2.8; or is the same as the hop limit parameter of the PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement (if available), then the UE shall discard the received PROSE PC5 DISCOVERY message.

NOTE 3: Based on UE implementation, the UE may decide to update the 5G ProSe UE-to-network relay discovery entry based on the Accumulated QoS for PC5 link Info instead of the Hop Count Info, or a combination of the two information elements.

NOTE 4: Based on UE implementation, the UE sets a locally configured timer for each 5G ProSe UE-to-network relay discovery entry. When the timer expires, if the UE does not have an active PC5 link with the 5G ProSe multi-hop UE-to-network relay UE and does not receive any new PROSE PC5 DISCOVERY message from the multi-hop UE-to-network relay UE, the UE removes 5G ProSe UE-to-network relay discovery entry of the 5G ProSe multi-hop UE-to-network relay UE.

8b.2.1.2.3.3 ProSe multi-hop remote UE procedure for multi-hop UE-to-network relay discovery monitoring

This procedure is performed by:

- a) a 5G ProSe multi-hop remote UE to monitor a 5G ProSe multi-hop UE-to-network relay UE or a 5G ProSe intermediate UE-to-network relay UE.

The UE is authorised to perform ProSe multi-hop remote UE procedure for multi-hop UE-to-network relay discovery monitoring if:

- a) the following is true:
 - 1) the UE is not served by NG-RAN, is authorised to perform 5G ProSe direct discovery using monitoring when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;
 - 2) the UE is served by NG-RAN and is authorised to perform 5G ProSe direct discovery monitoring in at least one PLMN or the subscribed SNPN; or
 - 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to perform 5G ProSe direct discovery using monitoring when the UE is not served by NG-RAN, and:
 - A) configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN;

- b) the UE is configured with the relay service code parameter identifying the connectivity service to be monitored, as specified in clause 5.2.8 and the indicated security procedure for the relay service code is supported by the UE; and
- c) for 5G ProSe multi-hop layer-2 remote UE, the UE is camped on a cell whose TAI is not in the list of "non-allowed tracking areas" or is camped on a cell whose TAI is in the list of "allowed tracking areas",

otherwise, the UE is not authorised to perform the ProSe multi-hop remote UE procedure for multi-hop UE-to-network relay discovery monitoring.

Figure 8b.2.1.2.3.3-1 illustrates the interaction of the UEs in the ProSe multi-hop remote UE procedure for multi-hop UE-to-network relay discovery monitoring.

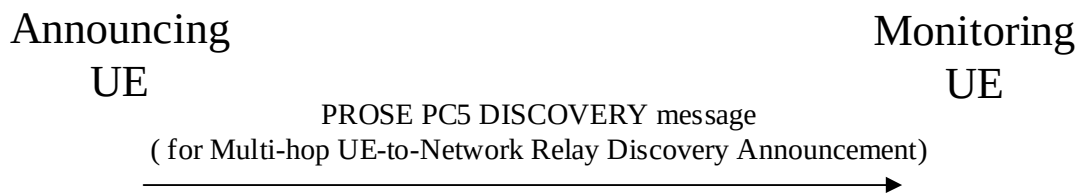


Figure 8b.2.1.2.3.3-1: ProSe multi-hop remote UE procedure for multi-hop UE-to-network relay discovery monitoring

When the UE is triggered by the upper layers to monitor proximity of a connectivity service provided by a multi-hop UE-to-network relay or an intermediate UE-to-network relay or when the UE decides to perform 5G ProSe multi-hop UE-to-network relay reselection as specified in clause 8b.2.3, and if the UE is authorised to perform the ProSe multi-hop remote UE procedure for multi-hop UE-to-network relay discovery monitoring, then the UE shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages with the default destination layer-2 ID as specified in clause 5.2.8.

If the traffic descriptor is configured as specified in clause 5.2.8, the 5G ProSe multi-hop remote UE shall determine the monitored RSC by mapping the traffic from the upper layer application with the traffic descriptor as follows:

- a) if there are at least one ProSe application traffic descriptor(s) to be used for the relayed traffic as specified in clause 5.2.8 which has not yet been evaluated,
 - 1) if the ProSe application traffic descriptor matches upper layer application information;

the UE shall select the RSC associated with the matched ProSe application traffic descriptor for monitoring, where:

 - i) if more than one RSCs are associated with the upper layer application information and the monitored RSC for the 5G ProSe multi-hop remote UE is specific for emergency, the UE should prioritize selecting an RSC that does not provide an indication of using N3IWF access for the relayed traffic; or
 - ii) otherwise, it is up to UE implementation which RSC to select in this release of specification;
 - 2) else, the UE shall select the next ProSe application traffic descriptor which has not yet been evaluated and proceed to step 1);
- b) else, it is up to UE implementation which RSC to select, where if the monitored RSC for the 5G ProSe multi-hop remote UE is specific for emergency, the UE should prioritize selecting an RSC that does not provide an indication of using N3IWF access for the relayed traffic.

NOTE 1: Selection of relay service code is up to UE implementation if there is no ProSe application traffic descriptor(s) configured in the UE.

Upon reception of a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement according to clause 10.2.1, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to monitor, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is

authorized to monitor, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used) and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUIK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement.

NOTE 1A: The use of an erroneous UTC-based counter for processing received PROSE PC5 DISCOVERY messages at the ProSe-enabled UE can cause MIC check failure after DUIK is used for integrity check and malformed contents after DUSK is used for unscrambling or DUCK is used for deciphering. How a ProSe-enabled UE ensures the accuracy of the UTC-based counter is left to UE implementation.

NOTE 2: The UE can determine the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement is for 5G ProSe direct discovery based on an indication from the lower layer.

Then if:

- a) the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement is the same as the relay service code parameter configured as specified in clause 5 for the connectivity service being monitored; and
- b) the target announcer info is not provided by upper layers for the connectivity service being monitored, or the announcer info parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement is the same as the target announcer info if the target announcer info is provided by upper layers for the connectivity service being monitored,

then the UE shall consider that the connectivity service the UE seeks to monitor has been discovered. In addition, the UE can measure the signal strength of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement for relay selection or reselection.

8b.2.1.2.3.4 Monitoring UE procedure for multi-hop UE-to-network relay discovery completion

When the UE is triggered by an upper layer application to stop monitoring proximity of other UEs in a discovery group, or when the UE stops being authorised to perform the monitoring UE procedure of the intermediate UE-to-network relay or the multi-hop remote UE for UE-to-network relay discovery, the UE shall instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8b.2.1.2.4 Announcing multi-hop UE-to-network relay discovery additional information

8b.2.1.2.4.1 General

The purpose of the announcing UE procedure for multi-hop UE-to-network relay discovery additional information is to announce to the 5G ProSe multi-hop remote UEs additional information about:

- a) the NCGI of the cell serving the 5G ProSe multi-hop layer-3 UE-to-network relay UE;
- b) the TAI of the cell serving the 5G ProSe multi-hop layer-3 UE-to-network relay UE;
- c) the NCGI of the cell serving the 5G ProSe layer-3 intermediate UE-to-network relay UE; and
- d) the NID of the subscribed SNPN.

as defined in 3GPP TS 23.304 [2].

8b.2.1.2.4.2 ProSe multi-hop UE-to-network relay UE procedure

This procedure is performed by:

- a) a 5G ProSe multi-hop UE-to-network relay UE towards a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop remote UE.

The 5G ProSe multi-hop UE-to-network relay UE announces the multi-hop UE-to-network relay discovery additional information:

- a) if a 5G ProSe multi-hop remote UE requests the 5G ProSe multi-hop UE-to-network relay UE to announce the NG-RAN Cell Global ID (NCGI) or TAI of the cell serving the 5G ProSe multi-hop UE-to-network relay UE, and optionally the NID of the SNPN in case the serving cell is operated by an SNPN, and as a response the 5G ProSe multi-hop UE-to-network relay UE acknowledges with the ProSe multi-hop additional parameters announcement response message, then the 5G ProSe multi-hop UE-to-network relay UE includes the NCGI or TAI of the serving cell and optionally the NID of the SNPN in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information until the timer T5107 expires (see clause 8b.2.1).

NOTE 1: 5G ProSe multi-hop UE-to-network relay UE announces the multi-hop UE-to-network relay discovery additional information only when it is in NG-RAN coverage.

Figure 8b.2.1.2.4.2-1 illustrates the interaction of the UEs in the ProSe multi-hop UE-to-network relay UE procedure for announcing multi-hop UE-to-network relay discovery additional information.



Figure 8b.2.1.2.4.2-1: ProSe multi-hop UE-to-network relay UE procedure for announcing multi-hop UE-to-network relay discovery additional information

The 5G ProSe multi-hop UE-to-network relay UE may start announcing multi-hop UE-to-network relay discovery additional information if:

- a) the 5G ProSe multi-hop UE-to-network relay UE is currently authorised to perform 5G ProSe direct discovery Model A announcing in the serving PLMN or the subscribed SNPN if the UE is served by NG-RAN, and
 - 1) additional parameters announcement for the serving cell of the 5G ProSe multi-hop UE-to-network relay UE has been requested and responded to 5G ProSe multi-hop remote UEs, the timer T5107 has not expired (periodic reporting);
 - 2) additional parameters announcement for the serving cell of the 5G ProSe multi-hop UE-to-network relay UE has been requested and responded to 5G ProSe multi-hop remote UEs, the timer T5107 has not expired and the 5G ProSe multi-hop UE-to-network relay UE detects camping on a new serving cell; or
 - 3) additional parameters announcement for the serving cell of the 5G ProSe multi-hop UE-to-network relay UE has been requested and responded to 5G ProSe multi-hop remote UEs, the timer T5107 has not expired and the 5G ProSe multi-hop UE-to-network relay UE detects entering a new tracking area.

When the 5G ProSe multi-hop UE-to-network relay UE has some additional information to broadcast (i.e., NCGI, TAI, NID), then the 5G ProSe multi-hop UE-to-network relay UE :

- a) shall request the parameters from the lower layers for ProSe direct discovery announcing (see 3GPP TS 38.331 [13]). If the 5G ProSe multi-hop UE-to-network relay UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], the 5G ProSe multi-hop UE-to-network relay UE shall perform a service request procedure or mobility registration procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time as specified in clause 11.2.5;

- c) shall generate PROSE PC5 DISCOVERY message(s) for multi-hop UE-to-network relay discovery additional information according to clause 10.2.1. In the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information, the 5G ProSe multi-hop UE-to-network relay UE:
- 1) shall include the relay service code used for 5G ProSe direct communication which the 5G ProSe multi-hop remote UE used to request for the multi-hop UE-to-network relay discovery additional information;
 - 2) shall set the announcer info parameter to the User info ID parameter configured in clause 5.2.8;
 - 3) shall set the NCGI parameter to the NCGI of the cell serving the UE, if the UE acts as 5G ProSe multi-hop layer-3 UE-to-network relay UE and the NCGI is to be announced;
 - 4) shall set the Relay TAI parameter to the TAI of the cell serving the UE, if the UE acts as 5G ProSe multi-hop layer-3 UE-to-network relay UE and the TAI is to be announced;
 - 5) shall set the hop count parameter to '1';
 - 6) may set the hop limit parameter to the value provided by the upper layer, if the value is smaller than the maximum number of allowed hops as specified in clause 5.2.8;
 - 6a) shall include the MIC field computed as described in 3GPP TS 33.503 [34], by using the UTC-based counter and the DUIK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe multi-hop UE-to-network relay is used;
 - 7) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 8) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.16;
 - 9) shall include the PLMN ID set to its HPLMN ID and in cleartext;

NOTE 1A: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 1B: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- 10) for SNPN, if NCGI, Relay TAI or both is included, shall include the NID of the subscribed SNPN;
- d) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the default destination layer-2 ID as specified in clause 5.2.5 to the destination layer-2 ID and self-assign a source layer-2 ID for sending the multi-hop UE-to-network relay discovery additional information; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.2.2, clause 6.2.15.2.2.2 and clause 8b.2.1.3.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

The 5G ProSe multi-hop UE-to-network relay UE shall ensure that it keeps on passing the PROSE PC5 DISCOVERY messages periodically to the lower layers for transmission until the corresponding timer expires. How this is achieved is left up to UE implementation.

NOTE 3: The announcing UE can stop announcing UE procedure for multi-hop UE-to-network relay discovery additional information for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

NOTE 4: The periodicity of sending the PROSE PC5 DISCOVERY messages for multi-hop UE-to-network relay discovery additional information by the 5G ProSe multi-hop UE-to-network relay UE is implementation specific and is normally lower than the one related to the additional parameters announcement request refresh timer T5106.

During the announcing operation, if one of the above conditions is no longer met, the 5G ProSe multi-hop UE-to-network relay UE may instruct the lower layers to stop announcing.

8b.2.1.2.4.3 ProSe intermediate UE-to-network relay UE procedure

This procedure is performed by:

- a) a 5G ProSe multi-hop parent UE-to-network relay UE towards a 5G ProSe multi-hop child UE-to-network relay UE; or
- b) a 5G ProSe intermediate UE-to-network relay UE towards a 5G ProSe multi-hop remote UE.

The 5G ProSe intermediate UE-to-network relay UE announces the multi-hop UE-to-network relay discovery additional information if it receives a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information from a 5G ProSe multi-hop UE-to-network relay UE or another 5G ProSe intermediate UE-to-network relay UE:

NOTE 1: 5G ProSe intermediate UE-to-network relay UE can announce the multi-hop UE-to-network relay discovery additional information both, when it is in NG-RAN coverage and when it is not in NG-RAN coverage.

Figure 8b.2.1.2.4.3-1 illustrates the interaction of the UEs in the 5G ProSe intermediate UE-to-network relay UE procedure for announcing multi-hop UE-to-network relay discovery additional information.



Figure 8b.2.1.2.4.3-1: ProSe intermediate UE-to-network relay UE procedure for announcing multi-hop UE-to-network relay discovery additional information

The 5G ProSe intermediate UE-to-network relay UE may start announcing multi-hop UE-to-network relay discovery additional information if:

- a) the UE is authorised to act as a 5G ProSe intermediate UE-to-network relay in the PLMN or the subscribed SNPN indicated by the serving cell as specified in clause 5.2.8, and
 - 1) the UE is served by NG-RAN and the UE is authorised to perform 5G ProSe direct discovery in the PLMN or the subscribed SNPN as specified in clause 5; or
 - 2) the UE is authorised to perform 5G ProSe direct discovery when not served by NG-RAN as specified in clause 5 and intends to use the provisioned radio resources for UE-to-network relay discovery; and
- b) it has received a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information from a 5G ProSe multi-hop UE-to-network relay UE or another 5G ProSe intermediate UE-to-network relay UE as specified clause 8b.2.1.2.5.2.

To announce the multi-hop UE-to-network relay discovery additional information, the 5G ProSe intermediate UE-to-network relay UE:

- a) shall request the parameters from the lower layers for ProSe direct discovery announcing (see 3GPP TS 38.331 [13]). If the 5G ProSe intermediate UE-to-network relay UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], the 5G ProSe intermediate UE-to-network relay UE shall perform a service request procedure or mobility registration procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time as specified in clause 11.2.5;
- c) shall generate PROSE PC5 DISCOVERY message(s) for multi-hop UE-to-network relay discovery additional information according to clause 10.2.1. In the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information, the 5G ProSe intermediate UE-to-network relay UE:
 - 1) shall include the relay service code set to the value of relay service code parameter in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information;
 - 2) shall set the announcer info parameter to the User info ID parameter configured in clause 5.2.8;
 - 3) shall set the NCGI of multi-hop UE-to-network relay parameter to the value of NCGI of multi-hop UE-to-network relay parameter in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information;
 - 4) shall set the Relay TAI parameter to the value of the Relay TAI parameter in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information;
 - 5) if the hop count parameter of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information is set to 1 and the NCGI of 5G ProSe intermediate UE-to-network relay UE is available, may set the NCGI info set of intermediate UE-to-network relay parameter including the NCGI of the cell serving the UE and the user info ID of the UE;
 - 6) if the hop count parameter of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information is set to a value greater than 1 and the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information contains the NCGI info set of intermediate UE-to-network relay parameter then, shall set the NCGI info set of intermediate UE-to-network relay parameter to the received one;
 - 7) shall increment the hop count parameter of the received PROSE PC5 DISCOVERY for multi-hop UE-to-network relay discovery additional information message by 1, and set it as the hop count parameter;
 - 8) shall set the hop limit parameter to the value in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information, if available;
 - 8a) shall include the MIC field computed as described in 3GPP TS 33.503 [34], by using the UTC-based counter and the DUIK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe multi-hop UE-to-network relay is used;
 - 9) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 10) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.16;
 - 11) if the root relay info parameter is included in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information, shall set the root relay info parameter to the received root relay info parameter. If the root relay info parameter is not included in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information, the 5G ProSe intermediate UE-to-network relay UE shall set the root relay info parameter to the announcer info parameter in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information;
 - 12) shall include the PLMN ID set to the PLMN ID value included in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information, and in cleartext;

NOTE 1A: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 1B: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- d) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the default destination layer-2 ID as specified in clause 5.2.5 to the destination layer-2 ID and self-assign a source layer-2 ID for sending the multi-hop UE-to-network relay discovery additional information; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.2.2, clause 6.2.15.2.2.2 and clause 8b.2.1.3.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

The 5G ProSe intermediate UE-to-network relay UE shall ensure that it keeps on passing the PROSE PC5 DISCOVERY messages periodically to the lower layers for transmission until the corresponding timer expires. How this is achieved is left up to UE implementation.

NOTE 3: The announcing UE can stop announcing UE procedure for multi-hop UE-to-network relay discovery additional information for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

During the announcing operation, if one of the above conditions is no longer met, the 5G ProSe multi-hop UE-to-network relay UE may instruct the lower layers to stop announcing.

If the 5G ProSe intermediate UE-to-network relay UE has the PC5 direct link with the 5G ProSe multi-hop UE-to-network relay UE and the 5G ProSe intermediate UE-to-network relay UE determines an update of the NCGI of the cell serving the UE (e.g., due to change of its serving cell), the 5G ProSe intermediate UE-to-network relay UE may announce the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information with the updated NCGI info set of intermediate UE-to-network relay parameter while keeps NCGI of multi-hop UE-to-network relay parameter and Relay TAI parameter unchanged in the message.

8b.2.1.2.5 Monitoring multi-hop UE-to-network relay discovery additional information

8b.2.1.2.5.1 General

The purpose of the monitoring UE procedure for multi-hop UE-to-network relay discovery additional information is to enable a 5G ProSe multi-hop remote UE to become aware of the additional information of the 5G ProSe multi-hop UE-to-network relay UE as described and the 5G ProSe intermediate UE-to-network relay UE in clause 8b.2.1.2.4.

8b.2.1.2.5.2 ProSe intermediate UE-to-network relay UE procedure

This procedure is performed by:

- a) a 5G ProSe intermediate UE-to-network relay UE to monitor a 5G ProSe multi-hop UE-to-network relay UE; or
- b) a 5G ProSe multi-hop child UE-to-network relay UE to monitor a 5G ProSe multi-hop parent UE-to-network relay UE.

Upon monitoring a PROSE PC5 DISCOVERY message with multi-hop UE-to-network relay discovery additional information and:

- a) the hop count parameter set to a value lower than the maximum number of allowed hops as specified in clause 5.2.8 or lower than the hop limit parameter in the received message (if available); and
- b) the included PLMN ID in the received message is associated with the target relay service code of the connectivity service which the UE is authorized to monitor;

the ProSe intermediate UE-to-network relay UE announces the multi-hop UE-to-network relay discovery additional information as specified in clause 8b.2.1.2.4.3.

8b.2.1.2.5.3 ProSe multi-hop remote UE procedure

This procedure is performed by:

- a) a 5G ProSe multi-hop remote UE to monitor a 5G ProSe multi-hop UE-to-network relay UE or a 5G ProSe intermediate UE-to-network relay UE.

The 5G ProSe multi-hop remote UE monitors multi-hop UE-to-network relay discovery additional information:

- a) until the additional parameters announcement request refresh timer T5106 expires if the 5G ProSe multi-hop remote UE has requested the 5G ProSe multi-hop UE-to-network relay UE to announce the NCGI or TAI of the cell serving the 5G ProSe multi-hop UE-to-network relay UE and received the ProSe additional parameters announcement response message from the 5G ProSe multi-hop UE-to-network relay UE .

The UE may instruct the lower layers to start monitoring if:

- a) a request from upper layers to monitor for multi-hop UE-to-network relay discovery additional information is still in place and either:
 - 1) the UE is currently authorised to perform 5G ProSe direct discovery Model A monitoring in at least one PLMN or the subscribed SNPN if the UE is served by NG-RAN;
 - 2) the UE is currently authorised to perform 5G ProSe direct discovery Model A monitoring if the UE is not served by NG-RAN; or
 - 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 36.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed " as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to perform 5G ProSe direct discovery Model A monitoring when the UE is not served by NG-RAN and configured with the radio parameters to be used for 5G ProSe direct discovery when not served by NG-RAN.

If the UE is in 5GMM-CONNECTED mode, the monitoring UE shall also trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

Upon reception of a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information according to clause 10.2.1, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to monitor, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code to be monitored, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used) and the UTC-based counter obtained during the monitoring operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G

DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUK and UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for multi-hop relay discovery additional information.

During the monitoring operation, if one of the above conditions is no longer met, the UE may instruct the lower layers to stop monitoring. When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

NOTE 1: The use of an erroneous UTC-based counter for processing received PROSE PC5 DISCOVERY messages at the ProSe-enabled UE can cause MIC check failure after DUK is used for integrity check and malformed contents after DUK is used for unscrambling or DUCK is used for deciphering. How a ProSe-enabled UE ensures the accuracy of the UTC-based counter is left to UE implementation.

NOTE 2: The UE can determine the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information is for 5G ProSe direct discovery based on an indication from the lower layer.

Then, if:

- a) the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information is the same as the relay service code parameter configured as specified in clause 5.2.8 for the connectivity service being monitored; and
- b) the target announcer info is not provided by upper layers for the connectivity service being monitored, or the announcer info parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information is the same as the target announcer info if the target announcer info is provided by upper layers,

then the UE shall consider that the multi-hop UE-to-network relay discovery additional information it intends to monitor has been discovered.

8b.2.1.3 Multi-hop UE-to-network relay discovery over PC5 interface with model B

8b.2.1.3.1 General

In this procedure:

- a) the UE sending the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation and receiving the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response is called the "discoverer UE"; and
- b) the UE receiving the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation and sending the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response is called the "discoveree UE".

The 5G ProSe multi-hop remote UE acts as a "discoverer UE", the 5G ProSe intermediate UE-to-network Relay UE acts as both "discoverer UE" and "discoveree UE", and the 5G ProSe multi-hop UE-to-network Relay UE acts as a "discoveree UE".

8b.2.1.3.2 Discoverer UE procedure for multi-hop UE-to-network relay discovery

8b.2.1.3.2.1 General

The purpose of the discoverer UE procedure for multi-hop UE-to-network Relay discovery is:

- a) to enable a ProSe-enabled UE to solicit proximity of a connectivity service provided by a multi-hop UE-to-network relay or intermediate UE-to-network relay, upon a request from upper layers; or
- b) to enable a ProSe-enabled UE to measure the PROSE PC5 DISCOVERY message signal strength between the ProSe-enabled UE and the 5G ProSe multi-hop UE-to-network Relay UE(s) or the 5G ProSe intermediate UE-to-network Relay UE(s) for relay selection/reselection.

8b.2.1.3.2.2 Discoverer remote UE procedure for multi-hop UE-to-network relay discovery initiation

This procedure is performed by:

- a) a 5G ProSe multi-hop remote UE towards a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE.

The UE is authorised to perform the discoverer remote UE procedure for multi-hop UE-to-network relay discovery if:

- a) one of the following is true:
 - 1) the UE is not served by NG-RAN, is authorised to act as a 5G ProSe multi-hop remote UE towards a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE, and is configured with the radio parameters to be used for ProSe multi-hop UE-to-network relay discovery when not served by NG-RAN;
 - 2) the UE is served by NG-RAN, is authorised to act as a 5G ProSe multi-hop remote UE towards a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE; or
 - 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to act as a 5G ProSe multi-hop remote UE towards a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE when the UE is not served by NG-RAN and configured with the radio parameters to be used for ProSe multi-hop UE-to-network relay discovery use when not served by NG-RAN; and
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be solicited as specified in clause 5.2.8 and the indicated security procedure for the relay service code is supported by the UE;
 - 2) an indication that multi-hop relay is allowed for the relay service code and the maximum number of allowed hops as specified in clause 5.2.8; and
 - 3) the User info ID for the multi-hop UE-to-network relay discovery parameter, as specified in clause 5.2.8;

otherwise, the UE is not authorised to perform the discoverer remote UE procedure for multi-hop UE-to-network relay discovery.

Figure 8b.2.1.3.2.2.1 illustrates the interaction of the UEs in the discoverer remote UE procedure for multi-hop UE-to-network relay discovery.

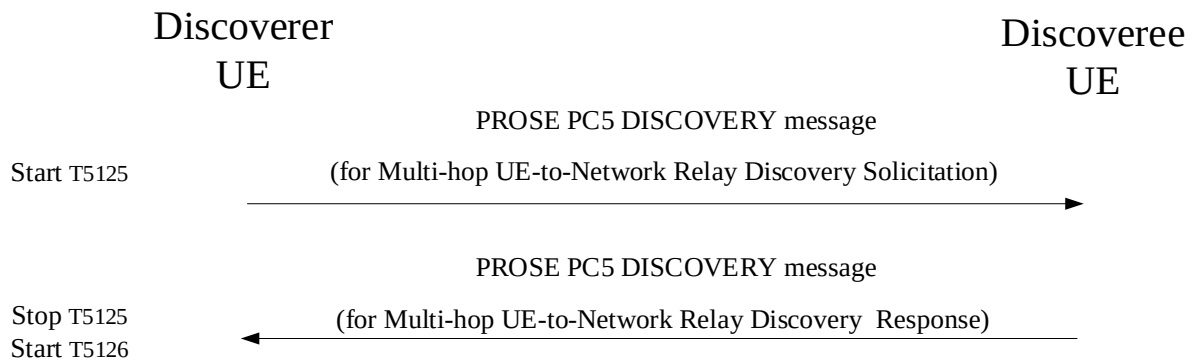


Figure 8b.2.1.3.2.2.1: Discoverer remote UE procedure for multi-hop UE-to-network Relay discovery

For PROSE PC5 DISCOVERY message signal strength measurement, the UE manages a periodic measurement timer T5126, which is used to trigger the periodic PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established. Timer T5126 is started whenever the UE has established a direct link with a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE and restarted whenever the UE receives the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response from the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established.

When the UE is triggered by the upper layers to solicit proximity of a connectivity service provided by a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE, or when the periodic measurement timer T5126 expires and if the UE is authorised to perform the discoverer remote UE procedure for multi-hop UE-to-network relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages for relay discovery as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- c) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation. In the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation, the UE:
 - 1) shall set the discoverer info parameter to the configured User info ID for the multi-hop UE-to-network relay discovery parameter, as specified in clause 5.2.8;
 - 2) shall set the relay service code parameter to the relay service code parameter identifying the connectivity service to be solicited, configured in clause 5.2.8. For the 5G ProSe multi-hop layer-3 remote UE, if the traffic descriptor is configured as specified in clause 5.2.8, the UE shall determine the RSC as follows:
 - i) if there are at least one ProSe application traffic descriptor(s) to be used for the relayed traffic as specified in clause 5.2.8 which has not yet been evaluated,
 - A) if the ProSe application traffic descriptor matches the upper layer application information;

the UE shall select the RSC associated with the matched ProSe application traffic descriptor for solicitation, where:

 - aa) if more than one RSCs are associated with the upper layer application information and the needed RSC for the 5G ProSe multi-hop layer-3 remote UE is specific for emergency, the UE should prioritize selecting an RSC that does not provide an indication of using N3IWF access for the relayed traffic; or
 - bb) otherwise, it is up to UE implementation which RSC to select in this release of specification;
 - B) else, the UE shall select the next ProSe application traffic descriptor which has not yet been evaluated and proceed to step A);

- ii) else, it is up to UE implementation which RSC to select, where if the needed RSC for the 5G ProSe multi-hop layer-3 remote UE is specific for emergency, the UE should prioritize selecting an RSC that does not provide an indication of using N3IWF access for the relayed traffic.

NOTE 1: Selection of relay service code is up to UE implementation if there is no ProSe application traffic descriptor(s) configured in the UE.

- 3) shall include the MIC field computed as described in 3GPP TS 33.503 [34] by using the UTC-based counter and the DUIK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe multi-hop UE-to-network relay is used;
- 4) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
- 5) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.17;
- 6) may include the target discoveree info parameter set to the user info ID of the targeted discoveree user (i.e. the targeted 5G ProSe multi-hop UE-to-network relay UE) if the target discoveree info is provided by the application layer;
- 7) may include the Intermediate relays IE containing the list of User info IDs of the 5G ProSe intermediate UE-to-network relay UEs that the 5G ProSe multi-hop remote UE wants to use in the path to the 5G ProSe multi-hop UE-to-network relay UE, if any;
- 8) may include the hop count parameter and set it to '1';
- 9) may include the hop limit parameter and set it to the value provided by the upper layer if the value is smaller than the maximum number of allowed hops as specified in clause 5.2.8; and
- 10) shall include the PLMN ID set to the PLMN ID for which the used security parameters are associated and in cleartext;

NOTE 1A: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 1B: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- d) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- e) shall set the default destination layer-2 ID as specified in clause 5.2.8 to the destination layer-2 ID and self-assign a source layer-2 ID for sending the multi-hop UE-to-network relay discovery solicitation message; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

If the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation is used to solicit proximity of a connectivity service provided by a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE, the UE shall ensure that it keeps on passing the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation for transmission until the UE is triggered by an upper layer application to stop soliciting proximity of a connectivity service provided by a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE, or until the UE stops being authorised to perform the discoverer remote UE procedure for multi-hop UE-to-network relay discovery. How this is achieved is left up to UE implementation.

NOTE 3: The discoverer UE can stop discoverer remote UE procedure for multi-hop UE-to-network relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

If the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation is used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and by the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established, the UE shall start the retransmission timer T5125. If retransmission timer T5125 expires, the UE shall retransmit the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation and restart timer T5125. If no response is received from the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established after reaching the maximum number of allowed retransmissions, the UE shall trigger relay reselection procedure.

NOTE 4: The maximum number of allowed retransmissions is UE implementation specific.

For the discoverer UE (the 5G ProSe multi-hop remote UE), upon reception of a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response along with the destination layer-2 ID which the UE is configured to respond for, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to monitor, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to discover, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for multi-hop 5G ProSe UE-to-network relay is used) and the UTC-based counter obtained during the reception operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUIK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response.

NOTE 5: The UE can determine the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response is for 5G ProSe direct discovery based on an indication from the lower layer.

Then if:

- a) the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response is the same as the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation; and
- b) the target discoveree info is not provided by upper layers for the connectivity service being solicited, or the discoveree info parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response is the same as the target discoveree info if the target discoveree info is provided by upper layers for the connectivity service being solicited;

then the UE shall consider that the connectivity service the UE seeks to discover has been discovered. In addition, the UE can measure the signal strength of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response for relay selection or reselection. If the UE has received the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response from the 5G ProSe intermediate UE-to-network Relay UE or the 5G ProSe multi-hop UE-to-network Relay UE with which the UE has a link established, the UE shall stop the retransmission timer T5125 and start the periodic measurement timer T5126.

NOTE 6: If the 5G ProSe multi-hop remote UE receives multiple matching PROSE PC5 DISCOVERY messages for multi-hop UE-to-network relay discovery response within an implementation dependent time window, the 5G ProSe multi-hop remote UE can decide on the selected path based on multiple factors such as the Multi-hop U2N path info, the PC5 signal strength between the 5G ProSe multi-hop remote UE and its neighbour 5G ProSe intermediate UE-to-network Relay UE, the Accumulated QoS for PC5 link, the RRC container (if provided in the received message) and the number of hops to the 5G ProSe multi-hop UE-to-network Relay UE.

NOTE 7: If the 5G ProSe multi-hop remote UE does not receive any PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response within an implementation dependent time window, the 5G ProSe multi-hop remote UE can increase the hop limit considering the application requirement and reinitiate the Discoverer remote UE procedure for multi-hop UE-to-network relay discovery. In all cases the hop limit is not allowed to be larger than the maximum number of allowed hops specified in clause 5.2.8.

8b.2.1.3.2.3 Discoverer intermediate UE procedure for multi-hop UE-to-network relay discovery initiation

This procedure is performed by:

- a) a 5G ProSe multi-hop child UE-to-network relay UE towards a 5G ProSe multi-hop parent UE-to-network relay UE; or
- b) a 5G ProSe intermediate UE-to-network UE towards a 5G ProSe multi-hop UE-to-network relay UE.

The UE is authorised to perform the discoverer intermediate UE procedure for multi-hop UE-to-network relay discovery if:

- a) the UE is authorised to act as a 5G ProSe intermediate UE-to-network UE in the PLMN or the subscribed SNPN indicated by the serving cell, and
 - 1) the UE is served by NG-RAN; or
 - 2) the UE is not served by NG-RAN and intends to use the provisioned radio resources for UE-to-network relay discovery;
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be solicited or responded to as specified in clause 5.2.8 and the indicated security procedure for the relay service code is supported by the UE. For 5G ProSe layer-3 intermediate UE-to-network relay UE:
 - i) the S-NSSAI associated with that relay service code shall belong to the allowed NSSAI of the UE; and
 - ii) if the UE is camped on a cell whose TAI is in the list of "non-allowed tracking areas" or is camped on a cell whose TAI is not in the list of "allowed tracking areas", then the relay service code shall be associated with high priority access as defined in clause 5.3.5 of 3GPP TS 24.501 [11];
 - 2) an indication that multi-hop relay is allowed for the relay service code and the maximum number of allowed hops as specified in clause 5.2.8; and
 - 3) the User info ID for the multi-hop UE-to-network relay discovery parameter, as specified in clause 5.2.8; and
- c) the back-off timer T3346 used for NAS mobility management congestion control as specified in clause 5.3.9 of 3GPP TS 24.501 [11] is not running at the UE;

otherwise, the UE is not authorised to perform the discoverer intermediate UE procedure for multi-hop UE-to-network relay discovery.

Figure 8b.2.1.3.2.3.1 illustrates the interaction of the UEs in the discoverer intermediate UE procedure for multi-hop UE-to-network relay discovery.

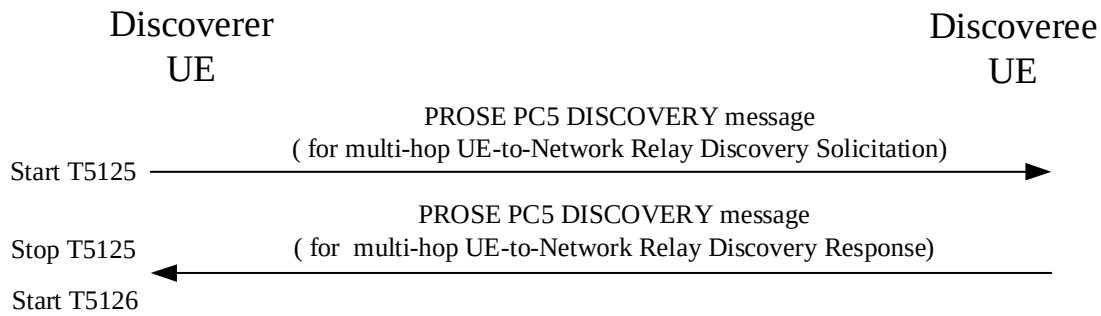


Figure 8b.2.1.3.2.3.1: Discoverer intermediate UE procedure for multi-hop UE-to-network Relay discovery

For PROSE PC5 DISCOVERY message signal strength measurement, the UE manages a periodic measurement timer T5126, which is used to trigger the periodic PROSE PC5 DISCOVERY message signal strength measurement between the UE and the next 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established. Timer T5126 is started whenever the UE has established a direct link with a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE and restarted whenever the UE receives the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response from the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established.

Upon receiving and processing a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation that has a matching RSC and has the User info ID of the receiving UE included in the list of User info IDs in the Intermediate relays IE and:

- if the UE is acting as a 5G ProSe layer-2 intermediate UE-to-network relay UE and the UE has already an established PC5 link with a 5G ProSe multi-hop parent UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE for the matching RSC, the UE shall proceed by sending PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response as specified in clause 8b.2.1.3.3.3 and the UE shall not further continue processing the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation specified in this clause;
- if the UE is acting as a 5G ProSe layer-3 intermediate UE-to-network relay UE and the UE has already an established PC5 link with a 5G ProSe multi-hop parent UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE for the matching RSC, the UE may either proceed by sending PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response as specified in clause 8b.2.1.3.3.3 or continue processing the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation as specified in this clause; or
- if the UE does not have an established PC5 link with the 5G ProSe multi-hop parent UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE for the matching RSC, the UE shall continue processing the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation as specified in this clause.

Then if the UE is authorised to perform the discoverer intermediate UE procedure for multi-hop UE-to-network relay discovery and:

- if UE decides to continue processing the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation as specified above;
- if the UE is triggered by the upper layers to solicit proximity of a connectivity service provided by a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE; or
- if the periodic measurement timer T5126 expires;

the UE:

- a0) if the hop count parameter received in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation is smaller than the hop limit parameter in the message, or is smaller than the maximum number of allowed hops for the RSC as specified in clause 5.2.8, shall continue as below, otherwise

shall ignore the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation;

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages for relay discovery as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11];
 - b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
 - c) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation. In the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation, the UE:
 - 1) shall set the discoverer info parameter to the User info ID obtained from the discoverer info parameter in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation;
 - 2) shall set the relay service code parameter to the relay service code parameter identifying the connectivity service to be solicited, as obtained from the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation;
 - 3) shall include the MIC field computed as described in 3GPP TS 33.503 [34] by using the UTC-based counter and the DUIK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe multi-hop UE-to-network relay is used;
 - 4) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 5) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.17;
 - 6) shall include the Multi-hop U2N path info IE and include in it the list of the User info IDs and layer-2 IDs received in the Multi-hop U2N path info IE of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation, if any, and add its own configured User info ID and layer-2 ID for the multi-hop UE-to-network relay discovery parameter, as specified in clause 5.2.8, at the end of the list;
 - 7) may include the target discoveree info parameter set to the user info ID of the targeted discoveree user (i.e. the targeted 5G ProSe multi-hop UE-to-network relay UE) if it was included in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation;
 - 8) may include the Intermediate relays IE containing the list of User info IDs of the 5G ProSe intermediate UE-to-network relay UEs if it was included in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation;
 - 9) shall include the hop count parameter after being incremented by 1;
 - 10) shall include the hop limit parameter and set it to the value obtained from the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation, if available;
 - 11) may include the Accumulated QoS obtained from the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation, after updating it with the QoS of the PC5 link between the discoverer UE and its 5G ProSe multi-hop child UE-to-network relay UE or its 5G ProSe multi-hop remote UE; and
 - 12) shall include the PLMN ID set to the PLMN ID value obtained from the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation, and in cleartext;
- NOTE 1: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].
- NOTE 1A: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.
- d) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be

applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];

- e) shall set the default destination layer-2 ID as specified in clause 5.2.8 to the destination layer-2 ID and self-assign a source layer-2 ID for sending the multi-hop UE-to-network relay discovery solicitation message; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

If the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation is used to solicit proximity of a connectivity service provided by another 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE, the UE shall ensure that it keeps on passing the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation for transmission until the UE is triggered by an upper layer application to stop soliciting proximity of a connectivity service provided by a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop UE-to-network relay UE, or until the UE stops being authorised to perform the discoverer intermediate UE procedure for multi-hop UE-to-network relay discovery. How this is achieved is left up to UE implementation.

NOTE 3: The discoverer UE can stop discoverer intermediate UE procedure for multi-hop UE-to-network relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

If the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation is used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and by the next 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established, the UE shall start the retransmission timer T5125. If retransmission timer T5125 expires, the UE shall retransmit the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation and restart timer T5125. If no response is received from the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established after reaching the maximum number of allowed retransmissions, the UE shall trigger relay reselection procedure.

NOTE 4: The maximum number of allowed retransmissions is UE implementation specific.

For the discoverer UE (the 5G ProSe intermediate UE-to-network relay UE), upon reception of a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response along with the destination layer-2 ID which the UE is configured to respond for, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to monitor, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to discover, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for multi-hop 5G ProSe UE-to-network relay is used) and the UTC-based counter obtained during the reception operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response.

NOTE 5: The UE can determine the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response is for 5G ProSe direct discovery based on an indication from the lower layer.

Then if:

- a) the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response is the same as the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation; and

- b) the User info ID of the Discoverer UE receiving the message is included in the list of User info IDs in the Multi-hop U2N path info IE of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response;

then the UE shall initiate the discoveree intermediate UE procedure for multi-hop UE-to-network relay discovery by sending PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response towards its 5G ProSe multi-hop child UE-to-network relay UE or 5G ProSe multi-hop remote UE as specified in clause 8b.2.1.3.3.3.

In addition, the UE can measure the signal strength of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response for relay selection or reselection. If the UE has received the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response from the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established, the UE shall stop the retransmission timer T5125 and start the periodic measurement timer T5126.

8b.2.1.3.2.4 Discoverer UE procedure for multi-hop UE-to-network relay discovery completion

When the UE is triggered by an upper layer application to stop soliciting for proximity of a connectivity service provided by a multi-hop UE-to-network relay, or when the UE stops being authorised to perform the Discoverer UE procedure for multi-hop UE-to-network relay discovery, the UE shall instruct the lower layers to stop the discoverer operation.

NOTE: The discoverer UE can stop discoverer UE procedure for multi-hop UE-to-network relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops discoverer operation, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8b.2.1.3.3 Discoveree UE procedure for multi-hop UE-to-network relay discovery

8b.2.1.3.3.1 General

The purpose of the discoveree UE procedure for multi-hop UE-to-network relay discovery is to enable a ProSe-enabled UE to respond to solicitation from other ProSe-enabled UEs on proximity of a connectivity service provided by the 5G ProSe multi-hop UE-to-network relay UE or 5G ProSe intermediate UE-to-network relay UE, upon a request from upper layers.

8b.2.1.3.3.2 Discoveree UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery initiation

This procedure is performed by:

- a) a 5G ProSe multi-hop UE-to-network relay UE towards a 5G ProSe intermediate UE-to-network relay UE or a 5G ProSe multi-hop remote UE.

The UE is authorised to perform the discoveree UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery if:

- a) the UE is authorised to act as a 5G ProSe multi-hop UE-to-network relay UE in the PLMN or the subscribed SNPN indicated by the serving cell, and
 - 1) the UE is served by NG-RAN; or
 - 2) the UE is not served by NG-RAN and intends to use the provisioned radio resources for UE-to-network relay discovery;
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be responded to as specified in clause 5.2.8 and the indicated security procedure for the relay service code is supported by the UE. For 5G ProSe multi-hop layer-3 UE-to-network relay UE,
 - i) the S-NSSAI associated with that relay service code shall belong to the allowed NSSAI of the UE; and

- ii) if the UE is camped on a cell whose TAI is in the list of "non-allowed tracking areas" or is camped on a cell whose TAI is not in the list of "allowed tracking areas", then the relay service code shall be associated with high priority access as defined in clause 5.3.5 of 3GPP TS 24.501 [11];
- 2) an indication that multi-hop relay is allowed for the relay service code and the maximum number of allowed hops as specified in clause 5.2.8; and
- 3) the User info ID for the multi-hop UE-to-network relay discovery parameter, as specified in clause 5.2.8; and
- c) the back-off timer T3346 used for NAS mobility management congestion control as specified in clause 5.3.9 of 3GPP TS 24.501 [11] is not running at the UE;

otherwise, the UE is not authorised to perform the discoveree UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery.

Figure 8b.2.1.3.3.2.1 illustrates the interaction of the UEs in the discoveree UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery.

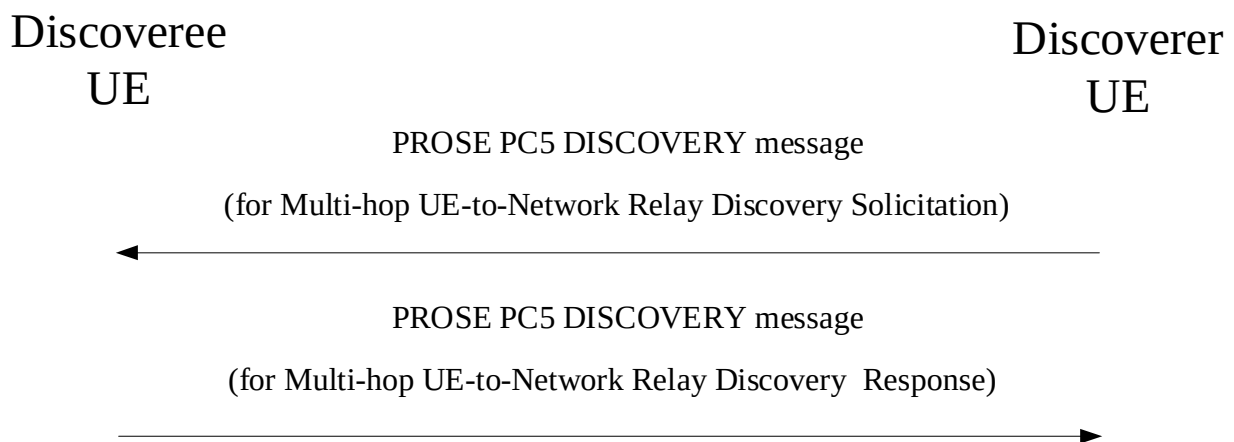


Figure 8b.2.1.3.3.2.1: Discoveree UE procedure for intermediate UE-to-network Relay discovery

When the UE is triggered by an upper layer application to start responding to solicitation on proximity of a connectivity service provided by the 5G ProSe multi-hop UE-to-network relay UE and if the UE is authorised to perform the discoveree UE-to-network relay UE procedure for multi-hop UE-to-network relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11]; and
- b) shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages.

Upon reception of a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation, for the relay service code of the connectivity service which the UE is authorized to respond, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to respond, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to respond, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used) and the UTC-based counter obtained during the reception operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUIK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation.

NOTE 1: The UE can determine the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation is for 5G ProSe direct discovery based on an indication from the lower layer.

Then, if:

- a) the relay service code parameter of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation is the same as the relay service code parameter configured as specified in clause 5.2.8 for the connectivity service;
- b) the target discoveree info parameter of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation is the same as the user info ID for the multi-hop UE-to-network relay discovery provided by upper layers or same as the configured user info ID for the multi-hop UE-to-network relay discovery as specified in clause 5.2.8, if the target discoveree info parameter is included in the received PROSE PC5 DISCOVERY message; and
- c) if the hop count parameter in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation is not greater than the maximum number of allowed hops as specified in clause 5.2.8;

then the UE:

- a) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- b) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response. In the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response, the UE:
 - 1) shall set the Discoveree info parameter to the configured User info ID for the multi-hop UE-to-network Relay discovery parameter, as specified in clause 5.2.8;
 - 2) shall set the relay service code parameter to the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation. The relay service code parameter is set to relay service code specific for emergency service if the UE is triggered by an upper layer application to announce availability of an emergency connectivity service provided by a UE-to-network relay, and either of the following:
 - i) for 5G ProSe multi-hop layer-3 UE-to-network relay UE, the EMC bit in the 5GS network feature support IE of the REGISTRATION ACCEPT message is not set to "Emergency services not supported" as specified in 3GPP TS 24.501 [11] and the UE is neither using its own emergency service nor relaying the emergency services from one 5G ProSe multi-hop layer-3 remote UE;
 - 3) shall set the Resource Status Indicator bit of the status indicator parameter to indicate whether or not the UE has resources available to provide a connectivity service for additional ProSe-enabled UEs;
 - 4) shall include the MIC field computed as described in 3GPP TS 33.503 [34] by using the UTC-based counter and the DUK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe multi-hop UE-to-network relay is used;
 - 5) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 6) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.10;
 - 7) shall include the Multi-hop U2N path info IE and include in it the ordered list of the User info IDs and layer-2 IDs of the selected path, starting from the User info ID and layer-2 ID of the 5G ProSe multi-hop remote UE and ending with the User info ID and layer-2 ID of the last 5G ProSe intermediate UE-to-network relay UE;
 - 8) may include the hop count parameter to indicate the number of hops between the 5G ProSe multi-hop remote UE and the 5G ProSe multi-hop UE-to-network relay UE on the path selected by the 5G ProSe multi-hop UE-to-network relay UE;
 - 9) may include the Accumulated QoS IE that includes the QoS supported over all the PC5 links along the path from the 5G ProSe multi-hop remote UE to the 5G ProSe multi-hop UE-to-network relay UE; and
 - 10) shall include the PLMN ID set to its HPLMN ID and in cleartext; and

NOTE 1: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 1A: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- 11) if acting as 5G ProSe multi-hop layer-2 UE-to-network relay UE, shall set the RRC container to the RRC container if provided by the lower layers;
- c) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];
- d) shall set the destination layer-2 ID to the source layer-2 ID received from the discoverer UE used in the transportation of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation and self-assign a source layer-2 ID for sending the multi-hop UE-to-network relay discovery response message; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

- e) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

NOTE 3: It is up to the implementation of the 5G ProSe multi-hop UE-to-network relay UE how it decides when to send the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response, e.g. due to considering the need to wait till it gets multiple PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation from different paths. The 5G ProSe multi-hop UE-to-network relay UE can decide on the selected path based on different factors such as the PC5 signal strength, number of hops to the 5G ProSe multi-hop remote UE, the path information in the Multi-hop U2N path info IE, the Accumulated QoS for PC5 link and the RRC container (if provided by the lower layers and the UE is acting as a 5G ProSe multi-hop layer-2 UE-to-network relay UE).

The UE shall maintain the association(s) between the self-assigned source layer-2 ID and relay service code once generating the PROSE PC5 DISCOVERY message. Each self-assigned source layer-2 ID can be associated with only one relay service code.

NOTE 4: If the UE is processing a PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the same source layer-2 ID of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation, it depends on UE implementation to avoid the conflict of destination layer-2 ID (e.g. send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #3 "conflict of layer-2 ID for unicast communication is detected", or ignore the PROSE DIRECT DISCOVERY message for multi-hop UE-to-network relay discovery solicitation).

8b.2.1.3.3.3 Discoverer intermediate UE procedure for multi-hop UE-to-network relay discovery initiation

This procedure is performed by:

- a) a 5G ProSe intermediate UE-to-network relay UE towards a 5G ProSe multi-hop remote UE; or
- b) a 5G ProSe multi-hop parent UE-to-network relay UE towards a 5G ProSe multi-hop child UE-to-network relay UE.

The UE is authorised to perform the discoverer intermediate UE procedure for multi-hop UE-to-network relay discovery if:

- a) the UE is authorised to act as a 5G ProSe intermediate UE-to-network relay UE in the PLMN or the subscribed indicated by the serving cell, and
- 1) the UE is served by NG-RAN; or

- 2) the UE is not served by NG-RAN and intends to use the provisioned radio resources for UE-to-network relay discovery;
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be solicited or responded to as specified in clause 5.2.8 and the indicated security procedure for the relay service code is supported by the UE. For 5G ProSe layer-3 intermediate UE-to-network relay UE,
 - i) the S-NSSAI associated with that relay service code shall belong to the allowed NSSAI of the UE; and
 - ii) if the UE is camped on a cell whose TAI is in the list of "non-allowed tracking areas" or is camped on a cell whose TAI is not in the list of "allowed tracking areas", then the relay service code shall be associated with high priority access as defined in clause 5.3.5 of 3GPP TS 24.501 [11];
 - 2) an indication that multi-hop relay is allowed for the relay service code; and
 - 3) the User info ID for the multi-hop UE-to-network relay discovery parameter, as specified in clause 5.2.8; and
- c) the back-off timer T3346 used for NAS mobility management congestion control as specified in clause 5.3.9 of 3GPP TS 24.501 [11] is not running at the UE;

otherwise, the UE is not authorised to perform the discoveree intermediate UE procedure for multi-hop UE-to-network relay discovery.

Figure 8b.2.1.3.3.2.1 illustrates the interaction of the UEs in the discoveree intermediate UE procedure for multi-hop UE-to-network relay discovery.

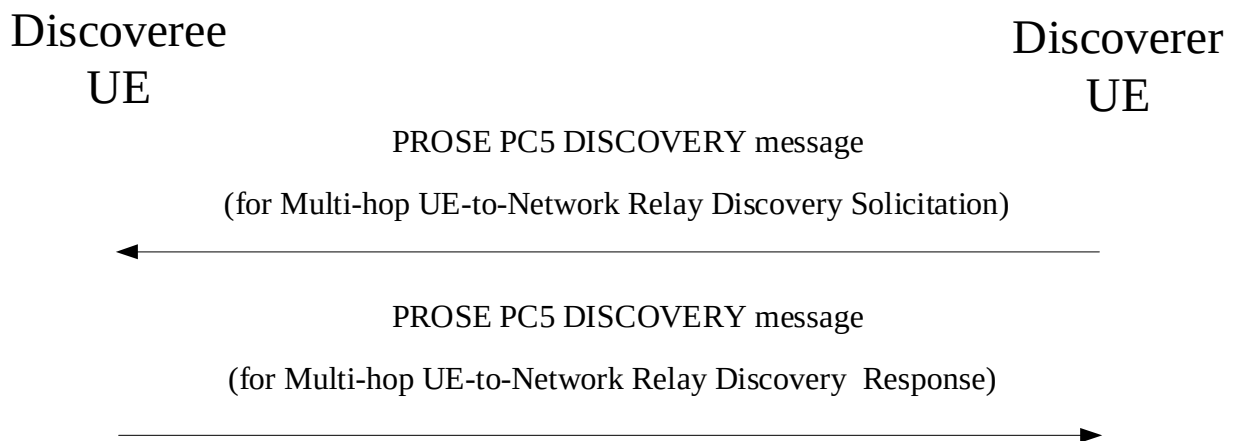


Figure 8b.2.1.3.3.2.1: Discoveree intermediate UE procedure for multi-hop UE-to-network relay discovery

When the UE is triggered by an upper layer application to start responding to responses of proximity of a connectivity service provided by the 5G ProSe multi-hop UE-to-network relay UE or another 5G ProSe intermediate UE-to-network relay UE and if the UE is authorised to perform the discoveree intermediate UE procedure for multi-hop UE-to-network relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11]; and
- b) shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages.

Upon reception of a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response, for the relay service code of the connectivity service which the UE is authorized to respond, if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to respond, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to respond the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-

network relay is used) and the UTC-based counter obtained during the reception operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used), the UE shall use the DUIK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response.

NOTE 1: The UE can determine the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response is for 5G ProSe direct discovery based on an indication from the lower layer.

Then, if:

- a) the relay service code parameter of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response is the same as the relay service code parameter configured as specified in clause 5.2.8 for the connectivity service; and
- b) the User info ID of the receiving UE is included in the list of User info IDs included in the Multi-hop U2N path info IE in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response;

then the UE:

- a) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- b) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response. In the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response, the UE:
 - 1) shall set the Discoveree info parameter to the User info ID obtained from the Discoveree info included in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response;
 - 2) shall set the relay service code parameter to the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response. The relay service code parameter is set to relay service code specific for emergency service if the UE is triggered by an upper layer application to announce availability of an emergency connectivity service provided by a multi-hop UE-to-network relay, and either of the following:
 - i) for 5G ProSe multi-hop layer-3 UE-to-network relay UE, the EMC bit in the 5GS network feature support IE of the REGISTRATION ACCEPT message is not set to "Emergency services not supported" as specified in 3GPP TS 24.501 [11] and the UE is neither using its own emergency service nor relaying the emergency services from one 5G ProSe multi-hop layer-3 remote UE;
 - 3) shall set the Resource Status Indicator bit of the status indicator parameter to indicate whether or not the UE has resources available to provide a connectivity service for additional ProSe-enabled UEs;
 - 4) shall include the MIC field computed as described in 3GPP TS 33.503 [34] by using the UTC-based counter and the DUIK contained in the <UNR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe multi-hop UE-to-network relay is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe multi-hop UE-to-network relay is used;
 - 5) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 6) shall set the ProSe direct discovery PC5 message type parameter as specified in table 10.2.1.10;
 - 7) shall include the Multi-hop U2N path info IE and include in it the same list of the User info IDs and the corresponding layer-2 IDs that were included in the Multi-hop U2N path info IE included in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response;
 - 8) may include the hop count parameter set to the same hop count parameter included in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response;

9) may include the Accumulated QoS IE set to the Accumulated QoS included in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response;

10) shall include the PLMN ID set to the PLMN ID value obtained from the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response, and in cleartext; and

NOTE 1A: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 1B: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

11) if acting as 5G ProSe layer-2 intermediate UE-to-network relay UE, shall set the RRC container to the RRC container if provided by the lower layers;

c) shall apply the DUIK, DUSK, or DUCK with the associated Encrypted Bitmask, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in 3GPP TS 33.503 [34];

d) shall set the destination layer-2 ID to the source layer-2 ID received from the discoverer UE used in the transportation of the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation and self-assign a source layer-2 ID for sending the multi-hop UE-to-network relay discovery response message; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

e) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

The UE shall maintain the association(s) between the self-assigned source layer-2 ID and relay service code once generating the PROSE PC5 DISCOVERY message. Each self-assigned source layer-2 ID can be associated with only one relay service code.

NOTE 3: If the UE is processing a PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the same source layer-2 ID of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation, it depends on UE implementation to avoid the conflict of destination layer-2 ID (e.g. send a PROSE DIRECT LINK ESTABLISHMENT REJECT message containing PC5 signalling protocol cause value #3 "conflict of layer-2 ID for unicast communication is detected", or ignore the PROSE DIRECT DISCOVERY message for multi-hop UE-to-network relay discovery solicitation).

8b.2.1.3.3.4 Discoverer UE procedure for multi-hop UE-to-network relay discovery completion

When the UE is triggered by an upper layer application to stop responding to solicitation on proximity of a connectivity service provided by a 5G ProSe multi-hop UE-to-network relay UE, or when the UE stops being authorised to perform the discoverer UE procedure for UE-to-network relay discovery, the UE shall instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8b.2.2 5G ProSe multi-hop UE-to-network relay unicast direct communication over PC5 interface

8b.2.2.1 Overview

This clause describes the PC5 signalling protocol procedures between 5G ProSe multi-hop remote UE and 5G ProSe multi-hop UE-to-network relay UE, that goes through zero or more 5G ProSe intermediate UE-to-network relay UEs. The direct communication between 5G ProSe multi-hop remote UE and 5G ProSe multi-hop UE-to-network relay UE

reuses the procedures for unicast mode 5G ProSe direct communication over PC5 described in clause 7.2 but with considering the modifications specified in this clause.

8b.2.2.2 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay

8b.2.2.2.1 General

The 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay is based on model A discovery or based on model B discovery. The 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay based on model A discovery and based on model B discovery reuse the procedure for 5G ProSe direct link establishment procedure for UE-to-network relay communication described in clause 7.2.2 where:

- a) if there is more than one hop, then for the first hop, i.e. the hop between the 5G ProSe multi-hop remote UE and the first 5G ProSe intermediate UE-to-network relay UE, the 5G ProSe multi-hop remote UE takes the role of the 5G ProSe remote UE and the first 5G ProSe intermediate UE-to-network relay UE takes the role of the 5G ProSe UE-to-network relay UE. If there is only one hop, then the 5G ProSe multi-hop remote UE takes the role of the 5G ProSe remote UE and the 5G ProSe multi-hop UE-to-network relay UE takes the role of the 5G ProSe UE-to-network relay UE;
- b) for each next hop after the first hop, if any, the 5G ProSe multi-hop child UE-to-network relay UE takes the role of the 5G ProSe remote UE and the 5G ProSe multi-hop parent UE-to-network relay UE takes the role of the 5G ProSe UE-to-network relay UE; and
- c) for the case of 5G ProSe multi-hop layer-3 UE-to-network relay, the 5G ProSe intermediate UE-to-network relay UE(s) shall initiate neither the UE requested PDU session establishment procedure for relaying the service associated with the RSC nor the remote UE report procedure, and only the 5G ProSe multi-hop UE-to-network relay UE shall initiate the UE requested PDU session establishment procedure for relaying the service associated with the RSC as described in clause 7.2.2.3, if needed, and the remote UE report procedure as described in clause 7.2.2.1.

8b.2.2.2.2 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay based on model A discovery

For 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay based on model A discovery, each 5G ProSe intermediate UE-to-network relay UE shall establish the 5G ProSe direct link with its 5G ProSe multi-hop parent UE-to-network relay UE or its 5G ProSe multi-hop UE-to-network relay UE before it generates the multi-hop UE-to-network relay discovery announcement with model A.

After the 5G ProSe multi-hop child UE-to-network relay UE establishes the 5G ProSe direct link with its 5G ProSe multi-hop parent UE-to-network relay UE, the 5G ProSe multi-hop parent UE-to-network relay UE, acting as a 5G ProSe multi-hop child UE-to-network relay UE, shall trigger a 5G ProSe direct link modification procedure for multi-hop UE-to-network relay towards its 5G ProSe multi-hop parent UE-to-network relay UE as described in clause 8b.2.2.3. Also after the 5G ProSe multi-hop remote UE establishes the 5G ProSe direct link with the 5G ProSe intermediate UE-to-network relay UE, the 5G ProSe direct link modification procedure for multi-hop UE-to-network relay is triggered as described in clause 8b.2.2.3.

8b.2.2.2.3 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay based on model B discovery

The 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay based on model B discovery shall be initiated by the 5G ProSe multi-hop remote UE towards the first 5G ProSe intermediate UE-to-network relay UE, after the 5G ProSe multi-hop remote UE completes the multi-hop UE-to-network relay discovery over PC5 interface with model B.

The 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay based on model B discovery reuses the procedure for 5G ProSe direct link establishment procedure for UE-to-network relay communication described in clause 7.2.2 but with the following modifications:

- a) for the first hop, i.e. the hop between the 5G ProSe multi-hop remote UE and the first 5G ProSe intermediate UE-to-network relay UE, the PROSE DIRECT LINK ESTABLISHMENT REQUEST message created by the 5G ProSe multi-hop remote UE:
 - 1) shall additionally include the Multi-hop U2N path info IE set to the list of the user info IDs and the corresponding layer-2 IDs of the 5G ProSe intermediate UE-to-network relay UE(s), if any, and the 5G ProSe multi-hop UE-to-network relay UE selected by the 5G ProSe multi-hop remote UE based on the path information provided to the 5G ProSe multi-hop remote UE during the multi-hop UE-to-network relay discovery over PC5 interface with model B. The user info IDs and the corresponding layer-2 IDs in the list shall be ordered starting from the first 5G ProSe intermediate UE-to-network relay UE till the 5G ProSe multi-hop UE-to-network relay UE; and
 - 2) may additionally include the End-to-end QoS flow descriptions IE to indicate the end to end QoS Information;
- b) Further, any 5G ProSe intermediate UE-to-network relay UE, after receiving and accepting the PROSE DIRECT LINK ESTABLISHMENT REQUEST message from its 5G ProSe child UE-to-network relay UE or the 5G ProSe multi-hop remote UE, shall use the Multi-hop U2N path info IE to determine its 5G ProSe parent UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE. The 5G ProSe intermediate UE-to-network relay UE shall then initiate the 5G ProSe direct link establishment procedure towards its 5G ProSe parent UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE before proceeding with establishing the secured PC5 link with its 5G ProSe child UE-to-network relay UE or the 5G ProSe multi-hop remote UE. The PROSE DIRECT LINK ESTABLISHMENT REQUEST message created by the 5G ProSe intermediate UE-to-network relay UE towards its 5G ProSe multi-hop parent UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE:
 - 1) shall additionally include the Multi-hop U2N path info IE set to the same list of the user info IDs and the corresponding layer-2 IDs received from the 5G ProSe multi-hop child UE-to-network relay UE or the 5G ProSe multi-hop remote UE,
 - 2) may additionally include the End-to-end QoS flow descriptions IE to indicate the end to end QoS Information; and
- c) any 5G ProSe intermediate UE-to-network relay UE, after receiving and accepting the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message from its 5G ProSe multi-hop parent UE-to-network relay UE or its 5G ProSe multi-hop UE-to-network relay UE, shall proceed with establishing the secured PC5 link with its 5G ProSe multi-hop child UE-to-network relay UE or the 5G ProSe multi-hop remote UE.

8b.2.2.3 5G ProSe direct link modification procedure for multi-hop UE-to-network relay

The 5G ProSe direct link modification procedure for multi-hop UE-to-network relay reuses the procedure for 5G ProSe direct link modification procedure for UE-to-network relay communication described in clause 7.2.3, with considering the same roles defined in bullet a) and b) of clause 8b.2.2.2.1.

When the 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay is based on model A discovery:

- a) after each of the 5G ProSe multi-hop child UE-to-network relay UE establishes the 5G ProSe direct link with its 5G ProSe intermediate UE-to-network relay UE, the 5G ProSe intermediate UE-to-network relay UE shall trigger a 5G ProSe direct link modification procedure for multi-hop UE-to-network relay towards its 5G ProSe multi-hop parent UE-to-network relay UE and include the User info ID of the 5G ProSe multi-hop child UE-to-network relay UE in the Child UEs multi-hop user info IE in the PROSE DIRECT LINK MODIFICATION REQUEST message. Consequently, every 5G ProSe multi-hop parent UE-to-network relay UE, acting as a 5G ProSe multi-hop child UE-to-network relay UE, shall trigger a 5G ProSe direct link modification procedure for multi-hop UE-to-network relay towards its 5G ProSe multi-hop parent UE-to-network relay UE and include the received Child UEs multi-hop user info IE in the PROSE DIRECT LINK MODIFICATION REQUEST message;
- b) after the 5G ProSe multi-hop remote UE establishes the 5G ProSe direct link with the 5G ProSe intermediate UE-to-network relay UE:
 - 1) the 5G ProSe multi-hop remote UE may initiate a 5G ProSe direct link modification procedure for multi-hop UE-to-network relay toward the 5G ProSe intermediate UE-to-network relay UE to inform its remote UE context after obtaining IP address/prefix from the 5G ProSe multi-hop UE-to-network relay UE, where the

PROSE DIRECT LINK MODIFICATION REQUEST message created by the 5G ProSe multi-hop remote UE:

- i) shall additionally include the List of multi-hop remote UE parameters IE with the Number of remote UE parameters set to 1 and the Remote UE parameters set to the identity, address information, total hop count and associated PC5 QoS flow of the 5G ProSe multi-hop remote UE; and
- 2) then, each 5G ProSe intermediate UE-to-network relay UE, starting from the 5G ProSe intermediate UE-to-network relay UE connected to the 5G ProSe multi-hop remote UE, shall initiate a 5G ProSe direct link modification procedure for multi-hop UE-to-network relay towards its 5G ProSe multi-hop parent UE-to-network relay UE, where the PROSE DIRECT LINK MODIFICATION REQUEST message created by each 5G ProSe intermediate UE-to-network relay UE towards its 5G ProSe multi-hop parent UE-to-network relay UE:
 - i) shall additionally include the List of multi-hop remote UE parameters IE to indicate the identity, address information, total hop count and associated PC5 QoS flow of the 5G ProSe multi-hop remote UE(s); and
- c) each 5G ProSe intermediate UE-to-network relay UE shall complete the 5G ProSe direct link modification procedure for multi-hop UE-to-network relay with its 5G ProSe multi-hop child UE-to-network relay UE or its the 5G ProSe multi-hop remote UE before triggering the same procedure for the next hop.

When the 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay is based on model B discovery, after the 5G ProSe multi-hop remote UE establishes the 5G ProSe direct link with the 5G ProSe intermediate UE-to-network relay UE:

- a) the 5G ProSe multi-hop remote UE may trigger the 5G ProSe direct link modification procedure for multi-hop UE-to-network relay towards the 5G ProSe intermediate UE-to-network relay UE, where the PROSE DIRECT LINK MODIFICATION REQUEST message:
 - 1) may additionally include the requested end-to-end QoS requirements as specified in clause 8b.2.6.2.3; and
 - 2) shall additionally include the List of remote UE parameters IE with the Number of remote UE parameters set to 1 and the Remote UE parameters set to the identity, address information, total hop count and associated PC5 QoS flow of the 5G ProSe multi-hop remote UE;
- b) then, each 5G ProSe intermediate UE-to-network relay UE, starting from the 5G ProSe intermediate UE-to-network relay UE connected to the 5G ProSe multi-hop remote UE, may initiate a 5G ProSe direct link modification procedure for multi-hop UE-to-network relay towards its 5G ProSe multi-hop parent UE-to-network relay UE, where the PROSE DIRECT LINK MODIFICATION REQUEST message created by each 5G ProSe intermediate UE-to-network relay UE towards its 5G ProSe multi-hop parent UE-to-network relay UE:
 - 1) may additionally include the end-to-end QoS requirements as specified in clause 8b.2.6.2.3; and
 - 2) shall additionally include the List of multi-hop remote UE parameters IE to indicate the identity, address information, total hop count and associated PC5 QoS flow of the 5G ProSe multi-hop remote UE(s); and
- c) each 5G ProSe multi-hop parent UE-to-network relay UE shall complete the 5G ProSe direct link modification procedure for multi-hop UE-to-network relay with its 5G ProSe multi-hop child UE-to-network relay UE before triggering the same procedure for the next hop.

When the 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay is based on model B discovery, after the 5G ProSe multi-hop remote UE establishes the 5G ProSe direct link with the 5G ProSe intermediate UE-to-network relay UE and the 5G ProSe intermediate UE-to-network relay UE has decided to initiate the multi-hop UE-to-network relay reselection procedure as described in clause 8b.2.3.2:

- a) the 5G ProSe intermediate UE-to-network relay UE may trigger the 5G ProSe direct link modification procedure for multi-hop UE-to-network relay towards the 5G ProSe multi-hop remote UE, where the PROSE DIRECT LINK MODIFICATION REQUEST message:
 - 1) shall include the relay reselection indication information.

8b.2.3 Multi-hop UE-to-network relay reselection procedure

8b.2.3.1 General

The purpose of the multi-hop UE-to-network relay reselection procedure is to enable a 5G ProSe multi-hop remote UE or a 5G ProSe intermediate UE-to-network relay UE to reselect a 5G ProSe intermediate UE-to-network relay UE or 5G ProSe multi-hop UE-to-network relay UE to obtain a connectivity service to 5GC when the serving 5G ProSe intermediate UE-to-network relay UE or 5G ProSe multi-hop UE-to-network relay UE is no longer suitable.

8b.2.3.2 Multi-hop UE-to-network relay reselection procedure initiation

The 5G ProSe multi-hop remote UE or the 5G ProSe intermediate UE-to-network relay UE shall trigger the multi-hop UE-to-network relay reselection procedure if one of the following conditions is met:

- a) the UE has received a lower layers indication that the serving 5G ProSe multi-hop UE-to-network relay UE or the serving 5G ProSe intermediate UE-to-network relay UE no longer fulfills the lower layers criteria as specified in 3GPP TS 38.331 [13];
- b) the parameters related to 5G ProSe multi-hop UE-to-network relay in the configuration parameters for 5G ProSe multi-hop UE-to-network relay as specified in clause 5.2.8 (e.g., relay service code, User info ID, etc.) have been updated and the serving 5G ProSe multi-hop UE-to-network relay UE no longer fulfills the conditions specified in clause 8b.2.5.1;
- c) the UE has received a PROSE DIRECT LINK ESTABLISHMENT REJECT message from the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE with the PC5 signalling protocol cause value #1 "direct communication to the target UE not allowed";
- d) the UE has received a PROSE DIRECT LINK RELEASE REQUEST message from the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE with the PC5 signalling protocol cause value #1 "direct communication to the target UE not allowed";
- e) the UE has received a PROSE DIRECT LINK RELEASE REQUEST message from the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE with the PC5 signalling protocol cause value #4 "direct connection is not available anymore";
- f) the UE has not received any response from the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE after M consecutive retransmissions of PROSE DIRECT LINK ESTABLISHMENT REQUEST or PROSE DIRECT LINK KEEPALIVE REQUEST messages;
- g) the UE has not received any response from the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE after M consecutive retransmissions of PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE with which the UE has a link established;

NOTE 1: The value of M is implementation specific and is less than or equal to the maximum number of retransmissions allowed for PC5 signalling protocol.

- h) the UE has received a PROSE DIRECT LINK ESTABLISHMENT REJECT message from the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE with the PC5 signalling protocol cause value #13 "congestion situation";
- i) the UE has received a PROSE DIRECT LINK RELEASE REQUEST message from the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE with the PC5 signalling protocol cause value #13 "congestion situation"; or
- j) the UE has received a PROSE DIRECT LINK ESTABLISHMENT REJECT message from the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE with the PC5 signalling protocol cause value #15 "security procedure failure of 5G ProSe UE-to-network relay".

In cases c), d), h) and i), the 5G ProSe multi-hop remote UE shall exclude the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE which sent the message specified in cases c), d), h) or i) from the multi-hop UE-to-network relay reselection process described below (at least for the indicated back-off time period if

provided from the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE in cases h) and i)).

In case j), when the 5G ProSe multi-hop remote UE has included the UE identity IE set to SUCI in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, the 5G ProSe multi-hop remote UE shall exclude the 5G ProSe multi-hop UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE which sent the message specified in case j) from the multi-hop UE-to-network relay reselection process.

To conduct multi-hop UE-to-network relay reselection process, the UE shall first initiate one of the following procedures or both depending on UE's configuration parameters for 5G ProSe multi-hop UE-to-network relay as specified in clause 5.2.8:

- a) monitoring procedure for UE-to-network relay discovery as specified in clause 8b.2.1.2.3; or
- b) discoverer procedure for UE-to-network relay discovery as specified in clause 8b.2.1.3.2.

After the execution of the above discovery procedure(s), the 5G ProSe multi-hop remote UE performs the multi-hop UE-to-network relay selection procedure as specified in clause 8b.2.5.

NOTE 2: It is left to UE implementation on how UE handles the case when there is no appropriate 5G ProSe multi-hop UE-to-network relay UE or 5G ProSe intermediate UE-to-network relay UE around.

For a 5G ProSe intermediate UE-to-network relay UE based on model B discovery, if the 5G ProSe intermediate UE-to-network relay UE detects link failure or link quality degradation, the 5G ProSe intermediate UE-to-network relay UE may send a relay reselection indication toward the 5G ProSe multi-hop remote UE by using the 5G ProSe direct link modification procedure as specified in clause 8b.2.2.3. If the 5G ProSe multi-hop remote UE receives the relay reselection indication, it may initiate the multi-hop UE-to-network relay reselection procedure.

8b.2.3.3 Multi-hop UE-to-network relay reselection procedure completion

If there exists only one the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE candidate satisfying the conditions in clause 8b.2.3.2, then that the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE is selected.

If there exist more than one the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE candidate satisfying the conditions in clause 8b.2.3.2, any relay candidates not satisfying the non-radio related ProSe layer criteria shall be discarded, the Root Relay Info may be used to prioritize a relay offering the connection to the same 5G ProSe multi-hop UE-to-network relay UE.

After the 5G ProSe multi-hop UE-to-network relay reselection procedure, if the same 5G ProSe multi-hop layer-3 UE-to-network relay UE is used for connection with a 5G ProSe multi-hop layer-3 remote UE, the existing IP address of the 5G ProSe Remote UE is reused.

After selecting the multi-hop path toward a 5G ProSe multi-hop UE-to-network relay UE by the 5G ProSe multi-hop remote UE based on model B discovery, the 5G ProSe multi-hop remote UE shall initiate the 5G ProSe direct link establishment procedure as specified in clause 8b.2.2.2.3 or the 5G ProSe direct link modification procedure as specified in clause 8b.2.2.3 to the 5G ProSe intermediate UE-to-network relay UE based on the selected multi-hop path. The 5G ProSe multi-hop child UE-to-network relay UE shall select the 5G ProSe multi-hop parent UE-to-network relay UE based on the User info ID in the Multi-hop path info IE received in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message or the PROSE DIRECT LINK MODIFICATION REQUEST message. The 5G ProSe multi-hop parent UE-to-network relay UE shall initiate the 5G ProSe direct link establishment procedure as specified in clause 8b.2.2.2.3 or the 5G ProSe direct link modification procedure as specified in clause 8b.2.2.3 to the selected 5G ProSe multi-hop parent UE-to-network relay UE or the selected 5G ProSe multi-hop UE-to-network relay UE based on the received multi-hop path info.

For 5G ProSe multi-hop remote UE based on model B discovery, after the 5G ProSe multi-hop UE-to-network relay reselection procedure, if the same 5G ProSe multi-hop layer-3 UE-to-network relay UE is used for connection with a 5G ProSe multi-hop layer-3 remote UE, the existing IP address of the 5G ProSe Remote UE is reused and the IP address of the 5G ProSe multi-hop layer-3 remote UE may be included in the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message or the PROSE DIRECT LINK MODIFICATION ACCEPT message by the 5G ProSe UE-to-network relay UE or the 5G ProSe intermediate UE-to-network relay UE.

For the 5G ProSe multi-hop UE-to-network relay discovery with model A, after the 5G ProSe multi-hop UE-to-network relay reselection procedure, if the 5G ProSe multi-hop child UE-to-network relay UE establishes the 5G ProSe direct

link with new 5G ProSe multi-hop parent UE-to-network relay UE, the 5G ProSe multi-hop parent UE-to-network relay UE, acting as a 5G ProSe multi-hop child UE-to-network relay UE, shall trigger a 5G ProSe direct link modification procedure for multi-hop UE-to-network relay to its 5G ProSe multi-hop parent UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE as described in clause 8b.2.2.3. Also, if the 5G ProSe multi-hop remote UE establishes the 5G ProSe direct link with new 5G ProSe intermediate UE-to-network relay UE after the 5G ProSe multi-hop UE-to-network relay reselection procedure, the 5G ProSe direct link modification procedure for multi-hop UE-to-network relay is triggered as described in clause 8b.2.2.3.

After the 5G ProSe multi-hop remote UE or the 5G ProSe intermediate UE-to-network relay UE completes the 5G ProSe multi-hop UE-to-network relay reselection procedure and successfully establishes a PC5 link with a new 5G ProSe intermediate UE-to-network relay UE or a new 5G ProSe multi-hop UE-to-network relay UE that is different than the old one, the 5G ProSe multi-hop remote UE or the 5G ProSe intermediate UE-to-network relay UE may trigger:

- a) a 5G ProSe direct link modification procedure as specified in clause 7.2.3; or
- b) a 5G ProSe direct link release procedure as specified in clause 7.2.6;

towards the old 5G ProSe intermediate UE-to-network relay UE or the old 5G ProSe multi-hop UE-to-network relay UE to remove the corresponding PC5 QoS flow.

8b.2.4 Procedure for UE to use provisioned radio resources for 5G ProSe multi-hop UE-to-network discovery

When the UE is not served by NG-RAN for 5G ProSe multi-hop UE-to-network relay discovery and is authorized to use 5G ProSe multi-hop UE-to-network relay discovery, the UE shall select the corresponding radio parameters to be used for 5G ProSe multi-hop UE-to-network relay discovery as follows:

- a) if the UE can determine itself located in a geographical area and the UE is provisioned with radio parameters for the geographical area, the UE shall select the radio parameters associated with that geographical area; or
- b) in all other cases, the UE shall not initiate 5G ProSe UE-to-network relay discovery.

If the UE intends to use "non-operator managed" radio parameters as specified in clause 5.2.8, the UE shall initiate 5G ProSe multi-hop UE-to-network relay discovery with the selected radio parameters.

If the UE intends to use "operator managed" radio parameters as specified in clause 5.2.8, before initiating 5G ProSe multi-hop UE-to-network relay discovery, the UE shall check with lower layers whether the selected radio parameters can be used in the current location without causing interference to other cells as specified in 3GPP TS 38.331 [13]; and:

- a) if the lower layers indicate that the usage would not cause any interference, the UE shall initiate 5G ProSe multi-hop UE-to-network relay discovery; or

NOTE: If the lower layers find that there exists a cell operating the provisioned radio resources (i.e., carrier frequency) and the cell belongs to the registered PLMN or a PLMN equivalent to the registered PLMN, or for SNPN, to the RSNPN and the RSNPN is the subscribed SNPN, and the UE is authorized for 5G ProSe multi-hop UE-to-network relay discovery in this PLMN or this RSNPN, the UE can use the radio parameters indicated by the cell as specified in 3GPP TS 38.331 [13].

- b) else if the lower layers report that one or more PLMNs or SNPNs operate in the provisioned radio resources (i.e., carrier frequency) then:

- 1) if the following conditions are met:

- i) either none of the PLMNs reported by the lower layers is the registered PLMN or equivalent to the registered PLMN, or for SNPN none of the SNPNs reported by the lower layers is the RSNPN and the RSNPN is not the subscribed SNPN;
- ii) either at least one of the PLMNs reported by the lower layers is in the list of authorized PLMNs for 5G ProSe multi-hop UE-to-network relay discovery and provides radio resources for 5G ProSe multi-hop UE-to-network relay discovery as specified in 3GPP TS 38.331 [13], or for SNPN one of the SNPNs reported by the lower layer is the subscribed SNPN and the UE is authorized to use 5G ProSe direct communication over PC5 interface in the subscribed SNPN; and

iii) the UE does not have an emergency PDU session;

then the UE shall:

- i) if in 5GMM-IDLE mode, perform PLMN selection or SNPN selection triggered by 5G ProSe multi-hop UE-to-network relay discovery as specified in 3GPP TS 23.122 [14]; or
- ii) else if in 5GMM-CONNECTED mode, either:
 - A) perform a De-registration procedure as specified in 3GPP TS 24.501 [11] and then perform PLMN selection or SNPN selection triggered by 5G ProSe multi-hop UE-to-network relay discovery as specified in 3GPP TS 23.122 [14]; or
 - B) not initiate 5G ProSe direct discovery.

Whether the UE performs i) or ii) above is left up to UE implementation; or

- 2) else the UE shall not initiate 5G ProSe multi-hop UE-to-network relay discovery.

If the registration to the selected PLMN or the selected SNPN is successful, the UE shall proceed with the procedure to initiate 5G ProSe multi-hop UE-to-network relay discovery as specified in clause 8b.2.1.

If the UE is performing 5G ProSe multi-hop UE-to-network relay discovery using radio parameters associated with a geographical area and moves out of that geographical area, the UE shall stop performing 5G ProSe multi-hop UE-to-network relay discovery and then if the UE is not served by NG-RAN for 5G ProSe multi-hop UE-to-network relay discovery, the UE shall select appropriate radio parameters for the new geographical area as specified above.

8b.2.5 Multi-hop UE-to-network relay selection procedure

8b.2.5.1 General

The purpose of the multi-hop UE-to-network relay selection procedure is to enable a 5G ProSe multi-hop remote UE to select a suitable 5G ProSe intermediate UE-to-network relay UE or 5G ProSe multi-hop UE-to-network relay UE to obtain a connectivity service to 5GC.

8b.2.5.2 Multi-hop UE-to-network relay selection procedure initiation

The 5G ProSe multi-hop remote UE or the 5G ProSe intermediate UE-to-network relay UE shall trigger the multi-hop UE-to-network relay selection procedure if the following conditions are met:

- a) the UE is authorised to act as a 5G ProSe multi-hop remote UE or as a 5G ProSe intermediate UE-to-network relay UE as specified in clause 5.2.8 (e.g., relay service code, User info ID, etc.):
 - 1) if the authorized UE is expected to use 5G ProSe multi-hop layer-3 UE-to-network relay, the indication whether the UE is authorized to use a 5G ProSe multi-hop layer-3 UE-to-network relay UE shall be set;
 - 2) if the authorized UE is expected to use 5G ProSe multi-hop layer-2 UE-to-network relay, either the subset of the PLMN(s) provided by the 5G ProSe layer-2 UE-to-network relay UE shall be in the list of PLMNs in which the UE is authorized to use a 5G ProSe multi-hop layer-2 UE-to-network relay UE or the SNPN provided by the 5G ProSe multi-hop layer-2 UE-to-network relay UE shall be the subscribed SNPN in which the UE is authorized to use a 5G ProSe multi-hop layer-2 UE-to-network relay UE; and
 - 3) if the authorized UE is expected to use 5G ProSe multi-hop layer-2 UE-to-network relay, either the authorized UE selected PLMN shall be in the list of PLMNs in which the UE is authorized to use a 5G ProSe multi-hop layer-2 UE-to-network relay UE and in the subset of the PLMN(s) provided by the 5G ProSe multi-hop layer-2 UE-to-network relay UE, or the authorized UE selected SNPN shall be the subscribed SNPN in which the UE is authorized to use a 5G ProSe multi-hop layer-2 UE-to-network relay UE and provided by the 5G ProSe multi-hop layer-2 UE-to-network relay UE;
- b) the UE has obtained a list of 5G ProSe multi-hop UE-to-network relay UE candidate(s) fulfilling ProSe layer criteria with the monitoring procedure for multi-hop UE-to-network relay discovery as specified in clause 8b.2.1.2.3 or the discoverer procedure for UE-to-network relay discovery as specified in clause 8b.2.1.3.1; and

- c) the UE has obtained a list of 5G ProSe multi-hop UE-to-network relay UE candidate(s) fulfilling lower layers criteria as specified in 3GPP TS 38.331 [13].

8b.2.5.3 Multi-hop UE-to-network relay selection procedure completion

If there exists only one 5G ProSe intermediate UE-to-network relay UE or 5G ProSe multi-hop UE-to-network relay UE candidate satisfying the conditions in clause 8b.2.5.2, then that 5G ProSe intermediate UE-to-network relay UE or 5G ProSe multi-hop UE-to-network relay UE is selected.

If there exist more than one 5G ProSe intermediate UE-to-network relay UE or 5G ProSe multi-hop UE-to-network relay UE candidate satisfying the conditions in clause 8b.2.5.2, any relay candidates not satisfying the non-radio related ProSe layer criteria shall be discarded.

It is up to the UE implementation how the 5G ProSe multi-hop remote UE or the 5G ProSe multi-hop child UE-to-network relay UE selects the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE based on multi-hop factors such as the value of the resource status indicator, the Multi-hop U2N path info, the PC5 signal strength between the 5G ProSe multi-hop remote UE and its neighbour 5G ProSe intermediate UE-to-network relay UE, the Accumulated QoS for PC5 link and the number of hops to the 5G ProSe multi-hop UE-to-network relay UE. It is up to the UE implementation whether the ProSe layer or the lower layers takes the final selection on which 5G ProSe intermediate UE-to-network relay UE or 5G ProSe multi-hop UE-to-network relay UE to select.

NOTE 1: Multi-hop U2N path info is only used for the multi-hop UE-to-network relay discovery with model B.

NOTE 2: How the UE determines the non-radio related ProSe layer criteria is up to UE implementation.

After a 5G ProSe intermediate UE-to-network relay UE is selected by the 5G ProSe multi-hop remote UE or a 5G ProSe multi-hop child UE-to-network relay UE, and a 5G ProSe direct link for multi-hop UE-to-network relay is established based on model A discovery between:

- a) the 5G ProSe multi-hop remote UE and the 5G ProSe intermediate UE-to-network relay UE; or
- b) the 5G ProSe multi-hop child UE-to-network relay UE and the 5G ProSe intermediate UE-to-network relay UE,

the 5G ProSe intermediate UE-to-network relay UE shall initiate the 5G ProSe direct link modification procedure for multi-hop UE-to-network relay towards its 5G ProSe multi-hop parent UE-to-network relay UE as specified in clause 8b.2.2.3.

After a 5G ProSe multi-hop parent UE-to-network UE is selected by the 5G ProSe multi-hop child UE based on model A discovery, the 5G ProSe multi-hop child UE can initiate the ProSe multi-hop UE-to-network relay UE discovery procedure.

After selecting the multi-hop path toward a 5G ProSe multi-hop UE-to-network relay UE by the 5G ProSe multi-hop remote UE based on model B discovery, the 5G ProSe multi-hop remote UE shall initiate the 5G ProSe direct link establishment procedure to the 5G ProSe intermediate UE-to-network relay UE with the selected multi-hop U2N path info as specified in clause 8b.2.2.2.3.

After the 5G ProSe multi-hop remote UE establishes the 5G ProSe direct link with the 5G ProSe intermediate UE-to-network relay UE, the 5G ProSe direct link modification procedure for multi-hop UE-to-network relay is triggered as described in clause 8b.2.2.3.

8b.2.6 QoS handling for 5G ProSe multi-hop UE-to-network relay

8b.2.6.1 General

This clause describes the QoS handling between a 5G ProSe multi-hop UE-to-network relay UE and a 5G ProSe multi-hop remote UE through zero or more 5G ProSe intermediate UE-to-network relay UEs. The purpose of QoS handling for 5G ProSe multi-hop UE-to-network relay is to meet the end-to-end QoS requirement between 5G ProSe multi-hop remote UE and the network.

8b.2.6.2 QoS handling for 5G ProSe multi-hop layer-3 UE-to-network relay without N3IWF

8b.2.6.2.1 General

The QoS handling by a 5G ProSe multi-hop layer-3 UE-to-network relay without an N3IWF to achieve an end-to-end QoS between the 5G ProSe multi-hop layer-3 remote UE and the network through zero or more 5G ProSe intermediate layer-3 UE-to-network relay UEs is described in clause 5.6.2.4 of 3GPP TS 23.304 [2].

For a 5G ProSe multi-hop layer-3 remote UE accessing the network via a 5G ProSe multi-hop layer-3 UE-to-network relay without N3IWF, the end-to-end QoS requirement between 5G ProSe multi-hop layer-3 remote UE and the network can be satisfied by the corresponding QoS control:

- a) QoS control between 5G ProSe multi-hop layer-3 remote UE and 5G ProSe multi-hop layer-3 UE-to-network relay UE through zero or more 5G ProSe intermediate layer-3 UE-to-network relay UEs (PC5 QoS control); and
- b) QoS control between 5G ProSe multi-hop layer-3 UE-to-network relay UE and the network (Uu QoS control).

To achieve this, the QoS mapping can be pre-configured as specified in clause 5.2.8 or provided to the 5G ProSe multi-hop UE-to-network relay UE by the PCF using Prose Policy as specified in clause 5.3.2.

8b.2.6.2.2 QoS flows handling initiated by the network

For QoS flows setup initiated by the network, the 5G ProSe multi-hop layer-3 UE-to-network relay UE shall determine the end-to-end PC5 QoS parameters based on the QoS flow level parameters received from the network, and shall determine the PC5 QoS flow parameters for the PC5 link with its adjacent 5G ProSe intermediate layer-3 UE-to-network relay UE based on the determined end-to-end PC5 QoS parameters.

To determine the end-to-end PC5 QoS parameters, upon reception of QoS rules and QoS flow level parameters from the SMF, the 5G ProSe multi-hop layer-3 UE-to-network relay UE:

- a) shall determine the PQI of the end-to-end PC5 QoS based on the QoS mapping rules configured in clause 5.2.8;
- b) shall set the GFBR value for the end-to-end PC5 GBR QoS flow to the GFBR value from the SMF, if any;
- c) shall set the MFBR value for the end-to-end PC5 QoS GBR QoS flow to the MFBR value from the SMF, if any;
- d) shall set the averaging window value for the end-to-end PC5 QoS GBR QoS flow to the averaging value from the SMF, if any;
- e) shall determine the maximum PDB of the end-to-end PC5 QoS based on the QoS mapping rules configured in clause 5.2.8; and
- f) may derive the packet filter(s) used for end-to-end PC5 QoS rule(s) from the packet filter(s) used over Uu reference.

To determine the PC5 QoS flow descriptions for the PC5 link with its adjacent 5G ProSe intermediate layer-3 UE-to-network relay UE, the 5G ProSe multi-hop layer-3 UE-to-network relay UE:

- a) shall determine the PQI of the PC5 QoS flow based on the PQI of the end-to-end PC5 QoS;
- b) shall set the GFBR value for the PC5 GBR QoS flow to the end-to-end GFBR value, if any;
- c) shall set the MFBR value for the PC5 GBR QoS flow to the end-to-end MFBR, if any;
- d) shall set the averaging window value for the PC5 GBR QoS flow to the end-to-end averaging value, if any; and
- e) shall determine the PDB of the PC5 QoS flow based on the end-to-end maximum PDB and the number of hops till the 5G ProSe multi-hop remote UE, i.e. by applying a hop adjustment factor.

Then, the 5G ProSe multi-hop layer-3 UE-to-network relay UE shall initiate the 5G ProSe direct link modification procedure as defined in clause 8b.2.2.3 towards its adjacent 5G ProSe intermediate layer-3 UE-to-network relay UE to either update the existing PC5 QoS flow or to set up a new PC5 QoS flow, where the 5G ProSe multi-hop layer-3 UE-to-network relay UE includes in the PROSE DIRECT LINK MODIFICATION REQUEST message the PC5 QoS flow

parameters in the QoS flow descriptions IE and the end-to-end PC5 QoS flow parameters in the End-to-end QoS flow descriptions IE, as well as the QoS rules IE.

Upon receiving PROSE DIRECT LINK MODIFICATION REQUEST message that includes the PC5 QoS flow parameters and the end-to-end PC5 QoS flow parameters, each 5G ProSe intermediate layer-3 UE-to-network relay UE shall determine the PC5 QoS flow parameters for the PC5 link towards its 5G ProSe multi-hop child layer-3 UE-to-network relay UE or 5G ProSe multi-hop layer-3 remote UE based on the received end-to-end PC5 QoS parameters and by following implementation specific means but with considering that:

- a) the GFBR value for the PC5 GBR QoS flow shall be set to the end-to-end GFBR;
- b) the MFBR value for the PC5 GBR QoS flow shall be set to the end-to-end MFBR; and
- c) the PDB of the PC5 QoS flow shall be based on the end-to-end maximum PDB but after considering the total number of hops from the 5G ProSe multi-hop layer-3 UE-to-network relay UE till the 5G ProSe multi-hop remote UE, i.e. by applying a hop adjustment factor.

Further, each 5G ProSe intermediate layer-3 UE-to-network relay UE shall initiate the 5G ProSe direct link modification procedure towards its 5G ProSe multi-hop child layer-3 UE-to-network relay UE or 5G ProSe multi-hop layer-3 remote UE and includes in the PROSE DIRECT LINK MODIFICATION REQUEST message the determined PC5 QoS flow parameters in the QoS flow descriptions IE and the received end-to-end PC5 QoS flow parameters in the End-to-end QoS flow descriptions IE, as well as the QoS rules IE.

8b.2.6.2.3 PC5 QoS flows handling initiated by the 5G ProSe multi-hop layer-3 remote UE

For PC5 QoS flows setup or modification initiated by the 5G ProSe multi-hop layer-3 remote UE, the 5G ProSe multi-hop layer-3 remote UE shall provide the PC5 QoS flow context to the 5G ProSe multi-hop layer-3 UE-to-network relay UE, through zero or more 5G ProSe intermediate layer-3 UE-to-network relay UEs, to indicate the end-to-end QoS requirements for the traffic transmission between 5G ProSe multi-hop layer-3 remote UE and the network, using 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay or 5G ProSe direct link modification procedure for multi-hop UE-to-network relay.

In order to achieve that, the 5G ProSe multi-hop layer-3 remote UE shall initiate the 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay or 5G ProSe direct link modification procedure for multi-hop UE-to-network relay towards the 5G ProSe intermediate layer-3 UE-to-network relay UE, where in the PROSE DIRECT LINK SECURITY MODE COMPLETE message or the PROSE DIRECT LINK MODIFICATION REQUEST message, the 5G ProSe multi-hop layer-3 remote UE:

- a) shall include the requested end-to-end QoS requirements in the PC5 QoS flow descriptions IE.

Then, each 5G ProSe intermediate layer-3 UE-to-network relay UE, before replying with PROSE DIRECT LINK ESTABLISHMENT ACCEPT message or the PROSE DIRECT LINK MODIFICATION ACCEPT message towards its 5G ProSe multi-hop child layer-3 UE-to-network relay UE or 5G ProSe multi-hop layer-3 remote UE, shall initiate the 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay or 5G ProSe direct link modification procedure for multi-hop UE-to-network relay towards its 5G ProSe multi-hop parent layer-3 UE-to-network relay UE or its 5G ProSe multi-hop layer-3 UE-to-network relay UE, where in the PROSE DIRECT LINK SECURITY MODE COMPLETE message or the PROSE DIRECT LINK MODIFICATION REQUEST message, the 5G ProSe intermediate layer-3 UE-to-network relay UE:

- a) shall include the end-to-end QoS requirements received from the previous hop in the PC5 QoS flow descriptions IE.

In addition, if the 5G ProSe multi-hop layer-3 remote UE wants to add new PC5 QoS flow(s) or modify the existing PC5 QoS flow(s) for IP traffic or Ethernet traffic, the 5G ProSe multi-hop layer-3 remote UE may also provide the PC5 QoS rule(s) for the PC5 QoS flow(s) to be added or modified to the 5G ProSe layer-3 UE-to-network relay UE, through the zero or more 5G ProSe intermediate layer-3 UE-to-network relay UEs, using 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay or 5G ProSe direct link modification procedure for multi-hop UE-to-network relay.

Upon reception of the PC5 QoS flow context containing the end-to-end QoS requirements from the 5G ProSe intermediate layer-3 UE-to-network relay UE, the 5G ProSe multi-hop layer-3 UE-to-network relay UE:

- a) shall perform one of the following:

- 1) if the end-to-end QoS requirements can be supported by an entry in QoS mapping configured in clause 5.2.8, then the 5G ProSe multi-hop layer-3 UE-to-network relay UE uses the 5QI of the entry for the Uu QoS control and uses the PQI of the entry for the end-to-end PC5 QoS control and also determines the maximum PDB of the end-to-end PC5 QoS, also with considering any implementation specific adjustments taking into account the number of hops; or
 - 2) if the end-to-end QoS requirements cannot be supported by any entry in QoS mapping configured in clause 5.2.8, then the 5G ProSe layer-3 UE-to-network relay UE determines the 5QI for the Uu QoS control and PQI for the end-to-end PC5 QoS control and the maximum PDB of the end-to-end PC5 QoS based on its implementation, also with considering any implementation specific adjustments taking into account the number of hops;
- b) optionally, may derive the packet filter(s) used over Uu reference point if the 5G ProSe multi-hop layer-3 UE-to-network relay UE received PC5 QoS rule(s) from 5G ProSe multi-hop layer-3 remote UE through the zero or more 5G ProSe intermediate layer-3 UE-to-network relay UEs;
 - c) if a new QoS flow needs to be established or the existing QoS flow(s) needs to be modified, shall perform UE-requested PDU session modification procedure as specified in clause 6.4.2 in 3GPP TS 24.501 [11] providing:
 - 1) the Requested QoS flow descriptions IE with the 5QI value determined in bullet a); or
 - 2) the Requested QoS rules IE with the packet filter(s) if packet filter(s) are derived in bullet b);
 - d) shall further update the end-to-end PC5 QoS parameters with the updated PQI value if the 5G ProSe layer-3 UE-to-network relay UE receives the authorized QoS flow descriptions with a 5QI value which is different from the 5QI value indicated by the 5G ProSe multi-hop layer-3 UE-to-network relay UE as described in bullet c);
 - e) shall further determine the PC5 QoS flow descriptions, including the PDB of the PC5 QoS flow, for the PC5 link established with its 5G ProSe intermediate layer-3 UE-to-network relay UE by considering the end-to-end PC5 QoS parameters in the same way specified in clause 8b.2.6.2.2; and
 - f) shall reply to the 5G ProSe intermediate layer-3 UE-to-network relay UE with a PROSE DIRECT LINK ESTABLISHMENT ACCEPT message (if 5G ProSe direct link establishment procedure for multi-hop UE-to-network relay was initiated) or a PROSE DIRECT LINK MODIFICATION ACCEPT message (if 5G ProSe direct link modification procedure for multi-hop UE-to-network relay was initiated) that includes:
 - 1) the determined PC5 QoS flow descriptions in the QoS flow descriptions IE; and
 - 2) the end-to-end PC5 QoS parameters (as determined in bullet a) or as updated in bullet d)) in the End-to-end QoS flow descriptions IE.

Further, each 5G ProSe intermediate layer-3 UE-to-network relay UE, upon receiving the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message or a PROSE DIRECT LINK MODIFICATION ACCEPT message containing the PC5 QoS flow descriptions and the end-to-end PC5 QoS parameters:

- a) shall determine the PC5 QoS flow descriptions, including the PDB of the PC5 QoS flow, for the PC5 link established with its 5G ProSe multi-hop child layer-3 UE-to-network relay UE or its 5G ProSe multi-hop layer-3 remote UE by considering the received end-to-end PC5 QoS parameters in the same way specified in clause 8b.2.6.2.2; and
- b) shall reply to its 5G ProSe multi-hop child layer-3 UE-to-network relay UE or 5G ProSe multi-hop layer-3 remote UE with a PROSE DIRECT LINK ESTABLISHMENT ACCEPT message or a PROSE DIRECT LINK MODIFICATION ACCEPT message containing:
 - 1) the determined PC5 QoS flow descriptions in the QoS flow descriptions IE; and
 - 2) the received end-to-end PC5 QoS parameters in the End-to-end QoS flow descriptions IE.

8b.2.7 IP address allocation in 5G ProSe multi-hop layer-3 UE-to-network relay procedure

For the UE acting as the 5G ProSe multi-hop child UE-to-network relay UE or the 5G ProSe multi-hop layer-3 remote UE receiving the IP address configuration IE in the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message from the UE's 5G ProSe multi-hop parent UE-to-network relay UE,

- a) if the IP address configuration IE indicates "DHCPv4 Server", the UE shall initiate the IPv4 address configuration with DHCPv4 procedure acting as a DHCP client, according to IETF RFC 2131 [23] and IETF RFC 4039 [24];
- b) if the IP address configuration IE indicates "IPv6 Router", the UE shall initiate the IPv6 address configuration with IPv6 stateless address auto-configuration acting as an IPv6 host based on IETF RFC 4862 [25].

The 5G ProSe layer-3 intermediate UE-to-network relay UE(s) are responsible for relaying router solicitation messages and router advertisement messages between the UE acting as the 5G ProSe multi-hop child UE-to-network relay UE or the 5G ProSe multi-hop layer-3 remote UE and the 5G ProSe multi-hop UE-to-network relay UE; and

- c) if the IP address configuration IE indicates "DHCPv4 Server & IPv6 Router", the UE shall choose the IP version and initiate the corresponding IP address configuration procedure as a client or host.

For the UE acting as a 5G ProSe multi-hop layer-3 UE-to-network relay UE, if

- a) the SSC mode of the PDU session is SSC mode 3; and
- b) the UE obtains a new IPv6 prefix by performing the UE-requested PDU session establishment procedure upon receiving the 5GSM cause IE set to #39 "reactivation requested" as specified in clause 6.3.2.3 of 3GPP TS 24.501 [11],

the UE shall advertise the new IPv6 prefix to be used by the 5G ProSe multi-hop layer-3 remote UE as defined in RFC 4862 [25].

NOTE: If the UE receives a new IPv4 address, the UE does not need to update the IPv4 address of the 5G ProSe multi-hop layer-3 remote UE since the IPv4 address of the 5G ProSe multi-hop layer-3 remote UE will be NAT translated by the UE.

8b.2.8 5G ProSe additional parameters announcement procedure for multi-hop UE-to-network relay

8b.2.8.1 General

The purpose of the 5G ProSe additional parameters announcement procedure for multi-hop UE-to-network relay is for the 5G ProSe multi-hop layer-3 remote UE to obtain NCGI or TAI of the cell serving the 5G ProSe multi-hop layer-3 UE-to-network relay UE and optionally the NID of the SNPN in case the serving cell is operated by a SNPN.

The 5G ProSe multi-hop layer-3 remote UE, 5G ProSe layer-3 intermediate UE-to-network relay UE, and the 5G ProSe multi-hop layer-3 UE-to-network relay UE in this procedure shall be a 5G ProSe-enabled UE and are authorised to act as a corresponding role as specified in clause 5.2.8.

8b.2.8.2 5G ProSe additional parameters announcement procedure initiation by the 5G ProSe multi-hop layer-3 remote UE

Before initiating the 5G ProSe additional parameters announcement procedure for 5G ProSe multi-hop UE-to-network relay, a direct link shall be successfully established between the 5G ProSe multi-hop layer-3 remote UE and the 5G ProSe multi-hop layer-3 UE-to-network relay UE through zero or more 5G ProSe intermediate UE-to-network relay UE(s).

The 5G ProSe multi-hop layer-3 remote UE shall initiate a 5G ProSe additional parameters announcement procedure:

- a) when the 5G ProSe multi-hop layer-3 remote UE is triggered by an upper layer application to report NCGI or TAI of the serving cell, and:
 - 1) if the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information from the 5G ProSe multi-hop layer-3 UE-to-network relay UE cannot be received;
 - 2) if the NCGI or TAI is not included in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information from the 5G ProSe multi-hop layer-3 UE-to-network relay UE; or

- 3) if the NCGI or TAI is not included in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response because the 5G ProSe multi-hop layer-3 UE-to-network relay discovery with model B is used for the direct link; or
- b) when the additional parameters announcement request refresh timer T5106 expires and the 5G ProSe multi-hop layer-3 remote UE still needs to obtain NCGI or TAI of the cell serving the 5G ProSe multi-hop layer-3 UE-to-network relay.

The 5G ProSe multi-hop layer-3 remote UE shall generate a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message and pass this message to the lower layers for transmission along with the 5G ProSe multi-hop layer-3 remote UE's layer-2 ID (for unicast communication) and the layer-2 ID of the next hop i.e., 5G ProSe intermediate UE-to-network relay UE or 5G ProSe multi-hop layer-3 UE-to-network relay UE for unicast communication.

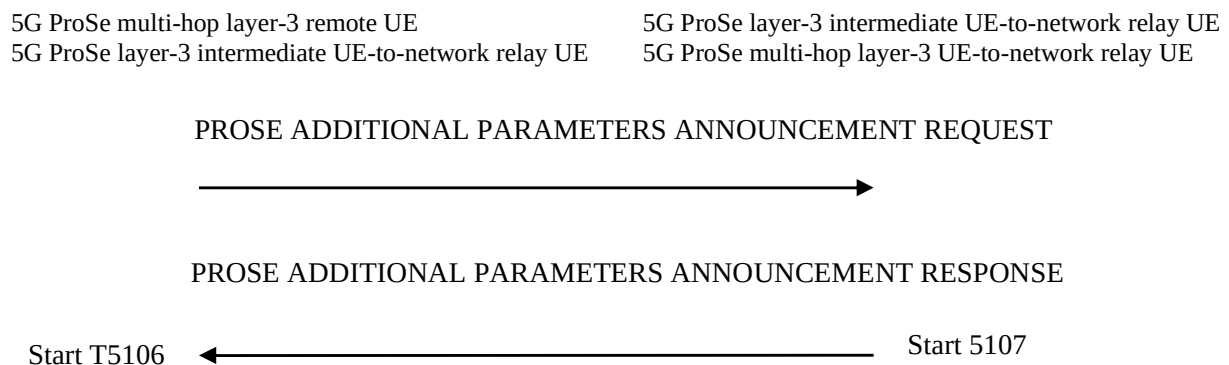


Figure 8b.2.8.2.1: 5G ProSe additional parameters announcement procedure for 5G ProSe multi-hop layer-3 UE-to-network relay

NOTE 1: The timer T5106 is started by the 5G ProSe multi-hop layer-3 remote UE.

NOTE 2: The timer T5107 is started by the 5G ProSe multi-hop layer-3 UE-to-network relay UE.

8b.2.8.3 5G ProSe additional parameters announcement procedure by the 5G ProSe layer-3 intermediate UE-to-network relay UE

Upon receiving a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message, the 5G ProSe layer-3 intermediate UE-to-network relay UE shall initiate a 5G ProSe additional parameters announcement procedure toward its 5G ProSe multi-hop parent UE-to-network relay UE or 5G ProSe multi-hop layer-3 UE-to-network relay UE:

- a) The 5G ProSe layer-3 intermediate UE-to-network relay UE shall generate a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message and pass this message to the lower layers for transmission along with the 5G ProSe layer-3 intermediate UE-to-network relay UE's layer-2 ID (for unicast communication) and the layer-2 ID of the next hop i.e., 5G ProSe multi-hop parent UE-to-network relay UE or 5G ProSe multi-hop layer-3 UE-to-network relay UE for unicast communication.

Upon receiving a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE message from its 5G ProSe multi-hop parent UE-to-network relay UE or 5G ProSe multi-hop layer-3 UE-to-network relay UE, the 5G ProSe layer-3 intermediate UE-to-network relay UE shall forward the received PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE message towards its 5G ProSe multi-hop remote UE or its 5G ProSe multi-hop child UE-to-network relay UE.

If the 5G ProSe multi-hop intermediate UE-to-network relay UE receives a PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information from a 5G ProSe multi-hop UE-to-network relay UE or its 5G ProSe multi-hop parent UE-to-network relay UE, the 5G ProSe multi-hop intermediate UE-to-network relay

UE shall perform the announcing UE procedure for multi-hop UE-to-network relay discovery additional information as described in clause 8b.2.1.2.4.

8b.2.8.4 5G ProSe additional parameters announcement procedure accepted by the 5G ProSe multi-hop layer-3 UE-to-network relay UE

Upon receiving a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message, the 5G ProSe multi-hop layer-3 UE-to-network relay UE shall allocate an additional parameters announcement request refresh timer T5106 to the 5G ProSe multi-hop layer-3 remote UE and start a timer T5107. The timer T5107 shall be longer than the additional parameters announcement request refresh timer T5106.

Then the 5G ProSe multi-hop layer-3 UE-to-network relay UE shall respond a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE message with an additional parameters announcement request refresh timer T5106 IE set to the T5106 timer value assigned by the 5G ProSe multi-hop layer-3 UE-to-network relay UE. The 5G ProSe multi-hop layer-3 UE-to-network relay UE shall start announcing the NCGI or TAI of the serving cell by triggering the announcing UE procedure for multi-hop UE-to-network relay discovery additional information as described in clause 8b.2.1.2.4.

8b.2.8.5 5G ProSe additional parameters announcement procedure completion by the 5G ProSe multi-hop layer-3 remote UE

Upon receiving a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE message, the 5G ProSe multi-hop layer-3 remote UE shall start the additional parameters announcement request refresh timer T5106 with the received value.

8b.2.8.6 Abnormal cases

8b.2.8.6.1 Abnormal cases in the 5G ProSe multi-hop layer-3 remote UE

If there is no response from the 5G ProSe layer-3 UE-to-network relay UE after the PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message has been successfully delivered, the 5G ProSe layer-3 remote UE shall retransmit the PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

8b.2.8.6.2 Abnormal cases in the 5G ProSe layer-3 intermediate UE-to-network relay UE

If there is no response from the 5G ProSe multi-hop layer-3 UE-to-network relay UE or the 5G ProSe multi-hop parent UE-to-network relay UE after the PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message has been successfully delivered, the 5G ProSe layer-3 intermediate UE-to-network relay UE shall retransmit the PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST message.

NOTE: The timer to trigger retransmission and the maximum number of allowed retransmissions are UE implementation specific.

8b.2.9 5G ProSe multi-hop public warning notification relay procedure

8b.2.9.1 General

The purpose of the 5G ProSe multi-hop public warning notification relay procedure is for the 5G ProSe multi-hop layer-3 UE-to-network relay UE to broadcast the warning message received from the network to 5G ProSe intermediate UE-to-network relay UE(s) and 5G ProSe multi-hop remote UE(s) nearby by sending PROSE PC5 BROADCASTING message for public warning notification. 5G ProSe intermediate UE-to-network relay UE(s) and 5G ProSe multi-hop remote UE(s) nearby can receive the PROSE PC5 BROADCASTING message for public warning notification without establishing a connection to the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE based on the configuration as specified in clause 5.2.8.

NOTE: In case of the UE acting as the 5G ProSe multi-hop layer-3 UE-to-network relay UE and the 5G ProSe layer-3 UE-to-network relay UE simultaneously, the UE can perform both 5G ProSe multi-hop public warning notification relay procedure and 5G ProSe public warning notification relay procedure (see clause 8.2.14).

8b.2.9.2 5G ProSe public warning notification relay initiation procedure for 5G ProSe multi-hop layer-3 UE-to-network relay

The 5G ProSe multi-hop layer-3 UE-to-network relay UE broadcasts the 5G ProSe broadcasting message for public warning notification if the 5G ProSe multi-hop layer-3 UE-to-network relay UE receives the public warning notification message from the network as specified in 3GPP TS 23.041 [54].

NOTE: The 5G ProSe multi-hop layer-3 UE-to-network relay UE can perform the duplication detection function as specified in 3GPP TS 23.041 [54] to suppress received duplicated warning messages over Uu in order to avoid broadcasting the duplicated warning message over PC5.

The 5G ProSe multi-hop layer-3 UE-to-network relay UE shall start broadcasting the received public warning notification message if:

- a) the 5G ProSe multi-hop layer-3 UE-to-network relay UE is served by NG-RAN for 5G ProSe communication;
- b) the 5G ProSe multi-hop layer-3 UE-to-network relay UE is authorised to act as a 5G ProSe multi-hop layer-3 UE-to-network relay UE;
- c) either the registered PLMN is in the list of PLMNs in which the UE is authorized to use 5G ProSe communication over PC5, or the registered SNPN is the subscribed SNPN in which the UE is authorized to use 5G ProSe communication over PC5, when the UE is served by NG-RAN for 5G ProSe communication over PC5 as specified in clause 5.2.4; and
- d) the 5G ProSe multi-hop layer-3 UE-to-network relay UE is configured with the default destination layer-2 ID for broadcasting warning messages and the PC5 QoS parameters for broadcasting warning messages.

The UE shall generate the PROSE PC5 BROADCASTING message for public warning notification which includes:

- a) the warning message received from the network; and
- b) the hop count with the value set to 1.

After generating the PROSE PC5 BROADCASTING message for public warning notification, the UE shall include the PROSE PC5 BROADCASTING message for public warning notification in a protocol data unit with following parameters:

- a) a layer-3 protocol data unit type (see 3GPP TS 38.323 [16]) set to unstructured;
- b) the source layer-2 ID set to the layer-2 ID self-assigned by the UE for 5G ProSe communication over PC5 as specified in clause 7.3.2.1.2;
- c) the destination layer-2 ID set to the destination layer-2 ID configured for 5G ProSe broadcasting message for public warning notification as specified in clause 5.2.8;
- d) the PQFI set to the value corresponding to the configured PC5 QoS parameters for 5G ProSe broadcasting message for public warning notification as specified in clause 5.2.8; and
- e) the NR Tx profile based on the configuration for 5G ProSe broadcasting message for public warning notification as specified in clause 5.2.8.

Then the UE shall request radio resources for 5G ProSe communication over PC5 as specified in 3GPP TS 38.300 [21] and pass the protocol data unit(s) on the PC5 QoS flow identified by the PQFI to lower layers for transmission.

If the UE is camped on a serving cell indicating that 5G ProSe communication over PC5 is supported by the network, but not broadcasting any carrier frequencies and radio resources for 5G ProSe communication over PC5 as specified in 3GPP TS 38.331 [13], the UE shall request radio resources for 5G ProSe communication over PC5 as specified in 3GPP TS 24.501 [11].

8b.2.9.3 5G ProSe public warning notification reception procedure for 5G ProSe multi-hop layer-3 UE-to-network relay

5G ProSe intermediate UE-to-network relay UE(s) and 5G ProSe multi-hop remote UE(s) are configured with a destination layer-2 ID(s) for reception of data unit(s) over PC5 carrying the 5G ProSe broadcasting message for public warning notification. 5G ProSe intermediate UE-to-network relay UE and 5G ProSe multi-hop remote UE are a receiving UE for this procedure.

The receiving UE shall determine the PC5 QoS parameter and the NR Tx profile for 5G ProSe broadcasting message for public warning notification based on the configuration as specified in clause 5.2.8, and shall provide the PC5 QoS parameters, the NR Tx profile, and the destination layer-2 ID for 5G ProSe broadcasting message for public warning notification to lower layers.

For each received protocol data unit over PC5, the receiving UE shall check if the destination layer-2 ID of the received protocol data unit matches one of the configured destination layer-2 ID for the 5G ProSe broadcasting message for public warning notification. If yes, the UE shall then check the received protocol data unit carrying the 5G ProSe multi-hop public warning notification broadcast message.

If the 5G ProSe intermediate UE-to-network relay UE receives the PROSE PC5 BROADCASTING message for public warning notification, the UE shall pass the warning message payload in the PROSE PC5 BROADCASTING message for public warning notification to the corresponding upper layer entity for public warning system and check the hop count included in the PROSE PC5 BROADCASTING message for public warning notification.

- a) If the hop count in the PROSE PC5 BROADCASTING message for public warning notification is equal or less than the hop count info stored in the 5G ProSe UE-to-Network relay discovery entry, the 5G ProSe intermediate UE-to-network relay UE shall generate a PROSE PC5 BROADCASTING message for public warning notification as specified in clause 10.9.1 which includes:
 - 1) the warning message payload as received in the PROSE PC5 BROADCASTING message for public warning notification; and
 - 2) the hop count parameter set to value incremented by one from the hop count in the received PROSE PC5 BROADCASTING message for public warning notification.
- b) If the hop count in the PROSE PC5 BROADCASTING message for public warning notification is greater than the hop count info stored in the 5G ProSe UE-to-Network relay discovery entry, the 5G ProSe intermediate UE-to-network relay UE shall not generate the PROSE PC5 BROADCASTING message for public warning notification.
- c) If the 5G ProSe intermediate UE-to-network relay UE does not have the 5G ProSe UE-to-Network relay discovery entry stored, the 5G ProSe intermediate UE-to-network relay UE may use the Multi-hop U2N path info IE, if available from the multi-hop UE-to-network relay discovery over PC5 interface with model B, to compare the hop count with that in the PROSE PC5 BROADCASTING message for public warning notification. Based on this comparison, the 5G ProSe intermediate UE-to-network relay UE decides whether to generate the PROSE PC5 BROADCASTING message for public warning notification to forward to downstream UEs.

NOTE 1: If there are more than one 5G ProSe UE-to-Network relay discovery entries stored in the 5G ProSe intermediate UE-to-network relay UE, the 5G ProSe intermediate UE-to-network relay UE checks with the largest value of the hop count among 5G ProSe UE-to-Network relay discovery entries.

If the 5G ProSe multi-hop remote UE receives the PROSE PC5 BROADCASTING message for public warning notification, the UE shall pass the warning message payload in the PROSE PC5 BROADCASTING message for public warning notification to the corresponding upper layer entity for public warning system.

NOTE 2: The 5G ProSe multi-hop remote UE and the 5G ProSe intermediate UE-to-network relay UE can perform the duplication detection function as specified in 3GPP TS 23.041 [54] to detect duplicated warning messages received over PC5 and/or Uu, for example, if there are multiple 5G ProSe multi-hop layer-3 UE-to-network relay UEs or 5G ProSe intermediate UE-to-network relay UEs broadcasting the new 5G ProSe public warning notification broadcast message.

NOTE 2A: The 5G ProSe intermediate UE-to-network relay UE can broadcast duplicated warning messages received over PC5 only if the message has the lowest hop count received so far. Broadcasting such a message can help reach downstream UEs that missed earlier public warning notifications due to hop count limits.

NOTE 3: The 5G ProSe multi-hop remote UE can perform the geo-fencing check for the received warning message over PC5 as specified in 3GPP TS 23.041 [54].

8b.2.10 5G ProSe security procedures over PC8 interface

8b.2.10.1 General

8b.2.10.1.1 Transport protocol for PC8 messages

The transport protocol for PC8 messages are the same as described in clause 8.2.10.1.1.

8b.2.10.1.2 Handling of UE-initiated procedures

The handling of UE-initiated procedures are the same as described in clause 8.2.10.1.2.

8b.2.10.2 Procedures

The following procedures are defined:

- a) 5G ProSe multi-hop UE-to-network relay discovery security parameters request procedure;
- b) 5G ProSe multi-hop user key request procedure; and
- c) Multi-hop key request procedure.

In the following descriptions of 5G procedures over PC8 interface, the terms "request" and "response" refer to the corresponding PC8 messages, not to the HTTP request or response. The following procedure descriptions use a single PC8 message for illustration purposes.

The 5G ProSe procedures over PC8 interface shall be integrity protected and confidentiality protected using the security procedures using GBA or AKMA, see clause 5.2.5.3 and clause 5.2.5.4 in 3GPP TS 33.503 [34].

NOTE 1: A single HTTP request message can contain multiple PC8 requests and a single HTTP response message can contain multiple PC8 responses.

NOTE 2: The privacy of the UE identity included in the PC8 messages of 5G ProSe procedures over PC8 interface is ensured by the confidentiality protection of those procedures.

The 5G ProSe multi-hop UE-to-network relay discovery security parameters request procedure reuses the 5G ProSe UE-to-network relay discovery security parameters request procedure as described in clause 8.2.10.2.2, where the 5G ProSe remote UE is replaced by the 5G ProSe multi-hop remote UE or the 5G ProSe multi-hop child UE-to-network relay UE and the 5G ProSe UE-to-network relay UE is replaced by the 5G ProSe parent UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE.

The 5G ProSe multi-hop user key request procedure reuses the 5G ProSe remote user key request procedure as described in clause 8.2.10.2.3, where the 5G ProSe remote UE is replaced by the 5G ProSe multi-hop remote UE or the 5G ProSe multi-hop child UE-to-network relay UE.

The Multi-hop key request procedure reuses the Multi-hop key request procedure as described in clause 8.2.10.2.4, where the 5G ProSe remote UE is replaced by the 5G ProSe parent UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE.

8b.2.11 5G ProSe security procedures over PC3a interface

8b.2.11.1 General

8b.2.11.1.1 Transport protocol for PC3a messages

The transport protocol for PC3a messages are the same as described in clause 8.2.12.1.1.

8b.2.11.1.2 Handling of UE-initiated procedures

The handling of UE-initiated procedures are the same as described in clause 8.2.12.1.2.

8b.2.11.2 Procedures

The following procedures are defined:

- a) 5G ProSe multi-hop UE-to-network relay discovery security material request procedure.

In the following descriptions of 5G procedures over PC3a interface, the terms "request" and "response" refer to the corresponding PC3a messages, not to the HTTP request or response. The following procedure descriptions use a single PC3a message for illustration purposes.

The PC3a control protocol procedures for 5G ProSe direct discovery shall be integrity protected and confidentiality protected using the security procedures defined in clause 5.2.3 in 3GPP TS 33.503 [34].

NOTE: A single HTTP request message can contain multiple PC3a control protocol requests and a single HTTP response message can contain multiple PC3a control protocol responses.

When the TLS tunnel between the UE and the 5G DDNMF for transport of PC3a messages is established by the UE according to 3GPP TS 33.503 [34], the 5G DDNMF shall obtain identity of the served UE using the procedures specified in 3GPP TS 33.220 [46] or 3GPP TS 33.535 [47].

The 5G ProSe multi-hop UE-to-network relay discovery security material request procedure reuses the 5G ProSe UE-to-network relay discovery security material request procedure as described in clause 8.2.12.2.2, where:

- a) the 5G ProSe remote UE is replaced by the 5G ProSe multi-hop remote UE or the 5G ProSe multi-hop child UE-to-network relay UE; and
- b) the 5G ProSe UE-to-network relay UE is replaced by the 5G ProSe parent UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE.

8c 5G ProSe multi-hop UE-to-UE relay

8c.1 Overview

This clause describes the procedures for 5G ProSe multi-hop UE-to-UE relay. The UE is configured with the related information as described in clause 5.2.9.

8c.2 Procedures

8c.2.1 5G ProSe multi-hop layer-3 UE-to-UE relay discovery over PC5 interface

8c.2.1.1 General

This clause describes the procedures for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery over the PC5 interface using following operations:

- a) 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type (see clause 8c.2.1.2); and
- b) 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for Ethernet and unstructured data unit type (see clause 8c.2.1.3).

For a), the purpose of the procedures is to discover the 5G ProSe multi-hop layer-3 UE-to-UE relay.

NOTE: The discovery of the target 5G ProSe multi-hop end UEs for IP data unit type performed via DNS queries is specified in clause 8c.2.3.

For b), the purpose of the procedures is to discover the 5G ProSe multi-hop layer-3 UE-to-UE relay, the target 5G ProSe multi-hop end UE and the selection of the path between the source 5G ProSe multi-hop end UE and the target 5G ProSe multi-hop end UE.

8c.2.1.2 5G ProSe multi-hop layer-3 UE-to-UE relay discovery over PC5 interface for IP data unit type

8c.2.1.2.1 General

This clause describes the procedures for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type for public safety use and commercial services at a ProSe-enabled UE over the PC5 interface, including:

- a) 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type with model A (see clause 8c.2.1.2.2); and
- b) 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type with model B (see clause 8c.2.1.2.3).

The purpose of the 5G ProSe multi-hop layer-3 UE-to-UE relay discovery procedure over PC5 interface for IP data unit type is to enable a 5G ProSe multi-hop end UE or a 5G ProSe multi-hop layer-3 UE-to-UE Relay to detect and identify another 5G ProSe multi-hop layer-3 UE-to-UE Relay over PC5 interface for 5G ProSe multi-hop layer-3 UE-to-UE relay communication for IP data unit type.

A 5G ProSe multi-hop layer-3 UE-to-UE relay supporting multiple relay service codes for IP data unit type can advertise the relay service codes using multiple discovery messages, with one relay service code per discovery message.

To perform 5G ProSe multi-hop layer-3 UE-to-UE relay discovery over PC5 interface for IP data unit type, the UE is configured with the related information as described in clause 5.2.9. The following models for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery procedure over PC5 interface for IP data unit type as specified in 3GPP TS 23.304 [2] are supported:

- a) Model A uses a single discovery protocol message (Announcement); and
- b) Model B uses two discovery protocol messages (Solicitation and Response).

NOTE: If the UE is authorized to perform both 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type with Model A and 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type with Model B, it is up to the UE implementation to select which model to perform or to perform both models simultaneously.

The 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall use the security materials provisioned by the security procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type as specified in clause 8c.2.5 and clause 8c.2.6 to protect the 5G ProSe multi-hop UE-to-UE relay discovery messages.

The 5G ProSe multi-hop layer-3 UE-to-UE relay UE and 5G ProSe multi-hop end UE may use the PC5 DRX mechanism to perform 5G ProSe multi-hop layer-3 UE-to-UE relay discovery over PC5 interface for IP data unit type when the UE is not served by NG-RAN as specified in clause 5.2.9.

The following procedures are defined for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery over PC5 interface for IP data unit type:

- a) 5G ProSe multi-hop layer-3 UE-to-UE relay discovery over PC5 interface for IP data unit type with Model A:
 - 1) Announcing UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type initiation;
 - 2) Announcing UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type completion;
 - 3) Monitoring UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type initiation; and
 - 4) Monitoring UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type completion; and

b) 5G ProSe multi-hop layer-3 UE-to-UE relay discovery over PC5 interface for IP data unit type with Model B:

- 1) Discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type initiation;
- 2) Discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type completion;
- 3) void;
- 4) Discoveree relay UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type initiation; and
- 5) Discoveree relay UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type completion.

8c.2.1.2.2 Multi-hop layer-3 UE-to-UE relay discovery for IP data unit type with model A

8c.2.1.2.2.1 General

In this procedure, a 5G ProSe multi-hop layer-3 UE-to-UE relay acts as an "announcing UE", and a 5G ProSe multi-hop end UE or another 5G ProSe multi-hop layer-3 UE-to-UE relay may act as a "monitoring UE".

8c.2.1.2.2.2 Announcing UE relay discovery for multi-hop layer-3 UE-to-UE relay discovery

8c.2.1.2.2.2.1 General

The purpose of the announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type is to enable a 5G ProSe multi-hop layer-3 UE-to-UE relay to announce the availability of a connectivity service it provides to other ProSe-enabled UEs, upon a request from upper layers as defined in 3GPP TS 23.304 [2].

8c.2.1.2.2.2.2 Announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery initiation

The UE is authorised to perform the announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type if:

- a) the UE is authorised to act as a 5G ProSe multi-hop layer-3 UE-to-UE relay UE in the PLMN or the subscribed SNPN as specified in clause 5.2.9, and:
 - 1) the UE is served by NG-RAN and is authorised to perform 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type in the PLMN or the subscribed SNPN as specified in clause 5; or
 - 2) the UE is authorised to perform 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type when not served by NG-RAN as specified in clause 5 and intends to use the provisioned radio resources for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type; and
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the connectivity service to be announced as specified in clause 5.2.9 and the indicated security procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type for the relay service code is supported by the UE as per clause 6.1.3.5.3.1 of 3GPP TS 33.503 [34]; and
 - 2) the user info ID for the 5G ProSe multi-hop layer-3 UE-to-UE relay discovery as specified in clause 5.2.9;

otherwise, the UE is not authorised to perform the announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type.

Figure 8c.2.1.2.2.2.1 illustrates the interaction of the UEs in the announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type.

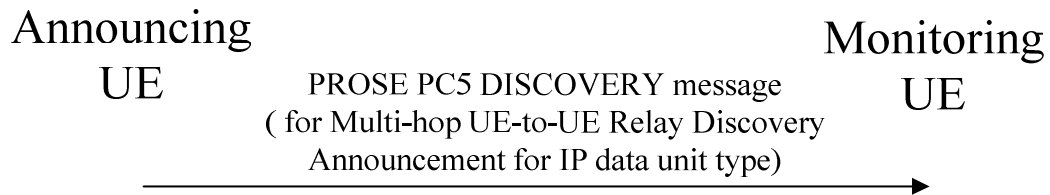


Figure 8c.2.1.2.2.2.1: Announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type

When a UE is triggered by the upper layers to announce the availability of an IP data unit type connectivity service provided by a multi-hop layer-3 UE-to-UE relay, if the UE is authorised to perform the announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages for 5G ProSe multi-hop UE-to-UE relay discovery announcement for IP data unit type as specified in 3GPP TS 38.331 [13], shall perform a service request procedure or mobility registration procedure as specified in 3GPP TS 24.501 [11];
- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time as specified in clause 11.2.5;
- c) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for IP data unit type according to clause 10.2.1. In the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for IP data unit type, the UE:
 - 1) shall set the announcer info parameter to the User info ID configured for the multi-hop layer-3 UE-to-UE relay discovery for IP data unit type, as specified in clause 5.2.9;
 - 2) shall set the relay service code parameter to the relay service code configured for the connectivity service to be announced, as specified in clause 5.2.9;
 - 3) shall include the MIC field computed as described in 3GPP TS 33.503 [34], by using the UTC-based counter and the DUIK contained in the <UUR-discovery-security-parameters-accept> element of the PROSE_SECURITY_PARAM_RESPONSE message, if security procedure over user plane for 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type is used, or the PROSE_SECURITY_MATERIAL_RESPONSE message, if security procedure over control plane for 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type is used;
 - 4) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 5) shall set the ProSe direct discovery PC5 message type IE and ProSe direct discovery PC5 message content type extensions IE as specified in table 11.2.1.1 and table 11.2.1a.1; and
 - 6) shall include the PLMN ID set to its HPLMN ID and in cleartext;

NOTE 0: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 0A: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- d) shall apply the DUIK, DUSK or DUCK with the associated encrypted bitmask for the relay service code for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type, along with the UTC-based counter, to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more above parameters, as specified in clause 6.1.3.5.3.1 of 3GPP TS 33.503 [34];
- e) shall set the destination layer-2 ID to the default destination layer-2 ID as specified in clause 5.2.9 and self-assign a source layer-2 ID for sending the multi-hop layer-3 UE-to-UE relay discovery announcement for IP data unit type; and

NOTE 1: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2, is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2 and is different from any other self-assigned source layer-2 ID in use for a simultaneous 5G ProSe direct discovery procedure over PC5 with a different discovery model as specified in clause 6.2.14.2.2.2, clause 6.2.15.2.2.2, clause 8.2.1.3.1.2, clause 8a.2.1.3.2, clause 8b.2.1.3 and clause 8c.2.1.2.3.

- f) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for IP data unit type to the lower layers for transmission over the PC5 interface with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery.

The UE shall maintain the association(s) between the self-assigned source layer-2 ID and relay service code once generating the PROSE PC5 DISCOVERY message. Each self-assigned source layer-2 ID can be associated with only one relay service code.

The UE shall ensure that it keeps on passing the same PROSE PC5 DISCOVERY message along with the same source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission, until the UE is triggered by the upper layers to stop announcing the availability of a connectivity service provided by the multi-hop layer-3 UE-to-UE relay, or until the UE stops being authorised to perform the announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type. How this is achieved is left up to the UE implementation.

8c.2.1.2.2.2.3 Announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type completion

When an announcing UE is triggered by the upper layers to stop announcing the availability for 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type, or when the announcing UE stops being authorised to perform the announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type, the UE shall instruct the lower layers to stop announcing.

NOTE: The announcing UE can stop announcing UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type for power saving by implementation specific means, e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops announcing, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8c.2.1.2.2.3 Monitoring UE relay discovery for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type

8c.2.1.2.2.3.1 General

The purpose of the monitoring UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type is to enable a ProSe-enabled UE, acting as a 5G ProSe multi-hop layer-3 UE-to-UE relay or a 5G ProSe multi-hop end UE, to become aware of the proximity of a connectivity service provided by another 5G ProSe multi-hop layer-3 UE-to-UE relay, upon a request from upper layers as defined in 3GPP TS 23.304 [2].

8c.2.1.2.2.3.2 Monitoring UE procedure for multi-hop layer-3 UE-to-UE relay discovery initiation for IP data unit type

The UE is authorised to perform the monitoring UE procedure for multi-hop layer-3 UE-to-UE relay discovery if:

- a) the following is true:
 - 1) the UE is not served by NG-RAN, is authorised to perform 5G ProSe multi-hop layer-3 UE-to-UE relay discovery using monitoring when the UE is not served by NG-RAN and is configured with the radio parameters to be used for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type when not served by NG-RAN;
 - 2) the UE is served by NG-RAN and is authorised to perform 5G ProSe layer-3 UE-to-UE relay discovery monitoring in at least one PLMN or the subscribed SNPN; or

3) the UE is:

- i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to perform 5G ProSe multi-hop layer-3 UE-to-UE relay discovery using monitoring when the UE is not served by NG-RAN, and:
 - A) configured with the radio parameters to be used for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery when not served by NG-RAN; and
- b) the UE is configured with the relay service code parameter identifying the connectivity service to be monitored, as specified in clause 5.2.9;

otherwise, the UE is not authorised to perform the monitoring UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type.

Figure 8c.2.1.2.2.3.2.1 illustrates the interaction of the UEs in the monitoring UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type.

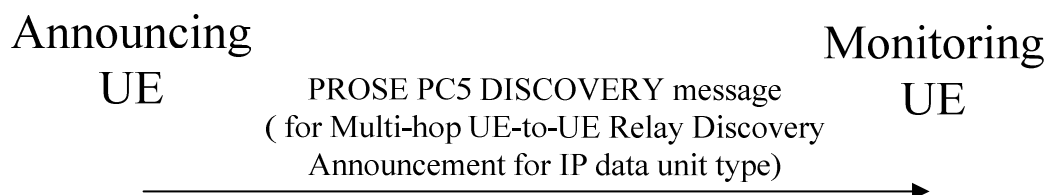


Figure 8c.2.1.2.2.3.2.1: Monitoring UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type

When the UE, acting as a 5G ProSe multi-hop layer-3 UE-to-UE relay or as a 5G ProSe multi-hop end UE, is triggered by the upper layers to monitor the proximity of a connectivity service provided by another 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type, and if the UE is authorised to perform the monitoring UE procedure for multi-hop UE-to-UE relay discovery for IP data unit type, then the UE shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages with the default destination layer-2 ID as specified in clause 5.2.9.

Upon the reception of a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for IP data unit type if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to discover, the UE shall ignore the message. If the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to discover, the UE shall obtain a valid UTC time from the lower layers and generate a UTC-based counter corresponding to this UTC time. The UE shall use the associated DUSK, if received from the 5G DDNMF (if security procedure over control plane for 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type is used) or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type is used) and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to unscramble the PROSE PC5 DISCOVERY message as described in clause 6.1.3.5.3.1 of 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF (if security procedure over control plane for 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type is used) or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type is used), the UE shall use the DUCK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to decrypt the configured message-specific confidentiality-protected portion, as described in clause 6.1.3.5.3.1 of 3GPP TS 33.503 [34]. Finally, if a DUK is received from the 5G DDNMF (if security procedure over control plane for 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type is used) or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type is used), the UE shall use the DUK and

the UTC-based counter associated with the PROSE PC5 DISCOVERY message to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement.

Then if the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for IP data unit type is the same as the relay service code parameter configured as specified in clause 5 for the connectivity service being monitored, the UE shall consider that the connectivity service the UE seeks to monitor has been discovered.

NOTE: This procedure may be used by a 5G ProSe multi-hop end UE or a 5G ProSe multi-hop layer-3 UE-to-UE relay to measure the signal strength of the PROSE PC5 DISCOVERY message from a 5G ProSe multi-hop layer-3 UE-to-UE relay. The measurements could be considered for 5G ProSe multi-hop layer-3 UE-to-UE relay selection/reselection.

8c.2.1.2.2.3.3 Monitoring UE procedure for multi-hop layer-3 UE-to-UE relay discovery completion for IP data unit type

When the UE is triggered by the upper layers to stop monitoring the proximity of 5G ProSe multi-hop layer-3 UE-to-UE relays for 5G ProSe multi-hop layer-3 UE-to-UE relay for IP data unit type, or when the UE stops being authorised to perform the monitoring UE procedure for multi-hop layer-3 UE-to-UE relay discovery for IP data unit type, the UE shall instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8c.2.1.2.3 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for IP data unit type with model B

8c.2.1.2.3.1 General

In the following procedures, the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE sending the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type are called the "discoverer end UE" and. The 5G ProSe multi-hop layer UE-to-UE relay UE sending the corresponding PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for IP data unit type is called the "discoveree relay UE".

8c.2.1.2.3.2 Discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery

8c.2.1.2.3.2.1 General

The purpose of the discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery is:

- a) to enable a ProSe-enabled UE to solicit proximity of a connectivity service provided by a 5G ProSe multi-hop layer-3 UE-to-UE relay UE, upon a request from upper layers; or
- b) to enable a ProSe-enabled UE to measure the PROSE PC5 DISCOVERY message signal strength between the ProSe-enabled UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE(s) for 5G ProSe multi-hop layer-3 UE-to-UE relay selection/reselection.

8c.2.1.2.3.2.2 Discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery initiation

The UE is authorised to perform the discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery if:

- a) one of the following is true:
 - 1) the UE is not served by NG-RAN, is authorised to act as a 5G ProSe multi-hop layer-3 end UE towards a 5G ProSe multi-hop layer-3 UE-to-UE relay UE and is configured with the radio parameters to be used for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery when not served by NG-RAN;

- 2) the UE is served by NG-RAN, is authorised to act as a 5G ProSe multi-hop layer-3 end UE towards a 5G ProSe multi-hop layer-3 UE-to-UE relay UE; or
- 3) the UE is:
 - i) in 5GMM-IDLE mode, in limited service state as specified in 3GPP TS 23.122 [14] and the reason for the UE being in limited service state is one of the following:
 - A) the UE is unable to find a suitable cell in the selected PLMN or the subscribed SNPN as specified in 3GPP TS 38.304 [15];
 - B) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #11 "PLMN not allowed" as specified in 3GPP TS 24.501 [11]; or
 - C) the UE received a REGISTRATION REJECT message or a SERVICE REJECT message with the 5GMM cause #7 "5GS services not allowed" as specified in 3GPP TS 24.501 [11]; and
 - ii) authorised to act as a 5G ProSe multi-hop layer-3 end UE towards a 5G ProSe multi-hop layer-3 UE-to-UE relay UE when the UE is not served by NG-RAN and configured with the radio parameters to be used for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery use when not served by NG-RAN; and
- b) the UE is configured with:
 - 1) the relay service code parameter with the IP traffic type of the relayed service provided by a 5G ProSe multi-hop layer-3 UE-to-UE relay to be solicited as specified in clause 5.2.9 and the indicated security procedure for the relay service code is supported by the UE;

otherwise, the UE is not authorised to perform the discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery.

Figure 8c.2.1.2.3.2.2.1 illustrates the interaction of the UEs in the discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery.

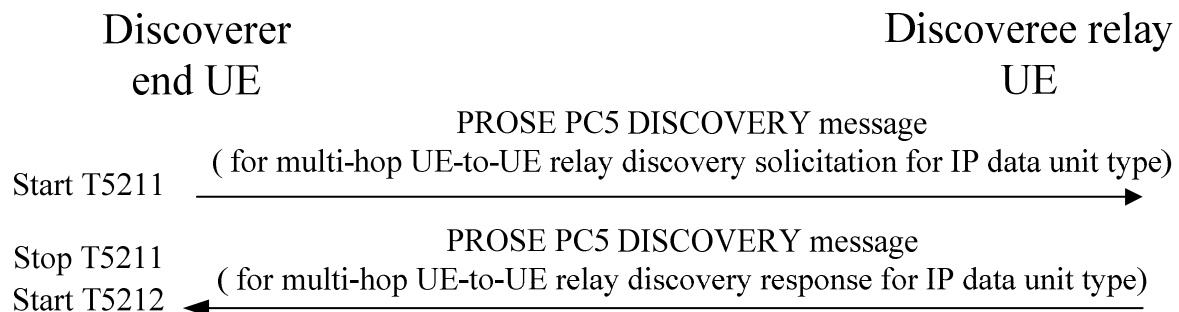


Figure 8c.2.1.2.3.2.2.1: Discoverer end UE procedure for multi-hop layer-3 UE-to-UE Relay discovery

For PROSE PC5 DISCOVERY message signal strength measurement, the UE manages a periodic measurement timer T5212, which is used to trigger the periodic PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE with which the UE has a link established. Timer T5212 is started whenever the UE has established a direct link with a 5G ProSe multi-hop layer-3 UE-to-UE relay UE and restarted whenever the UE receives the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for IP data unit type from the 5G ProSe multi-hop layer-3 UE-to-UE relay UE with which the UE has a link established.

When the UE is triggered by the upper layers to solicit proximity of a connectivity service provided by a 5G ProSe multi-hop layer-3 UE-to-UE relay UE or when the periodic measurement timer T5212 expires and if the UE is authorised to perform the discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages for multi-hop UE-to-UE relay discovery as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11];

- b) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- c) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type. In the PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery solicitation for IP data unit type, the UE:
 - 1) shall set the relay service code parameter to the relay service code parameter identifying the IP connectivity service to be solicited, configured in clause 5.2.9. The security procedure selection is based on the relay service codes configured at the UE;
 - 2) shall include the MIC field computed as described in 3GPP TS 33.503 [34];
 - 3) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 4) shall set the ProSe direct discovery PC5 message type IE and ProSe direct discovery PC5 message content type extensions IE as specified in table 11.2.1.1 and table 11.2.1a.1;
 - 5) shall include the direct discovery set IE which contains the list of protected user infos as follows:
 - i) set the "protected user info 1" field to the protected user info of the discoverer end UE as described in table 11.2.17.1: the user info parameter set to the application layer ID of the discoverer end UE as provided by the upper layers, the corresponding MIC field computed as described in 3GPP TS 33.503 [34] for the discoverer user info, and the corresponding UTC-based counter LSB parameter set to the 4 least significant bits of the UTC-based counter;

and shall apply the DUSK or DUCK, along with the UTC-based counter, and the associated encrypted bitmask in the code-sending security parameter for the ProSe service received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-UE relay is used) as described in clause 6.2, to each of the application layer ID of the end UE as specified in 3GPP TS 33.503 [34];

- 6) shall include the PLMN ID set to the PLMN ID for which the used security parameters are associated and in cleartext; and

NOTE 0: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- 7) may set the Multi-hop UE-to-UE relay UE info parameter to user info ID for the 5G ProSe multi-hop layer-3 UE-to-UE relay UE, if the UE intends to discover a specific 5G ProSe multi-hop layer-3 UE-to-UE relay UE and the UE has the user info ID of the specific 5G ProSe multi-hop layer-3 relay e.g. during previous 5G ProSe multi-hop layer-3 UE-to-UE relay discovery or 5G ProSe multi-hop layer-3 UE-to-UE relay communication procedure(s); and
- e) shall apply the DUIK, DUSK or DUCK with the associated encrypted bitmask for the relay service code for 5G ProSe UE-to-UE relay discovery, along with the UTC-based counter, to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more of the above parameters, as specified in 3GPP TS 33.503 [34];
- f) shall set the destination layer-2 ID to the default destination layer-2 ID as specified in clause 5.2.9 and self-assign a source layer-2 ID for sending the multi-hop layer-3 UE-to-UE relay discovery solicitation message; and
- g) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

If the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type is used to solicit proximity of a connectivity service provided by a 5G ProSe multi-hop layer-3 UE-to-UE relay UE, the UE shall ensure that it keeps on passing the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type for transmission until the UE is triggered by the upper layers to stop soliciting proximity of a connectivity service provided by a 5G ProSe multi-hop layer-3 UE-to-UE relay UE, or until the UE stops being authorised to perform the discoverer end UE procedure for multi-hop layer-3 UE-to-UE relay discovery. How this is achieved is left up to UE implementation.

NOTE 1: The discoverer end UE can stop discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

If the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type is used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE with which the UE has a link established, the UE shall start the retransmission timer T5211. If retransmission timer T5211 expires, the UE shall retransmit the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type and restart timer T5211. If no response is received from the 5G ProSe multi-hop layer-3 UE-to-UE relay UE with which the UE has a link established after reaching the maximum number of allowed retransmissions, the UE shall trigger multi-hop layer-3 UE-to-UE relay reselection procedure.

NOTE 2: The maximum number of allowed retransmissions is UE implementation specific.

If the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for IP data unit type is the same as the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type, then the UE shall consider that the connectivity service the UE seeks to discover has been discovered.

8c.2.1.2.3.2.3 Discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery completion

When the UE is triggered by the upper layers to stop soliciting for proximity of a connectivity service provided by a 5G ProSe multi-hop layer-3 UE-to-UE relay UE, or when the UE stops being authorised to perform the discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery, the UE shall instruct the lower layers to stop the discoverer operation.

NOTE: The discoverer end UE can stop discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops discoverer operation, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8c.2.1.2.3.3 void

8c.2.1.2.3.4 Discoveree relay UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery

8c.2.1.2.3.4.1 General

The purpose of the discoveree relay UE procedure for multi-hop layer-3 UE-to-UE relay discovery is to enable a 5G ProSe multi-hop layer-3 UE-to-UE relay UE to respond to solicitation from other ProSe-enabled UEs on proximity of a connectivity service provided by the 5G ProSe multi-hop layer-3 UE-to-UE relay UE, upon a request from upper layers.

8c.2.1.2.3.4.2 Discoveree relay UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery initiation

The UE is authorised to perform the discoveree relay UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery if:

- a) the UE is authorised to act as a 5G ProSe multi-hop layer-3 UE-to-UE relay UE in the PLMN or the subscribed SNPN indicated by the serving cell, and:
 - 1) the UE is served by NG-RAN; or
 - 2) the UE is not served by NG-RAN and intends to use the provisioned radio resources for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery; and
- b) the UE is configured with:

- 1) the relay service code parameter identifying the connectivity service to be responded to as specified in clause 5.2.9 and the indicated security procedure for the relay service code is supported by the UE;

otherwise, the UE is not authorised to perform the discoverer relay UE procedure for UE-to-UE relay discovery.

Figure 8c.2.1.3.4.2.1 illustrates the interaction of the UEs in the discoverer relay UE procedure for UE-to-UE relay discovery.

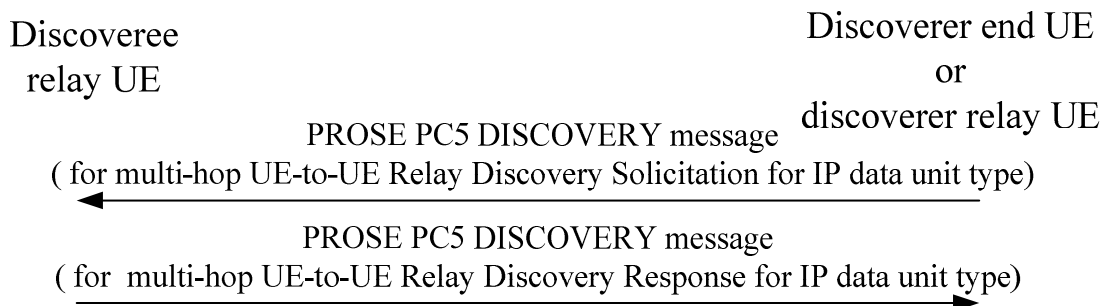


Figure 8c.2.1.3.4.2.1: Discoverer relay UE procedure for multi-hop layer-3 UE-to-UE relay discovery

When the UE is triggered by the upper layers to start responding to solicitation on proximity of a connectivity service for 5G ProSe multi-hop layer-3 UE-to-UE relay and if the UE is authorised to perform the discoverer relay UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11]; and
- b) shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages.

Upon reception of a PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery solicitation if the received PLMN ID in the message is not associated with the target relay service code of the connectivity service which the UE is authorized to respond, the UE shall ignore the message.

Upon reception of a PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery solicitation, if the received PLMN ID in the message is associated with the target relay service code of the connectivity service which the UE is authorized to respond, the UE shall obtain a valid UTC time from the lower layers and generate a UTC-based counter corresponding to this UTC time, and use it to recover the UTC-based counter associated with the PROSE PC5 DISCOVERY message and the UTC-based counter associated with the direct discovery set. The UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-UE relay is used) and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe UE-to-UE relay is used), the UE shall use the DUCK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-UE relay is used), the UE shall use the DUIK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery solicitation.

The UE shall further use the DUSK in code-receiving security parameter for the ProSe service which the UE is authorized for discovery (see clause 6.2.6) and the UTC-based counter associated with the direct discovery set to unscramble the direct discovery set IE in the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then if a DUCK is included in the code-receiving security parameter, the UE shall use the DUCK and the UTC-based counter associated with the direct discovery set to decrypt the direct discovery set IE, as described in 3GPP TS 33.503 [34]. The UE shall verify whether the application layer ID of the discoverer end UE in the decrypted direct discovery set matches the application layer ID of the UE as provided by the upper layers; if not, the UE shall discard the PROSE PC5 DISCOVERY message. Finally, if the application layer IDs match and a DUIK is included in the code-receiving security parameter, the UE shall use the DUIK and the UTC-based counter associated with the direct discovery set to verify the MIC for the direct discovery set IE in the PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery solicitation.

NOTE 1: The UE can determine the received PROSE PC5 DISCOVERY message for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery solicitation is for 5G ProSe direct discovery based on an indication from the lower layer.

Then, if:

- a) the relay service code parameter of the received PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery solicitation for IP data unit type is the same as the relay service code parameter configured as specified in clause 5.2.9 for the connectivity service and:
 - 1) the multi-hop UE-to-UE relay UE info parameter in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type is the same as the user info ID of the UE provided by upper layers; or
 - 2) the multi-hop UE-to-UE relay UE info parameter is not included in the received PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery solicitation for IP data unit type and the UE determines to responds to the multi-hop UE-to-UE relay discovery solicitation for IP data unit type for the relay service code,

then the UE:

- a) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- b) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for IP data unit type in which the UE:
 - 1) shall set the Multi-hop UE-to-UE relay UE info parameter to the user info ID of the UE provided by the upper layers for 5G ProSe multi-hop layer-3 UE-to-UE relay;
 - 2) shall include the direct discovery set IE which contains the discoverer user info parameter set to the application layer ID of the discoverer end UE or the discoverer relay UE received in the PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery solicitation, the corresponding MIC field computed as described in 3GPP TS 33.503 [34] for the discoverer user info, and the corresponding UTC-based counter LSB parameter set to the 4 least significant bits of the UTC-based counter;

and shall apply the DUSK or DUCK, along with the UTC-based counter, and the associated encrypted bitmask in the code-sending security parameter for the ProSe service received from the 5G DDNMF or 5G PKMF (if security procedure over user plane for 5G ProSe multi-hop UE-to-UE relay is used) as described in clause 6.2, to each of the application layer ID of the UE as specified in 3GPP TS 33.503 [34];
 - 3) shall set the relay service code parameter to the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery solicitation for IP data unit type;
 - 4) shall include the MIC field computed as described in 3GPP TS 33.503 [34];
 - 5) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
 - 6) shall set the ProSe direct discovery PC5 message type IE and ProSe direct discovery PC5 message content type extensions IE as specified in table 11.2.1.1 and table 11.2.1a.1; and
 - 7) shall include the PLMN ID set to the PLMN ID for which the used security parameters are associated and in cleartext;

NOTE 2: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- c) shall apply the DUIK, DUSK, or DUCK with the associated encrypted bitmask for the relay service code for 5G ProSe multi-hop UE-to-UE relay discovery, along with the UTC-based counter, to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more of the above parameters, as specified in 3GPP TS 33.503 [34];
- d) shall set the destination layer-2 ID to the source layer-2 ID from the 5G ProSe UE-to-UE relay UE used in the transportation of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type;

- e) shall set the source layer-2 ID to the self-assigned source layer-2 ID; and
- f) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for IP data unit type along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

8c.2.1.2.3.4.3 Discoveree relay UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery completion

When the UE is triggered by the upper layers to stop responding to solicitation on proximity of a connectivity service provided by a 5G ProSe multi-hop layer-3 UE-to-UE relay UE, or when the UE stops being authorised to perform the Discoveree relay UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery, the UE shall instruct the lower layers to stop monitoring.

NOTE: The 5G ProSe multi-hop layer-3 UE-to-UE relay UE can stop Discoveree relay UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for power saving by implementation specific means e.g. an implementation-specific maximum number of 5G ProSe direct links configured in the UE, or an implementation-specific timer expires.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8c.2.1.3 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for Ethernet and unstructured data unit type

8c.2.1.3.1 General

This clause specifies the procedures of 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for Ethernet and unstructured data unit type including:

- a) 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for Ethernet and unstructured data unit type with model A (see clause 8c.2.1.3.2); and
- b) 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for Ethernet and unstructured data unit type with model B (see clause 8c.2.1.3.3).

The 5G ProSe multi-hop layer-3 end UEs shall use the security materials provisioned by PC3a control protocol procedures for 5G ProSe direct discovery as specified in clause 6.2 to protect a direct discovery set so that the direct discovery set is transparent to the 5G ProSe multi-hop layer-3 UE-to-UE relay UE. The 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall use the security materials provisioned by 5G ProSe security procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay as specified in clause 8c.2.5 and clause 8c.2.6 to protect the PROSE PC5 DISCOVERY messages for multi-hop UE-to-UE relay discovery for Ethernet and unstructured data unit type.

8c.2.1.3.2 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for Ethernet and unstructured data unit type with model A

8c.2.1.3.2.1 General

In this procedure, both 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE may act as the "monitoring UE" to monitor the related announcement message sent by the 5G ProSe multi-hop layer-3 UE-to-UE relay UE acting the "announcing UE" as specified in clause 6.3.2.6.3 of 3GPP TS 23.304 [2].

8c.2.1.3.2.2 Announcing UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery

8c.2.1.3.2.2.1 General

For Ethernet and unstructured data unit type, the purpose as described in clause 8c.2.1.2.2.2.1 applies with following addition:

- a) to enable a ProSe-enabled UE to announce availability of a connectivity service provided by a 5G ProSe multi-hop layer-3 UE-to-UE relay of the ProSe-enabled UE to other ProSe-enabled UEs (e.g. List of multi-hop UE-to-UE relay paths) as specified in clause 6.3.2.6.3 of 3GPP TS 23.304 [2].

8c.2.1.3.2.2.2 Announcing UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery initiation

For Ethernet and unstructured data unit type, the procedure as specified in clause 8c.2.1.2.2.2.2 applies with following differences and clarifications:

- a) the UE is configured with the relay service code parameter with the Ethernet or Unstructured traffic type of the relayed service to be announced and the indicated security procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay for the relay service code is supported by the UE as per clause 6.1.3.5.3.2 of 3GPP TS 33.503 [34];
- b) the UE shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for Ethernet and unstructured data unit type according to clause 10.2.1. In the PROSE PC5 DISCOVERY message, the UE
 - 1) shall set the Multi-hop UE-to-UE relay UE info to the User info ID configured for the multi-hop layer-3 UE-to-UE relay discovery for Ethernet and unstructured data unit type, as specified in clause 5.2.9;
 - 2) shall include the List of multi-hop UE-to-UE relay paths IE defined in clause 11.2.24 and set each path info field in the List of multi-hop UE-to-UE relay paths IE as follows:
 - i) shall set the List of protected user infos field to the list of stored protected user info of 5G ProSe multi-hop layer-3 end UE(s) of which share the path of relays and are associated with the same relay service code to be announced;
 - ii) shall set the Path of relays field to the list of intermediate 5G ProSe multi-hop layer-3 UE-to-UE relays that need to be traversed to reach the 5G ProSe multi-hop layer-3 end UE(s) as indicated in the list of protected user infos field; and
 - iii) may set the hop limit parameter to a value smaller than the maximum number of hops as specified in clause 5.2.9.

8c.2.1.3.2.2.3 Announcing UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery completion

For Ethernet and unstructured data unit type, the procedure as specified in clause 8c.2.1.2.2.2.3 applies with following addition:

- a) when none of the List of multi-hop UE-to-UE relay paths IE to be announced is available, the UE shall instruct the lower layers to stop announcing.

8c.2.1.3.2.3 Monitoring UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery

8c.2.1.3.2.3.1 General

The purpose of the monitoring UE procedure for multi-hop layer-3 UE-to-UE relay discovery for Ethernet and unstructured data unit type is to enable a ProSe-enabled UE, acting as a 5G ProSe multi-hop layer-3 UE-to-UE relay UE or a 5G ProSe multi-hop layer-3 end UE, to become aware of the proximity of a connectivity service provided by another 5G ProSe multi-hop layer-3 UE-to-UE relay, upon a request from upper layers as defined in 3GPP TS 23.304 [2].

8c.2.1.3.2.3.2 Monitoring UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery initiation

For Ethernet and unstructured data unit type, the procedure as specified in clause 8c.2.1.2.2.3.2 applies with following differences and clarifications:

- a) the UE is configured with the relay service code parameter with the Ethernet or Unstructured traffic type of the relayed service to be monitored as specified in clause 5.2.9;

- b) if the UE is acting as the 5G ProSe multi-hop layer-3 UE-to-UE relay, upon reception of a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for Ethernet and unstructured data unit type, the UE shall proceed with each Path info field in the List of multi-hop UE-to-UE relay paths IE as follows:
- 1) if the path of relays field associated with the protected user info includes the user info ID of the UE itself, the UE shall discard this path info field and proceed to the next path info field, if any;
 - 2) if the path of relays field associated with the protected user info does not include the user info ID of the UE itself and the value of hop count is less than the value of the hop limit, the UE shall add UE's own user info ID into to the path relays field and increase the hop count by 1;
 - 3) if the UE already has the locally stored information of path of relays associated with the protected user info and the value of the hop count in the locally stored path info is less than or equal to the value of the hop count in the received path info field, UE may add the locally stored path of relays associated with the protected user info into the List of multi-hop UE-to-UE relay paths IE; and

NOTE: If the UE already has the locally stored information of the path of relays associated with the protected user info and the value of the hop count in the locally stored path info is more than the value of the hop count in the received path info field, UE can replace the stored information of the path of relays associated with the protected user info with the received path info field of the protected user info.

- 4) the UE shall include the List of multi-hop UE-to-UE relay paths IE updated as specified in 1), 2) and 3) as above in a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for Ethernet and unstructured data unit type and send the PROSE PC5 DISCOVERY message as specified in clause 8c.2.1.3.2.2.2.

8c.2.1.3.2.3.3 Monitoring UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery completion

For Ethernet and unstructured data unit type, the procedure as specified in clause 8c.2.1.2.2.3.3 applies.

8c.2.1.3.3 5G ProSe multi-hop layer-3 UE-to-UE relay discovery for Ethernet and unstructured data unit type with model B

8c.2.1.3.3.1 General

In the following procedures:

- a) the source 5G ProSe multi-hop layer-3 end UE sending the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type are called the "discoverer end UE";
- b) the 5G ProSe multi-hop layer-3 UE-to-UE relay UE sending the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type based on the received PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type from other 5G ProSe multi-hop layer-3 UE-to-UE relay UE or 5G ProSe multi-hop layer-3 end UE are called the "discoverer relay UE"; and
- c) the target 5G ProSe multi-hop layer-3 end UE sending the corresponding PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type is called the "discoveree end UE".

8c.2.1.3.3.2 Discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery

8c.2.1.3.3.2.1 General

For Ethernet and unstructured data unit type, the purpose described in clause 8c.2.1.2.3.2.1 applies with following addition:

- a) to enable a ProSe-enabled UE to discover the path between the source 5G ProSe multi-hop layer-3 end UE and the target 5G ProSe multi-hop layer-3 end UE.

8c.2.1.3.3.2.2 Discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery initiation

For Ethernet and unstructured data unit type, the procedure specified in clause 8c.2.1.2.3.2.2 applies with following differences and clarifications:

- a) the UE is configured with the relay service code parameter with the Ethernet or Unstructured traffic type of the relayed service provided by a 5G ProSe multi-hop layer-3 UE-to-UE relay to be solicited as specified in clause 5.2.9;
- b) in the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type, the UE shall include the List of multi-hop UE-to-UE relay paths IE as defined in clause 11.2.24. In the List of multi-hop UE-to-UE relay paths IE:
 - 1) only "Path info #1" is included;
 - 2) the Hop count field in the "Path info #1" is set to 0; and
 - 3) the list of protected user infos field in the "Path info #1" only includes the protected user info of the source 5G ProSe multi-hop layer-3 end UE;
 - 4) the value of the length of the path of relays field in the "Path info #1" is set to 0; and
 - 5) the "HL" bit is set to 1 and the hop limit field is included if the required hop limit by the 5G ProSe multi-hop layer-3 end UE for the 5G ProSe multi-hop layer-3 UE-to-UE relay service is less than the maximum number of hops for the relay service code as configured in clause 5.2.9; and
- c) if the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery response for Ethernet and unstructured data unit type is the same as the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type, then the UE shall consider that the target 5G ProSe multi-hop layer-3 end UE the UE seeks has been discovered.

8c.2.1.3.3.2.3 Discoverer end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery completion

For Ethernet and unstructured data unit type, the procedure specified in clause 8c.2.1.2.3.2.3 applies.

8c.2.1.3.3.3 Discoverer relay UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery

For Ethernet and unstructured data unit type, the procedure specified in clause 8a.2.1.3.3.2 applies with following differences and clarification:

- a) if the relay service code parameter of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type is the same as the relay service code parameter configured as specified in clause 5.2.9 for the connectivity service, the discoverer relay UE determines to send the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type upon receipt of a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type from the source 5G ProSe multi-hop layer-3 end UE or other 5G ProSe multi-hop layer-3 UE-to-UE relay UE.

For the received List of multi-hop UE-to-UE relay paths IE, if:

- 1) the value of the hop count field is less than the hop limit as described in clause 6.3.2.6.3.2 of 3GPP TS 23.304 [2]; and
- 2) the user info ID of the discoverer relay UE is not listed in the "Path of relays" field, if any,

the UE shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type and set the PROSE PC5 DISCOVERY message as specified in clause 8c.2.1.3.3.2.2 with following differences:

- i) shall update received List of multi-hop UE-to-UE relay paths IE as follows:

- the Hop count field is increased by 1;
- add the user info ID of the discoverer relay UE to the "Path of relays" as described in table 11.2.24.2;
- update the value of the length of the path of relays field accordingly;
- if the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type is from the source 5G ProSe multi-hop layer-3 end UE, the UE shall set the SL2I bit to "Source layer-2 ID of the discoverer end UE is present" and include the source layer-2 ID of the the source 5G ProSe multi-hop layer-3 end UE in the "Source layer-2 ID of the discoverer end UE" field; and

ii) shall include the updated List of multi-hop UE-to-UE relay paths IE in the PROSE PC5 DISCOVERY message.

otherwise, UE shall drop the received PROSE PC5 DISCOVERY message;

- b) if the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type is the same as the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type, and the user info ID of the discoverer relay UE is listed in the "Path of relays" field, the UE shall forward PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type as specified in 6.3.2.6.3.2 of 3GPP TS 23.304 [2].

The UE shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages for multi-hop layer-3 UE-to-UE relay discovery response from the discoverer end UE or other discoverer relay UE.

Upon reception of a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type, for the target relay service code of the connectivity service which the UE is authorized to respond, the UE shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF and the UTC-based counter obtained during the reception operation to unscramble the PROSE PC5 DISCOVERY message as described in 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF, the UE shall use the DUCK and the UTC-based counter to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF or 5G PKMF, the UE shall use the DUIK and the UTC-based counter to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type.

If the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type is the same as the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit, then the UE:

- a) shall obtain a valid UTC time for the discovery transmission from the lower layers and generate the UTC-based counter corresponding to this UTC time;
- b) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type. In the PROSE PC5 DISCOVERY message, the UE:
 - 1) shall set the List of multi-hop UE-to-UE relay paths IE to the List of multi-hop UE-to-UE relay paths as included in the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response;
 - 2) shall set the Discoverer info to the configured user info ID for the 5G ProSe multi-hop layer-3 UE-to-UE relay discovery, as specified in clause 5.2.9;
 - 3) shall set the Discoverer info to the Discoverer info as included in the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response;
 - 4) shall set the relay service code parameter to the relay service code parameter of the received PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type;
 - 5) shall include the MIC field computed as described in 3GPP TS 33.503 [34];
 - 6) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;

- 7) shall set the ProSe direct discovery PC5 message type parameter and the ProSe direct discovery PC5 message content type extensions as specified in table 10.2.1.24; and
- 8) shall include the PLMN ID set to its HPLMN ID and in cleartext;

NOTE 1: The confidentiality security mechanism ensures that the PLMN ID IE is not encrypted as specified in 3GPP TS 33.503 [34]. Also the scrambling security mechanism ensures that the PLMN ID IE is not scrambled as specified in 3GPP TS 33.503 [34].

NOTE 2: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- c) shall apply the DUIK, DUSK, or DUCK with the associated encrypted bitmask for the relay service code for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery, along with the UTC-based counter to the PROSE PC5 DISCOVERY message for whichever security mechanism(s) configured to be applied, e.g., integrity protection, message scrambling or confidentiality protection of one or more of the above parameters, as specified in 3GPP TS 33.503 [34]; and
- d) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

8c.2.1.3.3.4 Discoveree end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery

8c.2.1.3.3.4.1 General

The purpose of the discoveree end UE procedure for multi-hop layer-3 UE-to-UE relay discovery is to enable the target 5G ProSe multi-hop layer-3 end UE to respond to solicitation from other ProSe-enabled UEs on proximity of a connectivity service via a 5G ProSe UE-to-UE relay UE and discover the path between the source 5G ProSe multi-hop layer-3 end UE and the target 5G ProSe multi-hop layer-3 end UE, upon a request from upper layers.

8c.2.1.3.3.4.2 Discoveree end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery initiation

The UE is authorised to perform the discoveree end UE procedure for multi-hop layer-3 UE-to-UE relay discovery if:

- a) the UE is authorised to act as a 5G ProSe multi-hop layer-3 end UE in the PLMN or the subscribed SNPN indicated by the serving cell, and:
 - 1) the UE is served by NG-RAN; or
 - 2) the UE is not served by NG-RAN and intends to use the provisioned radio resources for multi-hop layer-3 5G ProSe UE-to-UE relay discovery; and
- b) the UE is configured with:
 - 1) the relay service code parameter identifying the non-IP connectivity service to be responded to as specified in clause 5.2.9 and the indicated security procedure for the relay service code is supported by the UE;

otherwise, the UE is not authorised to perform the discoveree end UE procedure for multi-hop UE-to-UE relay discovery.

Figure 8c.2.1.3.3.4.2.1 illustrates the interaction of the UEs in the discoveree end UE procedure for multi-hop layer-3 UE-to-UE relay discovery.

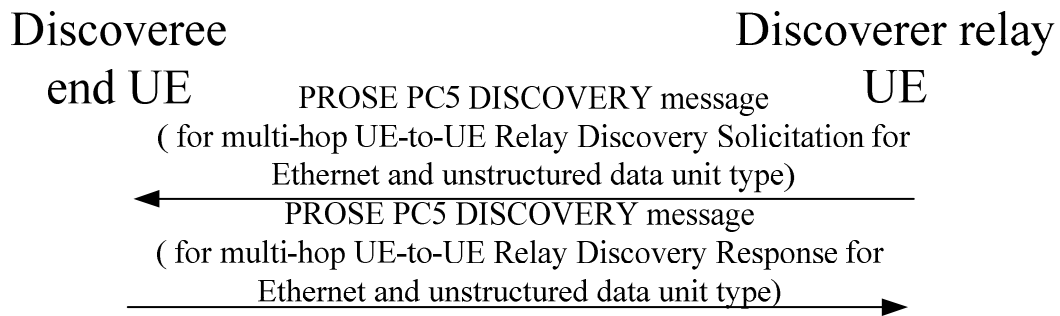


Figure 8c.2.1.3.3.4.2.1: Discoveree end UE procedure for multi-hop layer-3 UE-to-UE relay discovery

When the UE is triggered by the upper layers to start responding to solicitation on proximity of a connectivity service provided by a 5G ProSe multi-hop layer-3 UE-to-UE relay UE and if the UE is authorised to perform the discoveree end UE procedure for multi-hop layer-3 UE-to-UE relay discovery, then the UE:

- a) if the UE is served by NG-RAN and the UE in 5GMM-IDLE mode needs to request resources for sending PROSE PC5 DISCOVERY messages as specified in 3GPP TS 38.331 [13], shall perform a service request procedure as specified in 3GPP TS 24.501 [11]; and
- b) shall instruct the lower layers to start monitoring for PROSE PC5 DISCOVERY messages.

Upon reception of a PROSE PC5 DISCOVERY message for multi-hop layer-3 UE-to-UE relay discovery solicitation, if:

- a) the received PLMN ID in the message is not associated with the relay service code parameter configured as specified in clause 5.2.9 for the connectivity service, the UE shall ignore the message. If the received PLMN ID in the message is associated with the relay service code parameter configured as specified in clause 5.2.9 for the connectivity service and the relay service code parameter of the received message is the same as the relay service code parameter configured as specified in clause 5.2.9 for the connectivity service; and
- b) the Target discoveree info IE containing the User info ID of the discoveree end UE in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type is the same as the User info ID of the UE provided by upper layers;

the UE:

- a) shall obtain a valid UTC time for the discovery transmission from the lower layers, generate the UTC-based counter corresponding to this UTC time. Then the UE shall use the generated the UTC-based counter to recover the UTC-based counter associated with the PROSE PC5 DISCOVERY message and the UTC-based counter associated with the list of protected user infos in the received List of multi-hop UE-to-UE relay paths IE;
- b) shall use the associated DUSK, if received from the 5G DDNMF or 5G PKMF and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to unscramble the PROSE PC5 DISCOVERY message as described in clause 6.1.3.5.3.2 of 3GPP TS 33.503 [34]. Then, if a DUCK is received from the 5G DDNMF or 5G PKMF, the UE shall use the DUCK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to decrypt the configured message-specific confidentiality-protected portion, as described in 3GPP TS 33.503 [34]. Finally, if a DUIK is received from the 5G DDNMF or 5G PKMF, the UE shall use the DUIK and the UTC-based counter associated with the PROSE PC5 DISCOVERY message to verify the MIC field in the unscrambled PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation;
- c) shall generate a PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type in which the UE:
 - 1) shall include the List of multi-hop UE-to-UE relay paths IE in the received PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type;
 - 2) shall set the relay service code parameter to the relay service code parameter of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type;
 - 3) shall include the MIC field computed as described in 3GPP TS 33.503 [34];

- 4) shall set the UTC-based counter LSB parameter to the 4 least significant bits of the UTC-based counter;
- 5) shall set the ProSe direct discovery PC5 message type IE and ProSe direct discovery PC5 message content type extensions IE as specified in table 11.2.1.1 and table 11.2.1a.1;
- 6) shall set the Discoveree info to the configured user info ID for the 5G ProSe multi-hop layer-3 UE-to-UE relay discovery, as specified in clause 5.2.9;
- 7) shall set the Discoverer info to the Discoverer info as included in the received PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response; and
- 8) shall include the PLMN ID set to the PLMN ID for which the used security parameters are associated and in cleartext;

NOTE 1: For SNPN, the PLMN ID IE includes the PLMN ID of the subscribed SNPN.

- d) shall set the destination layer-2 ID to the source layer-2 ID from the 5G ProSe multi-hop layer-3 UE-to-UE relay UE used in the transportation of the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type and self-assign a source layer-2 ID for sending the multi-hop UE-to-UE relay discovery response message for Ethernet and unstructured data unit type; and

NOTE 2: The UE implementation ensures that the value of the self-assigned source layer-2 ID is different from any other self-assigned source layer-2 ID(s) in use for 5G ProSe direct communication as specified in clause 7.2 and is different from any other provisioned destination layer-2 ID(s) as specified in clause 5.2.

- e) shall pass the resulting PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type along with the source layer-2 ID, destination layer-2 ID and an indication that the message is for 5G ProSe direct discovery to the lower layers for transmission over the PC5 interface.

8c.2.1.3.3.4.3 Discoveree end UE procedure for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery completion

When the UE is triggered by the upper layers to stop responding to solicitation on proximity of a connectivity service via a 5G ProSe multi-hop layer-3 UE-to-UE relay UE, or when the UE stops being authorised to perform the discoveree end UE procedure for multi-hop layer-3 UE-to-UE relay discovery, the UE shall instruct the lower layers to stop monitoring.

When the UE stops monitoring, if the UE is in 5GMM-CONNECTED mode, the UE shall trigger the corresponding procedure in lower layers as specified in 3GPP TS 38.331 [13].

8c.2.2 5G ProSe multi-hop UE-to-UE relay unicast direct communication over PC5 interface

8c.2.2.1 General

The 5G ProSe direct link management procedure for IP based 5G ProSe multi-hop layer-3 UE-to-UE relay is described in clause 8c.2.2.2.

NOTE: For Ethernet and Unstructured traffic encapsulated in IP packet over the IP based 5G ProSe multi-hop layer-3 UE-to-UE relay, 5G ProSe direct link management procedure for IP based 5G ProSe multi-hop layer-3 UE-to-UE relay applies.

Depending on the type of data unit, IP or Ethernet type or Unstructured, different RSC shall be used for 5G ProSe multi-hop layer-3 UE-to-UE relay as defined in clause 5.2.9.

8c.2.2.2 5G ProSe direct link management procedure for IP based 5G ProSe multi-hop layer-3 UE-to-UE relay

The direct communication between 5G ProSe multi-hop layer-3 end UEs and 5G ProSe UE-to-UE relay UE reuses the procedures for unicast mode 5G ProSe direct communication over PC5 described in clause 7.2. In this clause, additions

to the procedures defined for unicast mode 5G ProSe direct communication over PC5 to support IP based 5G ProSe multi-hop layer-3 UE-to-UE relay are described.

NOTE 1: Any modifications needed to the procedures defined for unicast mode 5G ProSe direct communication over PC5 to support the direct communication between 5G ProSe end UEs and 5G ProSe multi-hop UE-to-UE relay UE are described within clause 7.2.

For IP based 5G ProSe multi-hop layer-3 UE-to-UE relay, the 5G ProSe multi-hop UE-to-UE relay UE shall establish an IP-based 5G ProSe direct link with other 5G ProSe multi-hop UE-to-UE relay UEs supporting the same RSC, if available. These 5G ProSe multi-hop UE-to-UE relay UEs shall use Mobile Ad-hoc Network (MANET) based routing protocols, IETF RFC 6130 [60] and IETF RFC 7181 [61]), and form a MANET, where each 5G ProSe direct link is considered as a MANET interface. Each of the 5G ProSe multi-hop UE-to-UE relay UE acts as a MANET router and provides multi-hop forwarding functionality between 5G ProSe multi-hop layer-3 end UEs connected to any of 5G ProSe multi-hop UE-to-UE relay UEs in the MANET.

In order to obtain the IP address/prefix of the target 5G ProSe multi-hop layer-3 end UE, the source 5G ProSe multi-hop layer-3 end UE shall send DNS queries as specified in IETF RFC 1035 [53] to the 5G ProSe multi-hop UE-to-UE relay UE.

Once the 5G ProSe multi-hop UE-to-UE relay UE becomes aware of followings:

- i) the user info of the 5G ProSe multi-hop layer-3 end UE and the hop limit set by the 5G ProSe multi-hop layer-3 end UE based on the 5G ProSe direct link establishment procedure as specified in clause 7.2.2 or the ProSe direct link identifier update procedure as specified in clause 7.2.4; and
- ii) the 5G ProSe multi-hop layer-3 end UE's IP address/prefix based on the IP address allocation procedure as specified in clause 8c.2.4,

in order to propagate the DNS information (i.e. user info of the 5G ProSe multi-hop layer-3 end UE, the associated IP address/prefix) for 5G ProSe multi-hop layer-3 end UE to other 5G ProSe multi-hop UE-to-UE relay UEs connected to the same MANET, the 5G ProSe multi-hop UE-to-UE relay UE shall send either:

- 1) MANET signalling as specified in IETF RFC 7181 [61] to update the MANET routing table of other 5G ProSe multi-hop UE-to-UE relay UEs; or
- 2) the 5G ProSe MANET message including the multi-hop UE-to-UE discovery info which contains a list of MANET end UE info (i.e., application layer Id of the 5G ProSe multi-hop layer-3 end UE) and its IP address accessible via the MANET.

When the 5G ProSe multi-hop UE-to-UE relay UE uses the 5G ProSe MANET message for propagating the DNS information for the 5G ProSe multi-hop layer-3 end UE, the 5G ProSe multi-hop UE-to-UE relay UE shall generate the 5G ProSe MANET message and set the Multi-hop UE-to-UE discovery info parameters in the 5G ProSe MANET message as follows:

- 1) the hop limit of the MANET discovery entry to
 - a) the value of the hop limit received from the 5G ProSe multi-hop layer-3 end UE if the hop limit is provided during the 5G ProSe direct link establishment procedure or the 5G ProSe direct link identifier update procedure; or
 - b) the value of the configured maximum number of hops for the associated relay service code as specified in clause 5.2.9 if the hop limit is not provided by the 5G ProSe multi-hop layer-3 end UE;
- 2) the entry status of the MANET discovery entry to:
 - a) "Addition of MANET end UE" if the 5G ProSe multi-hop UE-to-UE relay UE propagate new DNS information for 5G ProSe multi-hop layer-3 end UE;
 - b) "Update of MANET end UE" if the 5G ProSe multi-hop UE-to-UE relay UE propagate the updated DNS information for 5G ProSe multi-hop layer-3 end UE e.g., new IP address of the 5G ProSe multi-hop layer-3 end UE; or
 - c) "Removal of MANET end UE" if the 5G ProSe multi-hop UE-to-UE relay UE propagate the DNS information for 5G ProSe multi-hop layer-3 end UE to be removed, e.g., due to the release of 5G ProSe direct link with the 5G ProSe multi-hop layer-3 end UE;

- 3) the hop count of the MANET discovery entry to 1;
- 4) the MANET end UE info of the MANET discovery entry to the Application layer ID of the 5G ProSe multi-hop layer-3 end UE end UE info; and
- 5) the MANET end UE IP address of the MANET discovery entry to the IP address of the 5G ProSe multi-hop layer-3 end UE.

When the 5G ProSe multi-hop UE-to-UE relay UE receives the 5G ProSe MANET message including the multi-hop UE-to-UE discovery info parameter, the 5G ProSe multi-hop UE-to-UE relay UE updates its MANET routing table based on the entity status of the MANET discovery entity in the received multi-hop UE-to-UE discovery info parameter of the 5G ProSe MANET message. The 5G ProSe multi-hop UE-to-UE relay UE shall check the hop limit and the hop count of the MANET discovery entry in the received multi-hop UE-to-UE discovery info parameter of the 5G ProSe MANET message, and

- 1) if the value of the hop limit is equal to the value of the hop count, the 5G ProSe multi-hop UE-to-UE relay UE shall not send the MANET discovery entry to other 5G ProSe multi-hop UE-to-UE relay UEs in the MANET; or
- 2) if the value of the hop limit is greater than the value of the hop count, the 5G ProSe multi-hop UE-to-UE relay UE shall update the MANET discovery entry by incrementing the hop count by 1 and include the updated MANET discovery entry in the multi-hop UE-to-UE discovery info parameter of the 5G ProSe MANET message and send the 5G ProSe MANET message to other 5G ProSe multi-hop UE-to-UE relay UEs in the MANET.

NOTE 1A: The 5G ProSe multi-hop UE-to-UE relay UE can consolidate the MANET discovery entry received from another 5G ProSe multi-hop UE-to-UE relay UE and the MANET discovery entry generated by itself into the multi-hop UE-to-UE discovery info parameter.

When the hop limit for the 5G ProSe multi-hop layer-3 end UE changes, e.g., during the 5G ProSe direct link establishment procedure or the 5G ProSe direct link identifier update procedure, the 5G ProSe multi-hop UE-to-UE relay UE shall:

- 1) remove the old MANET discovery entry by including the previous MANET discovery entry for the 5G ProSe multi-hop layer-3 end UE with the entry status "Removal of MANET end UE"; and
- 2) add the new MANET discovery entry by including the MANET discovery entry for the 5G ProSe multi-hop layer-3 end UE with the updated hop limit and the entry status "Addition of MANET end UE".

The 5G ProSe multi-hop UE-to-UE relay UE may use the MPR flooding mechanism as defined in IETF RFC 7181 [61] to send the MANET discovery info message. If the MPR flooding mechanism is not supported in the 5G ProSe multi-hop UE-to-UE relay UE, the 5G ProSe multi-hop UE-to-UE relay UE may send the MANET discovery info message toward all other 5G ProSe multi-hop UE-to-UE relay UE(s), except the one from which the MANET discovery info message was sent.

NOTE 2: If available list of MANET end UE info exceeds the max size of the multi-hop UE-to-UE discovery info, the 5G ProSe multi-hop UE-to-UE relay UE sends another MANET discovery info message for the remaining list of MANET end UE info.

The 5G ProSe multi-hop layer-3 end UE may establish multiple 5G ProSe direct link with different 5G ProSe multi-hop UE-to-UE relay UEs supporting the same RSC to maximize the reachability.

NOTE 3: If a 5G ProSe multi-hop UE-to-UE relay UE supports multiple RSCs, the 5G ProSe multi-hop UE-to-UE relay UE can establish a 5G ProSe direct link per RSC. In this case, the 5G ProSe multi-hop UE-to-UE relay UE operates as separate logical entities in the separate MANET respectively, i.e. the 5G ProSe multi-hop UE-to-UE relay UE as a MANET router does not share the routing table and does not forward traffic across different MANET. These multiple 5G ProSe direct links of the 5G ProSe UE-to-UE relay UE can share the same IP address, as they are isolated to each MANET. Similarly, the 5G ProSe multi-hop end UE can have separate logical entities and separate routing tables, each associated with a specific RSC as well.

8c.2.3 DNS-based discovery of target 5G ProSe end UE in 5G ProSe multi-hop layer-3 UE-to-UE relay procedure for IP communication

The source 5G ProSe end UE discovers the IP address/prefix of the target 5G ProSe end UE by sending the DNS queries to its peer UE (i.e. the 5G ProSe multi-hop layer-3 UE-to-UE relay UE).

The 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall support DNS server functionality. Once the 5G ProSe multi-hop layer-3 UE-to-UE relay UE is aware of the IP address/prefix of the 5G ProSe end UE after IP address allocation for 5G ProSe layer-3 end UE in 5G ProSe multi-hop layer-3 UE-to-UE relay procedure as specified in clause 8c.2.4, the 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall generate and store the DNS information related to the 5G ProSe end UE (i.e. the user info ID and associated IP address/prefix of the of the 5G ProSe end UE) into its DNS entries. The DNS information generated by the 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall be distributed to other 5G ProSe multi-hop layer-3 UE-to-UE relay UE as described in clause 8c.2.2.

8c.2.4 IP address allocation for 5G ProSe multi-hop layer-3 end UE in 5G ProSe multi-hop layer-3 UE-to-UE relay procedure

IP address allocation for 5G ProSe multi-hop layer-3 end UE in 5G ProSe multi-hop layer-3 UE-to-UE relay procedure is performed as specified in clause 5.14.3.2 of 3GPP TS 23.304 [2] in one of the following ways:

- a) the 5G ProSe multi-hop layer-3 end UE is configured with a static IPv4 address, a static IPv6 prefix or both associated with the RSC; or
- b) the 5G ProSe multi-hop layer-3 end UE obtains an IPv4 address, an IPv6 prefix or both associated with the RSC during the procedure of 5G ProSe direct link establishment for 5G ProSe direct communication between the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE.

For a), the 5G ProSe multi-hop layer-3 end UE may set the List of source end UE IP addresses IE to the static IPv4 address or IPv6 prefix or both in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message so that the target UE (i.e. the 5G ProSe multi-hop layer-3 UE-to-UE relay UE) can be aware of the IP address of the 5G ProSe multi-hop layer-3 end UE.

For b), the IP address allocation mechanisms of unicast mode of 5G ProSe direct communication over PC5 as described in clause 7.2.2.3 and clause 7.2.10.3 are reused between the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE.

8c.2.5 5G ProSe security procedures over PC8 interface

8c.2.5.1 General

8c.2.5.1.1 Transport protocol for PC8 messages

The transport protocol for PC8 messages are the same as described in clause 8.2.10.1.1.

8c.2.5.1.2 Handling of UE-initiated procedures

The handling of UE-initiated procedures are the same as described in clause 8.2.10.1.2.

8c.2.5.2 Procedures

The following procedures are defined:

- a) 5G ProSe multi-hop layer-3 UE-to-UE relay discovery security parameters request procedure;
- b) 5G ProSe multi-hop end UE key request procedure; and
- c) 5G ProSe multi-hop layer-3 UE-to-UE relay UE key request procedure.

The 5G ProSe multi-hop layer-3 UE-to-UE relay discovery security parameters request procedure reuses the 5G ProSe UE-to-UE relay discovery security parameters request procedure as described in clause 8a.2.12.2.2, where the 5G ProSe

UE-to-UE relay UE is replaced by the 5G ProSe multi-hop UE-to-UE relay UE and the 5G ProSe end UE is replaced by the 5G ProSe multi-hop end UE.

The 5G ProSe multi-hop end UE key request procedure reuses the 5G ProSe end UE key request procedure as described in clause 8a.2.12.2.3, where the 5G ProSe UE-to-UE relay UE is replaced by the 5G ProSe multi-hop UE-to-UE relay UE and the 5G ProSe end UE is replaced by the 5G ProSe multi-hop end UE.

The 5G ProSe multi-hop layer-3 UE-to-UE relay UE key request procedure reuses the 5G ProSe UE-to-UE relay UE key request procedure as described in clause 8a.2.12.2.4, where the 5G ProSe UE-to-UE relay UE is replaced by the 5G ProSe multi-hop UE-to-UE relay UE and the 5G ProSe end UE is replaced by the 5G ProSe multi-hop end UE.

8c.2.6 5G ProSe security procedures over PC3a interface

8c.2.6.1 General

8c.2.6.1.1 Transport protocol for PC3a messages

The transport protocol for PC3a messages is the same as described in clause 8.2.12.1.1.

8c.2.6.1.2 Handling of UE-initiated procedures

The handling of UE-initiated procedures is the same as described in clause 8.2.12.1.2.

8c.2.6.2 Procedures

The following procedures are defined:

- a) 5G ProSe multi-hop layer-3 UE-to-UE relay discovery security material request procedure.

In the following descriptions of 5G procedures over PC3a interface, the terms "request" and "response" refer to the corresponding PC3a messages, not to the HTTP request or response. The following procedure descriptions use a single PC3a message for illustration purposes.

The PC3a control protocol procedures for 5G ProSe UE-to-UE relay discovery shall be integrity protected and confidentiality protected using the security procedures defined in clause 5.2.3 in 3GPP TS 33.503 [34].

NOTE: A single HTTP request message can contain multiple PC3a control protocol requests and a single HTTP response message can contain multiple PC3a control protocol responses.

When the TLS tunnel between the UE and the 5G DDNMF for transport of PC3a messages is established by the UE according to 3GPP TS 33.503 [34], the 5G DDNMF shall obtain identity of the served UE using the procedures specified in 3GPP TS 33.220 [46] or 3GPP TS 33.535 [47].

The 5G ProSe multi-hop layer-3 UE-to-UE relay discovery security material request procedure reuses the 5G ProSe UE-to-UE relay discovery security material request procedure as described in clause 8a.2.11.2.2, where the 5G ProSe UE-to-UE relay UE is replaced by the 5G ProSe multi-hop UE-to-UE relay UE and the 5G ProSe end UE is replaced by the 5G ProSe multi-hop end UE.

8c.2.7 QoS handling for 5G ProSe multi-hop UE-to-UE relay

8c.2.7.1 General

This clause describes the QoS handling between two 5G ProSe multi-hop end UEs through one or more 5G ProSe multi-hop UE-to-UE relay UE. The purpose of QoS handling for 5G ProSe multi-hop UE-to-UE relay is to meet the end-to-end QoS requirement between two 5G ProSe multi-hop end UEs.

The QoS handling for 5G ProSe multi-hop layer-3 UE-to-UE relay for Ethernet and unstructured data unit type is specified in clause 8c.2.7.2.

8c.2.7.2 QoS handling for 5G ProSe layer-3 UE-to-UE relay for Ethernet and unstructured data unit type

8c.2.7.2.1 General

The QoS handling by 5G ProSe multi-hop layer-3 UE-to-UE relay UEs to achieve an end-to-end QoS between two 5G ProSe multi-hop layer-3 end UEs for Ethernet and unstructured data unit type is specified in clause 5.6.3.1 of 3GPP TS 23.304 [2].

For a source 5G ProSe multi-hop layer-3 end UE, the end-to-end QoS requirement between the source 5G ProSe multi-hop layer-3 end UE and the target 5G ProSe multi-hop layer-3 end UE can be satisfied by the corresponding QoS control:

- a) QoS control between the source 5G ProSe multi-hop layer-3 end UE and the first 5G ProSe layer-3 UE-to-UE relay UE in the 5G ProSe multi-hop UE-to-UE relay path (first hop PC5 QoS control); and
- b) QoS control between each 5G ProSe multi-hop layer-3 UE-to-UE relay UE and the target 5G ProSe multi-hop layer-3 end UE over the rest of the 5G ProSe multi-hop UE-to-UE relay path (rest of path PC5 QoS control).

8c.2.7.2.2 PC5 QoS flows handling initiated by the source ProSe multi-hop layer-3 end UE

For PC5 QoS flows setup or modification initiated by the source 5G ProSe multi-hop layer-3 end UE, the source 5G ProSe multi-hop layer-3 end UE shall provide the PC5 QoS flow context as defined in clause 7.2.7 to the first 5G ProSe multi-hop layer-3 UE-to-UE relay UE to indicate the end-to-end QoS requirements for the traffic transmission between the source 5G ProSe multi-hop layer-3 end UE and the target 5G ProSe multi-hop layer-3 end UE, using 5G ProSe direct link security mode control procedure as specified in clause 7.2.10 or 5G ProSe direct link modification procedure as specified in clause 7.2.3.

In addition, if the source 5G ProSe multi-hop layer-3 end UE wants to add new PC5 QoS flow(s) or modify the existing PC5 QoS flow(s), the source 5G ProSe multi-hop layer-3 end UE may also provide the PC5 QoS rule(s) for the PC5 QoS flow(s) to be added or modified to the first 5G ProSe multi-hop layer-3 UE-to-UE relay UE, using 5G ProSe direct link establishment procedure as specified in clause 7.2.2 or 5G ProSe direct link modification procedure as specified in clause 7.2.3.

Upon reception of the PC5 QoS flow context from the previous hop, which may be the source 5G ProSe multi-hop layer-3 end UE or another 5G ProSe multi-hop layer-3 UE-to-UE relay UE, the 5G ProSe multi-hop layer-3 UE-to-UE relay UE:

- a) shall split the PC5 QoS parameters received in the PC5 QoS flow context from the previous hop into
 - 1) the PC5 QoS parameters of the previous hop, for the previous hop PC5 QoS control, and
 - 2) the PC5 QoS parameters from itself to the target 5G ProSe multi-hop layer-3 end UE, for the rest of path PC5 QoS control

NOTE: The upper bound for the per-hop packet delay budget is determined by equally splitting the end-to-end packet delay budget among the number of hops in the 5G ProSe multi-hop UE-to-UE relay path.

- b) may derive the packet filter(s) used over the next hop PC5 interface if the 5G ProSe multi-hop layer-3 UE-to-UE relay UE received the PC5 QoS rule(s) from the previous hop;
- c) if a new QoS flow needs to be established or the existing QoS flow(s) needs to be modified, shall perform 5G ProSe direct link establishment procedure as specified in clause 7.2.2 or 5G ProSe direct link modification procedure as specified in clause 7.2.3 providing:
 - 1) the PC5 QoS flow descriptions IE with the PC5 QoS parameters for the rest of path PC5 QoS control determined in bullet a.2) to the next hop UE; and
 - 2) the QoS rules IE with the packet filter(s) if packet filter(s) are derived in bullet b) to the next hop UE;
- d) may derive the packet filter(s) used over the previous hop PC5 interface if the 5G ProSe multi-hop layer-3 UE-to-UE relay UE determines the PC5 QoS rule(s) over the previous hop based on bullet a.1), the received QoS flow descriptions IE and the QoS rules IE that the next hop UE accepts; and

- e) shall provide to the previous hop UE, the PC5 QoS parameters determined in bullet a.1) or updated in bullet d), and the corresponding ProSe identifier(s) as specified in clause 7.2.2.3 (if 5G ProSe direct link establishment procedure was initiated by the previous hop UE) or clause 7.2.3.3 (if 5G ProSe direct link modification procedure was initiated by the previous UE).

8c.2.8 Support for Ethernet traffic via 5G ProSe multi-hop layer-3 UE-to-UE relay

When a 5G ProSe direct link is being established or modified between the source 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE (called source 5G ProSe direct link), 5G ProSe direct link is being established or modified between any two 5G ProSe multi-hop layer-3 UE-to-UE relay UE (called UE-to-UE relay 5G ProSe direct link), and 5G ProSe direct link is being established or modified between the 5G ProSe multi-hop layer-3 UE-to-UE relay UE and the target 5G ProSe multi-hop layer-3 end UE (called target 5G ProSe direct link), for Ethernet traffic:

- a) if the source 5G ProSe direct link is being established, MAC address of the source 5G ProSe multi-hop layer-3 end UE is indicated in the PROSE DIRECT LINK SECURITY MODE COMPLETE message of the source 5G ProSe direct link and MAC address of the target 5G ProSe multi-hop layer-3 end UE shall be indicated in the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message of the source 5G ProSe direct link;
- b) if the source 5G ProSe direct link is being modified:
 - 1) MAC address of the target 5G ProSe multi-hop layer-3 end UE shall be indicated in the PROSE DIRECT LINK MODIFICATION ACCEPT message of the source 5G ProSe direct link; or
 - 2) MAC address of the source 5G ProSe multi-hop layer-3 end UE shall be indicated in the PROSE DIRECT LINK MODIFICATION REQUEST message of the source 5G ProSe direct link if the MAC address of the source 5G ProSe multi-hop layer-3 end UE changed;
- c) if the UE-to-UE relay 5G ProSe direct link is being established, MAC address of the source 5G ProSe multi-hop layer-3 end UE is indicated in the PROSE DIRECT LINK SECURITY MODE COMPLETE message of the source 5G ProSe direct link and MAC address of the target 5G ProSe multi-hop layer-3 end UE is indicated in the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message of the source 5G ProSe direct link;
- d) if the UE-to-UE relay 5G ProSe direct link is being modified:
 - 1) MAC address of the target 5G ProSe multi-hop layer-3 end UE and the MAC address of the initiating 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall be indicated in the PROSE DIRECT LINK MODIFICATION ACCEPT message of the UE-to-UE relay 5G ProSe direct link if the MAC address of the target 5G ProSe multi-hop layer-3 end UE changed; and
 - 2) MAC address of the source 5G ProSe multi-hop layer-3 end UE and the MAC address of the initiating 5G ProSe multi-hop layer-3 UE-to-UE relay UE shall be indicated in the PROSE DIRECT LINK MODIFICATION REQUEST message of the UE-to-UE relay 5G ProSe direct link if the MAC address of the source 5G ProSe multi-hop layer-3 end UE changed;
- e) if the target 5G ProSe direct link is being established, MAC address of the source 5G ProSe multi-hop layer-3 end UE is indicated in PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT message of the target 5G ProSe direct link and MAC address of the target 5G ProSe multi-hop layer-3 end UE is indicated in the PROSE DIRECT LINK ESTABLISHMENT ACCEPT message of the target 5G ProSe direct link; and
- f) if the target 5G ProSe direct link is being modified:
 - 1) MAC address of the source 5G ProSe multi-hop layer-3 end UE shall be indicated in the PROSE DIRECT LINK MODIFICATION REQUEST message of the target 5G ProSe direct link; or
 - 2) MAC address of the target 5G ProSe multi-hop layer-3 end UE may be indicated in the PROSE DIRECT LINK MODIFICATION ACCEPT message of the target 5G ProSe direct link if the MAC address of the target 5G ProSe multi-hop layer-3 end UE changed.

The 5G ProSe multi-hop layer-3 UE-to-UE relay UE maintains associations between the 5G ProSe direct links and Ethernet MAC addresses provided by the 5G ProSe multi-hop layer-3 end UEs of the 5G ProSe direct links, shall ensure that each 5G ProSe multi-hop layer-3 end UE uses a different MAC address, and shall use the association for forwarding of the user data packets.

The 5G ProSe multi-hop layer-3 end UE maintains associations between the 5G ProSe direct link and Ethernet MAC address provided by the other 5G ProSe multi-hop layer-3 end UE and shall use the Ethernet MAC address provided by the other 5G ProSe layer-3 end UE as destination address of the user data packets.

9 Handling of unknown, unforeseen and erroneous protocol data

9.1 General

The procedures specified in the present document apply to those PC3a, PC8 or PC5 messages which pass the checks described in this clause.

This clause also specifies procedures for the handling of unknown, unforeseen and erroneous protocol data by the receiving entity. These procedures are called "error handling procedures", but in addition to providing recovery mechanisms for error situations they define a compatibility mechanism for future extensions of the protocols.

Detailed error handling procedures in the network are implementation dependent and may vary from PLMN to PLMN. However, when extensions of this protocol are developed, networks will be assumed to have the error handling that is indicated in this clause as mandatory ("shall") and that is indicated as strongly recommended ("should").

Also, the error handling of the network is only considered as mandatory or strongly recommended when certain thresholds for errors are not reached during a dedicated connection.

For definition of semantical and syntactical errors see 3GPP TS 24.007 [20], clause 11.4.2.

9.2 Handling of unknown, unforeseen and erroneous protocol data in messages sent over the PC3a or PC8 interface

9.2.1 Unforeseen message type

If the UE receives a PC3a or PC8 message with a message type corresponding to a ProSe discovery mechanism that the UE is not authorised to use by the network, the UE shall discard the message.

If the 5G DDNMF receives a PC3a message or the 5G PKMF receives a PC8 message, whose message type indicates that this is a ProSe discovery mechanism the sending UE is not authorised to support, the 5G DDNMF or the 5G PKMF shall discard the message.

9.3 Handling of unknown, unforeseen and erroneous protocol data in messages sent over the PC5 interface

9.3.0 General

Clauses 9.3.1 to 9.3.6 shall be applied in order of precedence.

9.3.1 Message too short or too long

9.3.1.1 Message too short

When a message is received that is too short to contain a complete message type information element, that message shall be ignored, cf. 3GPP TS 24.007 [20].

9.3.1.2 Message too long

The maximum size of a PC5 signalling message is 65535 octets.

9.3.2 Unknown or unforeseen message type

If the UE receives a PC5 signalling message with message type not defined for the PC5 signalling protocol or not implemented by the receiver, it shall ignore the PC5 signalling message.

NOTE: A message type not defined for the PC5 signalling protocol in the given direction is regarded by the receiver as a message type not defined for the PC5 signalling protocol, see 3GPP TS 24.007 [20].

If the UE receives a message not compatible with the PC5 signalling protocol state, the UE shall ignore the PC5 signalling message.

9.3.3 Non-semantical mandatory information element errors

When on receipt of a message,

- a) an "imperative message part" error; or
- b) a "missing mandatory IE" error

is diagnosed or when a message containing:

- a) a syntactically incorrect mandatory IE;
- b) an IE unknown in the message, but encoded as "comprehension required" (see 3GPP TS 24.007 [20]); or
- c) an out of sequence IE encoded as "comprehension required" (see 3GPP TS 24.007 [20]) is received,

the UE shall ignore the PC5 signalling message.

9.3.4 Unknown and unforeseen IEs in the non-imperative message part

9.3.4.1 IEs unknown in the message

The UE shall ignore all IEs unknown in a message which are not encoded as "comprehension required" (see 3GPP TS 24.007 [20]).

9.3.4.2 Out of sequence IEs

The UE shall ignore all out of sequence IEs in a message which are not encoded as "comprehension required" (see 3GPP TS 24.007 [20]).

9.3.4.3 Repeated IEs

If an information element with format T, TV, TLV, or TLV-E is repeated in a message in which repetition of the information element is not specified in clause 11.3, the UE shall handle only the contents of the information element appearing first and shall ignore all subsequent repetitions of the information element. When repetition of information elements is specified, the UE shall handle only the contents of specified repeated information elements. If the limit on repetition of information elements is exceeded, the UE shall handle the contents of information elements appearing first up to the limit of repetitions and shall ignore all subsequent repetitions of the information element.

9.3.5 Non-imperative message part errors

9.3.5.1 General

This category includes:

- a) syntactically incorrect optional IEs; and
- b) conditional IE errors.

9.3.5.2 Syntactically incorrect optional IEs

The UE shall treat all optional IEs that are syntactically incorrect in a message as not present in the message.

9.3.5.3 Conditional IE errors

When upon receipt of a PC5 signalling message, the UE diagnoses a "missing conditional IE" error or an "unexpected conditional IE" error, or when it receives a PC5 signalling message containing at least one syntactically incorrect conditional IE, the UE shall ignore the message.

9.3.6 Messages with semantically incorrect contents

When a message with semantically incorrect contents is received, the UE shall perform the foreseen reactions of the procedural part of clause 7.2. If, however no such reactions are specified, the UE shall ignore the message.

10 Message functional definitions and contents

10.1 Overview

This clause contains the definition and contents of the messages used in the procedures described in the present document. In this clause, Length in the tables denotes the overall length of the IEs in octets.

10.2 5G ProSe direct discovery messages

10.2.1 Message definition

This message is sent by the UE over the PC5 interface for open 5G ProSe direct discovery and restricted 5G ProSe direct discovery. See table 10.2.1.1, table 10.2.1.2, table 10.2.1.3, table 10.2.1.4, table 10.2.1.5, table 10.2.1.6, table 10.2.1.7, table 10.2.1.8, table 10.2.1.9, table 10.2.1.10, table 10.2.1.11, table 10.2.1.12, table 10.2.1.13, table 10.2.1.14, table 10.2.1.15, table 10.2.1.16, table 10.2.1.17, table 10.2.1.18 table 10.2.1.19, table 10.2.1.20, table 10.2.1.21, table 10.2.1.22, table 10.2.1.23 and table 10.2.1.24.

Message type: PROSE PC5 DISCOVERY

Significance: dual

Direction: UE to peer UE

Table 10.2.1.1: PROSE PC5 DISCOVERY message content for open 5G ProSe direct discovery announcement

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.14	M	V	1
	MIC	MIC 11.2.4	M	V	4
	ProSe application code	ProSe application code 11.2.2	M	V	23
7A	Metadata	Metadata 11.2.13	O	TLV-E	4-8195
NOTE: The discovery type is set to "Open discovery" and the content type is set to "Announcement".					

Table 10.2.1.2: PROSE PC5 DISCOVERY message content for restricted 5G ProSe direct discovery announcement

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.14	M	V	1
	MIC	MIC 11.2.4	M	V	4
	ProSe restricted code	ProSe restricted code 11.2.3	M	V	23
7A	Metadata	Metadata 11.2.13	O	TLV-E	4-8195
NOTE: The discovery type is set to "Restricted discovery" and the content type is set to "Announcement".					

Table 10.2.1.3: PROSE PC5 DISCOVERY message content for restricted 5G ProSe direct discovery solicitation

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.14	M	V	1
	MIC	MIC 11.2.4	M	V	4
	ProSe query code	ProSe restricted code 11.2.3	M	V	23
2A	Discoveree user info	Application layer ID 11.2.15	O	TLV	3-257
NOTE: The discovery type is set to "Restricted discovery" and the content type is set to "Solicitation".					

Table 10.2.1.4: PROSE PC5 DISCOVERY message content for restricted 5G ProSe direct discovery response

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.14	M	V	1
	MIC	MIC 11.2.4	M	V	4
	ProSe response code	ProSe restricted code 11.2.3	M	V	23
7A	Metadata	Metadata 11.2.13	O	TLV-E	4-8195
NOTE: The discovery type is set to "Restricted discovery" and the content type is set to "response".					

Table 10.2.1.5: PROSE PC5 DISCOVERY message for group member discovery announcement

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.14	M	V	1
	MIC	MIC 11.2.4	M	V	4
	Application layer group ID	Application layer group ID 11.2.6	M	LV	2-257
	Announcer info	User info ID 11.2.7	M	V	6
7A	Metadata	Metadata 11.2.13	O	TLV-E	4-8195
NOTE: The discovery type is set to "Restricted discovery", the content type is set to "Group member discovery announcement/group member discovery response" and the discovery model is set to "Model A".					

Table 10.2.1.6: PROSE PC5 DISCOVERY message for group member discovery solicitation

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.14	M	V	1
	MIC	MIC 11.2.4	M	V	4
	Application layer group ID	Application layer group ID 11.2.6	M	LV	2-256
	Discoverer info	User info ID 11.2.7	M	V	6
28	Target user info	User info ID 11.2.7	O	TV	7
NOTE: The discovery type is set to "Restricted discovery", the content type is set to "Group member discovery solicitation" and the discovery model is set to "Model B".					

Table 10.2.1.7: PROSE PC5 DISCOVERY message for group member discovery response

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.14	M	V	1
	MIC	MIC 11.2.4	M	V	4
	Application layer group ID	Application layer group ID 11.2.6	M	LV	2-256
	Discoveree info	User info ID 11.2.7	M	V	6
7A	Metadata	Metadata 11.2.13	O	TLV-E	4-8195
NOTE: The discovery type is set to "Restricted discovery", the content type is set to "Group member discovery announcement/group member discovery response" and the discovery model is set to "Model B".					

Table 10.2.1.8: PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Announcer info	User info ID 11.2.7	M	V	6
	Relay service code (NOTE 2)	Relay service code 11.2.8	M	V	3
	Status indicator	Status indicator 11.2.9	M	V	1
52	NCGI	NCGI 11.2.12	O	TV	9
63	RRC container	RRC container 11.2.14	O	TLV	3-257
NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "UE-to-network relay discovery announcement/UE-to-network relay discovery response" and the discovery model is set to "Model A".					
NOTE 2: If the announcing UE works as a 5G ProSe Layer-3 UE-to-network relay UE, the S-NSSAI associated with the relay service code belongs to the allowed NSSAI of the UE.					

Table 10.2.1.9: PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	MIC	MIC 11.2.4	M	V	4
	Discoverer info	User info ID 11.2.7	M	V	6
	Relay service code	Relay service code 11.2.8	M	V	3
29	Target discoveree info	User info ID 11.2.7	O	TV	7
NOTE: The discovery type is set to "Restricted discovery", the content type is set to "UE-to-network relay discovery solicitation" and the discovery model is set to "Model B".					

Table 10.2.1.10: PROSE PC5 DISCOVERY message for UE-to-network relay discovery response

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Discoveree info	User info ID 11.2.7	M	V	6
	Relay service code (NOTE 2)	Relay service code 11.2.8	M	V	3
	Status indicator	Status indicator 11.2.9	M	V	1
52	NCGI	NCGI 11.2.12	O	TV	9
63	RRC container	RRC container 11.2.14	O	TLV	3-257
NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "UE-to-network relay discovery announcement/UE-to-network relay discovery response" and the discovery model is set to "Model B".					
NOTE 2: If the discoveree UE works as a 5G ProSe Layer-3 UE-to-network relay UE, the S-NSSAI associated with the relay service code belongs to the allowed NSSAI of the UE.					

Table 10.2.1.11: PROSE PC5 DISCOVERY message for relay discovery additional information

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Relay service code	Relay service code 11.2.8	M	V	3
	Announcer info	User info ID 11.2.7	M	V	6
52	NCGI	NCGI 11.2.12	O	TV	9
51	Relay TAI	TAI 11.2.10	O	TV	4
10	NID	NID 11.2.23	O	TLV	8
NOTE: The discovery type is set to "Restricted discovery", the content type is set to "Relay discovery additional information" and the discovery model is set to "Model A".					

Table 10.2.1.12: PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Relay service code	Relay service code 11.2.8	M	V	3
	Direct discovery set	Direct discovery set 11.2.17	M	LV-E	15-8323
2D	Status indicator	Status indicator 11.2.9	O	TV	2
2C	UE-to-UE relay UE info	User info ID 11.2.7	O	TV	7
NOTE: The discovery type is set to "Restricted discovery", the content type is set to "UE-to-UE relay discovery announcement" and the discovery model is set to "Model A".					

Table 10.2.1.13: PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Relay service code	Relay service code 11.2.8	M	V	3
	Direct discovery set	Direct discovery set 11.2.17	M	LV-E	12-520
2C	UE-to-UE relay UE info	User info ID 11.2.7	O	TV	7
2D	Status indicator	Status indicator 11.2.9	O	TV	2
8-	Announce prohibited indication	Announce prohibited indication 11.2.19	O	TV	1
NOTE: The discovery type is set to "Restricted discovery", the content type is set to "UE-to-UE relay discovery solicitation" and the discovery model is set to "Model B".					

Table 10.2.1.14: PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Relay service code	Relay service code 11.2.8	M	V	3
	Direct discovery set	Direct discovery set 11.2.17	M	LV-E	12-520
2C	UE-to-UE relay UE info	User info ID 11.2.7	O	TV	7
2D	Status indicator	Status indicator 11.2.9	O	TV	2
8-	Announce prohibited indication	Announce prohibited indication 11.2.19	O	TV	1
NOTE: The discovery type is set to "Restricted discovery", the content type is set to "UE-to-UE relay discovery response" and the discovery model is set to "Model B".					

Table 10.2.1.15: PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	ProSe direct discovery PC5 message content type extensions (NOTE 2)	ProSe direct discovery PC5 message content type extensions 11.2.1a	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Announcer info	User info ID 11.2.7	M	V	6
	Relay service code (NOTE 3)	Relay service code 11.2.8	M	V	3
	Status indicator	Status indicator 11.2.9	M	V	1
	Hop count	Hop count 11.2.21	M	V	1
10	Hop limit	Hop limit 11.2.22	O	TV	1
11	Root relay info	User info ID 11.2.7	O	TV	7
12	Accumulated QoS	PC5 QoS flow descriptions 11.2.27	O	TLV	6-65538
52	NCGI	NCGI 11.2.12	O	TV	9
63	RRC container	RRC container 11.2.14	O	TLV	3-257
NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "Extended content type" and the discovery model is set to "Model A". NOTE 2: The extended content type is set to "Multi-hop UE-to-network relay discovery announcement". NOTE 3: If the announcing UE works as a 5G ProSe multi-hop layer-3 UE-to-network relay UE, the S-NSSAI associated with the relay service code belongs to the allowed NSSAI of the UE.					

Table 10.2.1.16: PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	ProSe direct discovery PC5 message content type extensions (NOTE 2)	ProSe direct discovery PC5 message content type extensions 11.2.1a	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Relay service code	Relay service code 11.2.8	M	V	3
	Announcer info	User info ID 11.2.7	M	V	6
	Hop count	Hop count 11.2.21	M	V	1
8-	Hop limit	Hop limit 11.2.22	O	TV	1
29	Root relay info	User info ID 11.2.7	O	TV	7
52	NCGI of multi-hop UE-to-network relay	NCGI 11.2.12	O	TV	9
10	NCGI info set of intermediate UE-to-network relay	NCGI info set 11.2.25	O	TLV	16
51	Relay TAI	TAI 11.2.10	O	TV	4
53	NID	NID 11.2.23	O	TLV	8
NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "Extended content type" and the discovery model is set to "Model A".					
NOTE 2: The extended content type is set to "Multi-hop UE-to-network relay discovery additional information".					

Table 10.2.1.17: PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	ProSe direct discovery PC5 message content type extensions (NOTE 2)	ProSe direct discovery PC5 message content type extensions 11.2.1a	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Discoverer info	User info ID 11.2.7	M	V	6
	Relay service code	Relay service code 11.2.8	M	V	3
29	Target discoveree info	User info ID 11.2.7	O	TV	7
20	Multi-hop U2N path info	List of user info IDs and layer-2 IDs 11.3.48	O	TLV	13-257
21	Intermediate relays	List of user info ID 11.2.26	O	TLV	8-257
22	Hop count	Hop count 11.2.21	O	TV	1
23	Hop limit	Hop limit 11.2.22	O	TV	1
24	Accumulated QoS	PC5 QoS flow descriptions 11.2.27	O	TLV	6-65538
NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "Extended content type" and the discovery model is set to "Model B".					
NOTE 2: The extended content type is set to "Multi-hop UE-to-network relay discovery solicitation".					

Table 10.2.1.18: PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	ProSe direct discovery PC5 message content type extensions (NOTE 2)	ProSe direct discovery PC5 message content type extensions 11.2.1a	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Discoveree info	User info ID 11.2.7	M	V	6
	Relay service code	Relay service code 11.2.8	M	V	3
	Status indicator	Status indicator 11.2.9	M	V	1
	Multi-hop U2N path info	List of user info IDs and layer-2 IDs 11.3.48	M	LV	12-256
10	Hop count	Hop count 11.2.21	O	TV	1
12	Accumulated QoS	PC5 QoS flow descriptions 11.2.27	O	TLV	6-65538
63	RRC container	RRC container 11.2.14	O	TLV	3-257
NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "Extended content type" and the discovery model is set to "Model B".					
NOTE 2: The extended content type is set to "Multi-hop UE-to-network relay discovery response".					

Table 10.2.1.19: PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for IP data unit type

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	ProSe direct discovery PC5 message content type extensions (NOTE 2)	ProSe direct discovery PC5 message content type extensions 11.2.1a	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Multi-hop UE-to-UE relay UE info	User info ID 11.2.7	M	V	6
	Relay service code	Relay service code 11.2.8	M	V	3
NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "Extended content type" and the discovery model is set to "Model A".					
NOTE 2: The extended content type is set to "Multi-hop UE-to-UE relay discovery announcement for IP data unit type".					

Table 10.2.1.20: PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	ProSe direct discovery PC5 message content type extensions (NOTE 2)	ProSe direct discovery PC5 message content type extensions 11.2.1a	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Direct discovery set	Direct discovery set 11.2.17	M	LV-E	11-519
	Relay service code	Relay service code 11.2.8	M	V	3
29	Multi-hop UE-to-UE relay UE info	User info ID 11.2.7	O	TV	7

NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "Extended content type" and the discovery model is set to "Model B".

NOTE 2: The extended content type is set to "Multi-hop UE-to-UE relay discovery solicitation for IP data unit type".

Table 10.2.1.21: PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for IP data unit type

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	ProSe direct discovery PC5 message content type extensions (NOTE 2)	ProSe direct discovery PC5 message content type extensions 11.2.1a	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Multi-hop UE-to-UE relay UE info	User info ID 11.2.7	M	V	6
	Direct discovery set	Direct discovery set 11.2.17	M	LV-E	11-519
	Relay service code	Relay service code 11.2.8	M	V	3

NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "Extended content type" and the discovery model is set to "Model B".

NOTE 2: The extended content type is set to "Multi-hop UE-to-UE relay discovery response for IP data unit type".

Table 10.2.1.22: PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for Ethernet and unstructured data unit type

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	ProSe direct discovery PC5 message content type extensions (NOTE 2)	ProSe direct discovery PC5 message content type extensions 11.2.1a	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Multi-hop UE-to-UE relay UE info	User info ID 11.2.7	M	V	6
	Relay service code	Relay service code 11.2.8	M	V	3
	List of multi-hop UE-to-UE relay paths	List of multi-hop UE-to-UE relay paths 11.2.24	M	LV-E	2-65537
NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "Extended content type" and the discovery model is set to "Model A".					
NOTE 2: The extended content type is set to "Multi-hop UE-to-UE relay discovery announcement for Ethernet and unstructured unit type".					

Table 10.2.1.23: PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	ProSe direct discovery PC5 message content type extensions (NOTE 2)	ProSe direct discovery PC5 message content type extensions 11.2.1a	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Discoverer info	User info ID 11.2.7	M	V	6
	Relay service code	Relay service code 11.2.8	M	V	3
10	List of multi-hop UE-to-UE relay paths	List of multi-hop UE-to-UE relay paths 11.2.24	O	TLV-E	3-65538
29	Target discoveree info	User info ID 11.2.7	O	TV	7
NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "Extended content type" and the discovery model is set to "Model B".					
NOTE 2: The extended content type is set to "Multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type".					

Table 10.2.1.24: PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe direct discovery PC5 message type (NOTE 1)	ProSe direct discovery PC5 message type 11.2.1	M	V	1
	ProSe direct discovery PC5 message content type extensions (NOTE 2)	ProSe direct discovery PC5 message content type extensions 11.2.1a	M	V	1
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	PLMN ID	PLMN ID 11.2.20	M	V	3
	MIC	MIC 11.2.4	M	V	4
	Discoveree info	User info ID 11.2.7	M	V	6
	Discoverer info	User info ID 11.2.7	M	V	6
	Relay service code	Relay service code 11.2.8	M	V	3
	List of multi-hop UE-to-UE relay paths	List of multi-hop UE-to-UE relay paths 11.2.24	M	LV-E	2-65537
NOTE 1: The discovery type is set to "Restricted discovery", the content type is set to "Extended content type" and the discovery model is set to "Model B".					
NOTE 2: The extended content type is set to "Multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type".					

10.2.2 Relay TAI

The information element may be included in PROSE PC5 DISCOVERY message for relay discovery additional information as in table 10.2.1.11 to indicate the tracking area identity corresponding to the serving cell of the 5G ProSe layer-3 UE-to-network relay for discoveree UEs supporting N3IWF discovery procedure.

10.2.3 NCGI

The NCGI information element shall be included in:

- PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement as in table 10.2.1.8; or
- PROSE PC5 DISCOVERY message for UE-to-network relay discovery response as in table 10.2.1.10;

to indicate the NCGI of the serving cell if the UE acts as a 5G ProSe layer-2 UE-to-network relay UE.

When the UE acts as a 5G ProSe layer-3 UE-to-network relay UE, the UE may include the NCGI information element in PROSE PC5 DISCOVERY message for relay discovery additional information as in table 10.2.1.11 to indicate the NCGI of the serving cell.

10.2.4 Target user info

The target user info IE shall be included in PROSE PC5 DISCOVERY message for group member discovery solicitation in as in table 10.2.1.6 if the target information is provided by the upper layers to identify a specific group member of the application layer group identified by the configured application layer group ID.

10.2.5 Metadata

The Metadata information element may be included:

- to provide the application layer metadata information in the following messages:

- 1) the PROSE PC5 DISCOVERY message for open 5G ProSe direct discovery announcement as in table 10.2.1.1;
 - 2) the PROSE PC5 DISCOVERY message for restricted 5G ProSe direct discovery announcement as in table 10.2.1.2; and
 - 3) the PROSE PC5 DISCOVERY message for restricted 5G ProSe direct discovery response as in table 10.2.1.4; or
- b) to provide the application layer discovery message in the following messages:
- 1) the PROSE PC5 DISCOVERY message for group member discovery announcement as in table 10.2.1.5; and
 - 2) the PROSE PC5 DISCOVERY message for group member discovery response as in table 10.2.1.7.

NOTE 1: The format of the application layer metadata information and the application layer discovery message are out of scope of this specification.

NOTE 2: Possible impact on the performance of the 5G ProSe direct discovery procedure is to be considered if the resulted Metadata information element size is too big, e.g., longer delay and lower reliability.

10.2.6 RRC container

The RRC container information element shall be included in:

- a) PROSE PC5 DISCOVERY message for UE-to-network relay discovery announcement as in table 10.2.1.8;
- b) PROSE PC5 DISCOVERY message for UE-to-network relay discovery response as in table 10.2.1.10;
- c) PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement as in table 10.2.1.15; or
- d) PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response as in table 10.2.1.18.

to indicate the RRC container information if it is received from the lower layers and the UE acts either as a 5G ProSe layer-2 UE-to-network relay UE for UE-to-network relay discovery, or as a 5G ProSe multi-hop layer-2 UE-to-network relay UE or a 5G ProSe layer-2 intermediate UE-to-network relay for multi-hop UE-to-network relay discovery.

10.2.7 Target discoveree info

The target discoveree info IE shall be included in PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation as in table 10.2.1.9 if the target discoveree info is provided by the application layer.

The target discoveree info IE shall be included in PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation as in table 10.2.1.23 if the target discoveree info is provided by the application layer.

10.2.8 Void

10.2.8a Void

10.2.9 UE-to-UE relay UE info

The UE-to-UE relay UE info IE shall be included in PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation as in table 10.2.1.13 or PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response as in table 10.2.1.14 if the message is sent by the 5G ProSe UE-to-UE relay UE.

The UE-to-UE relay UE info IE may be included in PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation as in table 10.2.1.13, if available, if the message is sent by the source 5G ProSe end UE.

The UE-to-UE relay UE info IE shall be included in PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement as in table 10.2.1.12, if the message is sent by the 5G ProSe UE-to-UE relay UE and 5G ProSe UE-to-UE relay UE is acting as announcing UE.

10.2.10 Status indicator

The status indicator IE shall be included in PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation as in table 10.2.1.13 and PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response in table 10.2.1.14 if the message is sent by the 5G ProSe UE-to-UE relay UE.

The status indicator IE shall be included in PROSE PC5 DISCOVERY message for UE-to-UE relay discovery announcement as in table 10.2.1.12, if the message is sent by the 5G ProSe UE-to-UE relay UE and 5G ProSe UE-to-UE relay UE is acting as announcing UE.

10.2.11 Announce prohibited indication

The announce prohibited indication IE with its value set as "It is prohibited to broadcast the user info" shall be included in PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation as in table 10.2.1.13 if the discoverer end UE needs to indicate to a 5G ProSe UE-to-UE relay UE that it is prohibited from broadcasting the user info of the discoverer end UE included in the direct discovery set during the procedure of 5G ProSe UE-to-UE relay discovery over PC5 interface with model A.

The announce prohibited indication IE with its value set as "It is prohibited to broadcast the user info" shall be included in PROSE PC5 DISCOVERY message for UE-to-UE relay discovery response as in table 10.2.1.14 if the discoverer end UE needs to indicate to the 5G ProSe UE-to-UE relay UE that it is prohibited from broadcasting the user info of the discoverer end UE included in the direct discovery set during the procedure of 5G ProSe UE-to-UE relay discovery over PC5 interface with model A.

10.2.11a Discoverer user info

The discoverer user info IE shall be included in the PROSE PC5 DISCOVERY message content for restricted 5G ProSe direct discovery solicitation as in table 10.2.1.3 if the application layer ID of the discoverer UE is provided by the upper layers to identify a specific discoverer UE.

10.2.12 NID

The NID information element shall be included in the PROSE PC5 DISCOVERY message for relay discovery additional information as in table 10.2.1.11, or in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information as in table 10.2.1.16, in case of SNPN when the NCGI, the Relay TAI or both is included in the message.

10.2.13 Hop count

The Hop count information element is included in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement, PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information, PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation and PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response to provide the number of PC5 hops required for the 5G ProSe multi-hop remote UE to reach the network.

10.2.14 Hop limit

The Hop limit information element is included in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement, PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information and PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation to provide the limit of the hops (i.e. the maximum number of hops) for the 5G ProSe multi-hop remote UE to reach the network.

10.2.15 Root relay info

The Root relay info information element is included in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery announcement and PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery additional information to provide the user info ID of the 5G ProSe multi-hop UE-to-network relay UE.

10.2.16 Multi-hop U2N path info

The Multi-hop U2N path info information element is included in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation and PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response to provide the ordered list of the user info IDs and layer-2 IDs of the selected path.

10.2.17 Intermediate relays

The Intermediate relays information element is included in the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation to provide the list of user info IDs of the 5G ProSe intermediate UE-to-network relay UEs that the 5G ProSe multi-hop remote UE wants to use in the path to the 5G ProSe multi-hop UE-to-network relay UE.

10.2.18 Multi-hop UE-to-UE relay UE info

The Multi-hop UE-to-UE relay UE info information element is included in the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for IP data unit type and PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for IP data unit type to provide the user info ID of the 5G ProSe multi-hop layer-3 UE-to-UE relay UE.

10.2.19 List of multi-hop UE-to-UE relay paths

The List of multi-hop UE-to-UE relay paths information element is included in the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery announcement for Ethernet and unstructured data unit type, PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type and PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type to provide the direct discovery set as specified in clause 11.2.24.

10.2.20 Void

10.2.21 Accumulated QoS

The UE may include this IE to deliver the accumulated QoS information when the UE is acting as a 5G ProSe UE-to-network relay UE or a 5G ProSe intermediate UE-to-network relay UE.

10.3 PC5 signalling messages

10.3.1 ProSe direct link establishment request

10.3.1.1 Message definition

This message is sent by a UE to another peer UE to establish a direct link. See table 10.3.1.1.1.

Message type: PROSE DIRECT LINK ESTABLISHMENT REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.1.1.1: PROSE DIRECT LINK ESTABLISHMENT REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK ESTABLISHMENT REQUEST message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	Source user info	Application layer ID 11.3.4	M	LV	2-256
	UE security capabilities	UE security capabilities 11.3.11	M	LV	3-9
	UE PC5 unicast signalling security policy	UE PC5 unicast signalling security policy 11.3.12	M	V	1
4F	MIC	MIC 11.3.38	O	TV	5
7B	ProSe identifiers	ProSe identifier 11.3.3	O	TLV-E	21-65538
74	Key establishment information container	Key establishment information container 11.3.9	O	TLV-E	4-65538
56	Nonce_1	Nonce 11.3.10	O	TV	17
5C	MSB of KNRP-sess ID	MSB of KNRP-sess ID 11.3.13	O	TLV	3
28	Target user info	Application layer ID 11.3.4	O	TLV	3-257
58	KNRP ID	KNRP ID 11.3.14	O	TV	5
54	Relay service code	Relay service code 11.3.26	O	TV	4
7D	UE identity	5GS mobile identity 11.3.30	O	TLV-E	4-n
64	User security key ID	User security key ID 11.3.32	O	TLV	3-n
2A	HPLMN ID	PLMN ID 11.3.33	O	TLV	5
2B	UTC-based counter LSB	UTC-based counter LSB 11.2.14	O	TV	2
65	UE-to-UE relay UE user info	User info ID 2 11.3.39	O	TLV	8
2D	Target end UE layer-2 ID	Layer-2 ID 11.3.25	O	TV	4
29	MSB of KSLP-sess ID	MSB of KSLP-sess ID 11.3.54	O	TLV	3
2C	KSLP ID	KSLP ID 11.3.55	O	TLV	6
8-	Relay indication	Relay indication 11.3.56	O	TV	1
10	Multi-hop path info	List of user info ID 11.3.47	O	TLV	8-257
9-	Hop limit	Hop limit 11.3.59	O	TV	1
11	End-to-end QoS flow descriptions	PC5 QoS flow descriptions 11.3.5	O	TLV-E	6-65538
12	Multi-hop U2N path info	List of user info IDs and layer-2 IDs 11.3.48	O	TLV	12-257

10.3.1.2 Target user info

The UE shall include this IE if the target UE's application layer ID is received from upper layers or known based on the unicast layer-2 ID of target UE (i.e. destination layer-2 ID) as described in clause 5.8.2.4 of 3GPP TS 23.304 [2], or if

the UE receives the user info ID of the 5G ProSe UE-to-network relay UE during the 5G ProSe UE-to-network relay discovery procedure, or if:

- a) the UE is acting as the source 5G ProSe end UE and the user info of the target 5G ProSe end UE is obtained during the 5G ProSe UE-to-UE relay discovery procedure; or
- b) the UE is acting as the 5G ProSe UE-to-UE relay UE and the user info of the target 5G ProSe end UE is obtained in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message from the source 5G ProSe end UE.

10.3.1.3 Key establishment information container

The UE shall include this IE if the UE PC5 unicast signalling security policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred".

10.3.1.4 Nonce_1

The UE shall include this IE if the UE PC5 unicast signalling security policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred" and the 5G ProSe direct link is neither for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE nor for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

NOTE: When the 5G ProSe direct link establishment procedure is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the security procedure over user plane is used as specified in 3GPP TS 33.503 [34], the "Nonce_1" is called "KNRP freshness parameter 1" as specified in 3GPP TS 33.503 [34].

10.3.1.5 MSB of $K_{\text{NRP-seSS}}$ ID

The UE shall include this IE if the UE PC5 unicast signalling security policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred".

10.3.1.6 K_{NRP} ID

The UE may include this IE if it has an existing K_{NRP} for the target UE.

10.3.1.7 Relay service code

The UE shall include this IE if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

10.3.1.8 ProSe identifiers

The UE shall include this IE if the 5G ProSe direct link establishment procedure is not for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE.

10.3.1.9 UE identity

The UE shall include this IE if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

10.3.1.10 User security key ID

The UE shall include this IE if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE, and:

- a) the security procedure over user plane for 5G ProSe UE-to-network relay is used as specified in 3GPP TS 33.503 [34] and the UE has a valid UP-PRUK; or

- b) the security procedure over control plane for 5G ProSe UE-to-network relay is used as specified in 3GPP TS 33.503 [34] and the UE has a valid CP-PRUK associated with the relay service code of the target UE.

The UE shall include this IE if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and:

- a) the security procedure over user plane for 5G ProSe UE-to-UE relay is used as specified in 3GPP TS 33.503 [34] and the UE has a valid UP-PRUK; or
- b) the security procedure over control plane for 5G ProSe UE-to-UE relay is used as specified in 3GPP TS 33.503 [34] and the UE has a valid CP-PRUK associated with the relay service code of the target UE.

The UE shall include this IE if the 5G ProSe direct link establishment procedure is for direct communication for ranging and sidelink positioning, and the security procedure for ranging and sidelink positioning is used as specified in 3GPP TS 33.533 [55] and the UE has a valid SLPK.

10.3.1.11 HPLMN ID

The UE shall include this IE if the UP-PRUK ID of the UE is included and is not in NAI format (see 3GPP TS 33.503 [34]) or the SLPK ID of the UE is included and is not in NAI format (see 3GPP TS 33.533 [55]).

10.3.1.12 UTC-based counter LSB

The UE shall include this IE if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE or for direct communication b for ranging and sidelink positioning.

10.3.1.13 MIC

The UE shall include this IE if the 5G ProSe direct link establishment procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or for direct communication between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE or for direct communication b for ranging and sidelink positioning, and the UE has the DUIK.

10.3.1.14 UE-to-UE relay UE user info

The UE shall include this IE if:

- a) the user info ID of the 5G ProSe UE-to-UE relay UE is obtained during the 5G ProSe UE-to-UE relay discovery procedure and the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE; or
- b) the UE is acting as the 5G ProSe UE-to-UE relay UE.

10.3.1.15 Target end UE layer-2 ID

The UE shall include this IE if the target end UE layer-2 ID is available to the source 5G ProSe end UE via the previous direct communication and the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

10.3.1.16 MSB of K_{SLP-sess} ID

The UE shall include this IE if the UE PC5 unicast signalling security policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred".

10.3.1.17 K_{SLP} ID

The UE may include this IE if it has an existing KSLP for the target UE.

10.3.1.18 Relay indication

The UE shall include this IE if the UE wants to indicate that the PROSE DIRECT LINK ESTABLISHMENT REQUEST message can be forwarded with required changes by a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link establishment procedure is for direct communication between the source 5G ProSe end UE and 5G ProSe UE-to-UE relay UE with integrated discovery.

10.3.1.19 Multi-hop path info

The UE shall include this IE if:

- a) the UE is acting as a source 5G ProSe multi-hop end UE towards a 5G ProSe multi-hop UE-to-UE relay UE, or acting as a 5G ProSe multi-hop UE-to-UE relay UE towards another 5G ProSe multi-hop UE-to-UE relay UE, to indicate the list of the user info IDs of the 5G ProSe multi-hop UE-to-UE relay UE(s) selected during the multi-hop layer-3 UE-to-UE relay discovery for Ethernet and Unstructured data unit type with model A or model B.

10.3.1.20 Hop limit

The UE may include this IE when the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe multi-hop layer-3 end UE and the 5G ProSe multi-hop layer-3 UE-to-UE relay UE and the required hop limit by the 5G ProSe multi-hop layer-3 end UE for the 5G ProSe multi-hop layer-3 UE-to-UE relay service is less than the maximum number of hops for the relay service code as configured in clause 5.2.9.

10.3.1.21 End-to-end QoS flow descriptions

The UE may include this IE to deliver the end-to-end QoS information when the UE is acting as a 5G ProSe multi-hop remote UE or a 5G ProSe intermediate UE-to-network relay UE.

10.3.1.22 Multi-hop U2N path info

The UE shall include this IE if the UE is acting as a 5G ProSe multi-hop remote UE or a 5G ProSe intermediate UE-to-network relay UE to indicate the list of the user info IDs and layer-2 IDs of the 5G ProSe intermediate UE-to-network relay UE(s), if any, and the 5G ProSe multi-hop UE-to-network relay UE selected during the multi-hop UE-to-network relay discovery over PC5 interface with model B.

10.3.2 ProSe direct link establishment accept

10.3.2.1 Message definition

This message is sent by a UE to another peer UE to accept the received PROSE DIRECT LINK ESTABLISHMENT REQUEST message. See table 10.3.2.1.1.

Message type: PROSE DIRECT LINK ESTABLISHMENT ACCEPT

Significance: dual

Direction: UE to peer UE

Table 10.3.2.1.1: PROSE DIRECT LINK ESTABLISHMENT ACCEPT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK ESTABLISHMENT ACCEPT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	Source user info	Application layer ID 11.3.4	M	LV	2-256
	Configuration of UE PC5 unicast user plane security protection	Configuration of UE PC5 unicast user plane security protection 11.3.23	M	V	1
79	QoS flow descriptions	PC5 QoS flow descriptions 11.3.5	O	TLV-E	6-65538
7C	QoS rules	PC5 QoS rules 11.3.29	O	TLV-E	7-65538
62	IP address configuration	IP address configuration 11.3.6	O	TV	2
61	Target link local IPv6 address	Link local IPv6 address 11.3.7	O	TV	17
65	UE-to-UE relay UE user info	User info ID 2 11.3.39	O	TLV	8
2E	Target 5G ProSe layer-3 end UE MAC address	MAC address 11.3.45	O	TLV	8
6E	Target end UE IP address	UE IP address 11.3.49	O	TLV	7-19
12	Multi-hop path info	List of user info ID 11.3.47	O	TLV	8-257

10.3.2.2 IP address configuration

The UE shall include this IE if IP communication is used.

10.3.2.3 Target link local IPv6 address

The UE shall include this IE if IP communication is used and the IP address configuration is set to "address allocation not supported".

10.3.2.4 QoS flow descriptions

The UE shall include this IE if:

- the 5G ProSe direct link establishment procedure is not for 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE; or
- the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the 5G ProSe layer-3 remote UE and the 5G ProSe layer-3 UE-to-network relay UE.

10.3.2.5 QoS rules

The UE may include this IE to indicate the PC5 QoS rules for the established PC5 QoS flow(s).

10.3.2.6 UE-to-UE relay UE user info

The UE shall include this IE if the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the (source or target) 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

10.3.2.7 Target 5G ProSe layer-3 end UE MAC address

The UE shall include this IE when the MAC address of the target 5G ProSe layer-3 end UE, or target 5G ProSe multi-hop layer-3 end UE needs to be indicated.

10.3.2.8 Target end UE IP address

The UE may include this IE if:

- a) the 5G ProSe direct link establishment procedure is for 5G ProSe direct communication between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE;
- b) the UE acts as the 5G ProSe layer-3 UE-to-UE relay UE;
- c) the data unit type is IP; and
- d) the IP address of the target 5G ProSe layer-3 end UE is available in the 5G ProSe layer-3 UE-to-UE relay UE.

10.3.2.9 Multi-hop path info

The UE shall include this IE if the UE is acting as a 5G ProSe multi-hop UE-to-UE relay UE towards another 5G ProSe multi-hop UE-to-UE relay UE or towards the source 5G ProSe multi-hop end UE to indicate the list of the user info IDs of the 5G ProSe multi-hop UE-to-UE relay UE(s) selected during the multi-hop layer-3 UE-to-UE relay discovery for Ethernet and Unstructured data unit type with model A or model B.

10.3.3 ProSe direct link establishment reject

10.3.3.1 Message definition

This message is sent by the UE to another peer UE to indicate that the link establishment request is not accepted. See table 10.3.3.1.1.

Message type: PROSE DIRECT LINK ESTABLISHMENT REJECT

Significance: dual

Direction: UE to peer UE

Table 10.3.3.1.1: PROSE DIRECT LINK ESTABLISHMENT REJECT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK ESTABLISHMENT REJECT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	PC5 signalling protocol cause	PC5 signalling protocol cause 11.3.8	M	V	1
5E	Back-off value	GPRS timer 11.3.27	O	TV	2
70	EAP message	EAP message 11.3.31	O	TLV-E	7-1503
68	PC5 end UE failure cause	PC5 signalling protocol cause 2 11.3.41	O	TLV	3
66	Source end UE info	Application layer ID 11.3.4	O	TLV	3-257
67	Target end UE info	Application layer ID 11.3.4	O	TLV	3-257
65	UE-to-UE relay UE user info	User info ID 2 11.3.39	O	TLV	8

10.3.3.2 Back-off value

The UE may include this IE when it needs to indicate a back-off timer to another peer UE for congestion control purpose.

10.3.3.3 EAP message

The EAP message IE is included if received from the network according to the security procedure over control plane as specified in 3GPP TS 33.503 [34], when the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

10.3.3.4 PC5 end UE failure cause

The UE may include this IE if:

- a) the UE acts as a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE to indicate the PC5 signalling protocol cause received from the target 5G ProSe end UE.

10.3.3.5 Source end UE info

The UE may include this IE if:

- a) the UE acts as a target 5G ProSe end UE and the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE; or
- b) the UE acts as a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;

to indicate the user info of the source 5G ProSe end UE.

10.3.3.6 Target end UE info

The UE may include this IE if:

- a) the UE acts as a target 5G ProSe end UE and the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE; or
- b) the UE acts as a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;

to indicate the user info of the target 5G ProSe end UE.

10.3.3.7 UE-to-UE relay UE user info

The UE may include this IE if:

- a) the UE acts as a target 5G ProSe end UE and the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE; or
- b) the UE acts as a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE;

to convey the user info ID of the 5G ProSe UE-to-UE relay UE.

10.3.4 ProSe direct link release request

10.3.4.1 Message definition

This message is sent by the UE to another peer UE to initiate the direct link release procedure. See table 10.3.4.1.1.

Message type: PROSE DIRECT LINK RELEASE REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.4.1.1: PROSE DIRECT LINK RELEASE REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK RELEASE REQUEST message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	PC5 signalling protocol cause	PC5 signalling protocol cause 11.3.8	M	V	1
	MSBs of KNRP ID	MSBs of KNRP ID 11.3.16	M	V	2
5E	Back-off value	GPRS timer 11.3.27	O	TV	2
6F	PC5 end UE release cause	PC5 signalling protocol cause 2 11.3.41	O	TLV	3

10.3.4.2 Back-off value

The UE may include this IE when it needs to indicate a back-off timer to another peer UE for congestion control purpose.

10.3.4.3 PC5 end UE release cause

The UE may include this IE if:

- a) the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE to indicate to the 5G ProSe layer-3 end UE the PC5 signalling protocol cause received from the peer 5G ProSe end UE that has released its 5G ProSe direct link with the 5G ProSe layer-3 UE-to-UE relay UE.

10.3.5 ProSe direct link release accept

10.3.5.1 Message definition

This message is sent by the UE to another peer UE to indicate that the link release request is accepted. See table 10.3.5.1.1.

Message type: PROSE DIRECT LINK RELEASE ACCEPT

Significance: dual

Direction: UE to peer UE

Table 10.3.5.1.1: PROSE DIRECT LINK RELEASE ACCEPT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK RELEASE ACCEPT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	LSBs of KNRP ID	LSBs of KNRP ID 11.3.17	M	V	2

10.3.6 ProSe direct link modification request

10.3.6.1 Message definition

This message is sent by the UE to another peer UE to initiate the direct link modification procedure. See table 10.3.6.1.1.

Message type: PROSE DIRECT LINK MODIFICATION REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.6.1.1: PROSE DIRECT LINK MODIFICATION REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK MODIFICATION REQUEST message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	Link modification operation code	Link modification operation code 11.3.19	M	V	1
	QoS flow descriptions	PC5 QoS flow descriptions 11.3.5	M	LV-E	5-65537
7C	QoS rules	PC5 QoS rules 11.3.29	O	TLV-E	7-65538
66	Source end UE info	Application layer ID 11.3.4	O	TLV	3-257
67	Target end UE info	Application layer ID 11.3.4	O	TLV	3-257
2D	Target end UE layer-2 ID	Layer-2 ID 11.3.25	O	TV	4
33	Source 5G ProSe layer-3 end UE MAC address	MAC address 11.3.45	O	TLV	8
9-	Relay reselection indication	Relay reselection indication 11.3.46	O	TV	1
2F	List of candidates U2U relay UE info	List of user info ID 11.3.47	O	TLV	8-257
30	Source end UE IP address	UE IP address 11.3.49	O	TLV	7-19
31	List of target end UE IP addresses	List of UE IP addresses 11.3.50	O	TLV	7-257
32	List of candidates U2U relay UE layer-2 IDs	List of user info IDs and layer-2 IDs 11.3.48	O	TLV	12-257
50	New MSBs of KNRP ID	MSBs of KNRP ID 2 11.3.52	O	TLV	4
70	List of multi-hop remote UE parameters	List of multi-hop remote UE parameters 11.3.58	O	TLV-E	22-65538
10	Child UEs multi-hop user info	List of user info ID 11.3.47	O	TLV	8-257
11	End-to-end QoS flow descriptions	PC5 QoS flow descriptions 11.3.5	O	TLV-E	6-65538
12	Multi-hop path info	List of user info ID 11.3.47	O	TLV	8-257
14	Initiating 5G ProSe multi-hop layer-3 UE-to-UE relay UE MAC address	MAC address 11.3.45	O	TLV	8

10.3.6.2 QoS rules

The UE may include this IE to indicate the PC5 QoS rules for the PC5 QoS flow(s) to be added or modified.

10.3.6.3 Source end UE info

The UE shall include this IE to indicate the user info (i.e. application layer ID) of the source 5G ProSe end UE if:

- a) the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE or 5G ProSe layer-2 UE-to-UE relay UE;
- b) the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE or between the 5G ProSe layer-2 UE-to-UE relay UE and the target 5G ProSe layer-2 end UE; and
- c) one of the following conditions is met:
 - 1) multiple source 5G ProSe layer-3 end UEs have established direct communication with the target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
 - 2) an additional source 5G ProSe end UE requests to establish direct communication with the target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
 - 3) one of the source 5G ProSe layer-3 end UEs requests to release the direct communication with the target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link; or
 - 4) an additional source 5G ProSe end UE requests to establish direct communication with the target 5G ProSe layer-2 end UE via the 5G ProSe layer-2 UE-to-UE relay UE using the same 5G ProSe direct link.

The UE may include this IE to indicate the user info (i.e. application layer ID) of the source 5G ProSe end UE if:

- a) the UE acts as a 5G ProSe UE-to-UE relay UE;
- b) the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE; and
- c) only one source 5G ProSe end UE has established direct communication with the target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link.

10.3.6.4 Target end UE info

The UE shall include this IE to indicate the user info of the target 5G ProSe end UE if:

- a) the UE acts as a source 5G ProSe layer-3 end UE or source 5G ProSe layer-2 end UE;
- b) the 5G ProSe direct link is between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE or between the source 5G ProSe layer-2 end UE and the 5G ProSe layer-2 UE-to-UE relay UE; and
- c) one of the following conditions is met:
 - 1) the source 5G ProSe layer-3 end UE have established direct communication with multiple target 5G ProSe layer-3 end UEs via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
 - 2) the source 5G ProSe layer-3 end UE requests to establish direct communication with an additional target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
 - 3) the source 5G ProSe layer-3 end UE requests to release the direct communication with one of the target 5G ProSe layer-3 end UEs via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link; or
 - 4) the source 5G ProSe layer-2 end UE requests to establish direct communication with an additional target 5G ProSe layer-3 end UE via the 5G ProSe layer-2 UE-to-UE relay UE using the same 5G ProSe direct link.

The UE may include this IE to indicate the user info of the target 5G ProSe end UE if:

- a) the UE acts as a source 5G ProSe end UE, the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the source 5G ProSe end UE has established direct communication with only one target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link.

The UE shall include this IE to indicate the user info of the target 5G ProSe end UE if:

- a) the UE acts as a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE.

10.3.6.5 Target end UE layer-2 ID

The UE may include this IE if:

- a) the UE acts as a source 5G ProSe end UE and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE to indicate the destination layer-2 ID of the target 5G ProSe End UE.

10.3.6.6 Void

10.3.6.7 Source 5G ProSe layer-3 end UE MAC address

The UE shall include this IE when the MAC address of the source 5G ProSe layer-3 end UE, or source 5G ProSe multi-hop layer-3 end UE needs to be indicated.

10.3.6.8 Relay reselection indication

The UE shall include this IE if the 5G ProSe direct link modification request is to trigger the negotiated 5G ProSe UE-to-UE relay reselection or multi-hop UE-to-network relay reselection procedure.

10.3.6.9 List of candidates U2U relay UE info

The UE shall include this IE if the relay reselection is indicated.

10.3.6.10 List of target end UE IP addresses

The UE shall include this IE to indicate the list of IP addresses of the target 5G ProSe end UEs, if relay reselection is indicated, and if:

- a) the UE acts as a source 5G ProSe end UE, and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

10.3.6.11 List of candidates U2U relay UE layer-2 IDs

The UE may include this IE if the relay reselection is indicated to indicate a list of the candidates 5G ProSe UE-to-UE relay UE user info IDs and the associated layer-2 IDs.

10.3.6.12 Source end UE IP address

The UE shall include this IE to indicate the IP address of the source 5G ProSe layer-3 end UE, if relay reselection is indicated, and if:

- a) the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE, and the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE.

10.3.6.13 New MSBs of K_{NRP} ID

The UE shall include this IE if the relay reselection indication is included and the 5G ProSe direct link is between the source 5G ProSe layer-2 end UE and the target 5G ProSe layer-2 end UE.

10.3.6.14 List of multi-hop remote UE parameters

The UE shall include this IE if the UE is acting as a 5G ProSe intermediate UE-to-network relay UE to indicate the list of remote UE parameters, i.e., the identity, address information, total hop count, and the associated PC5 QoS flow for the 5G ProSe multi-hop remote UE(s), to its 5G ProSe multi-hop parent UE-to-network relay UE or its 5G ProSe multi-hop UE-to-network relay UE.

10.3.6.15 Child UEs multi-hop user info

The UE shall include this IE if the UE is acting as a 5G ProSe intermediate UE-to-network relay UE to indicate the list of User info IDs of its one or more 5G ProSe multi-hop child UE-to-network relay UEs or its 5G ProSe multi-hop remote UE to its 5G ProSe multi-hop parent UE-to-network relay UE or its 5G ProSe multi-hop UE-to-network relay UE.

10.3.6.16 End-to-end QoS flow descriptions

The UE may include this IE to deliver the end-to-end QoS information when the UE is acting as a 5G ProSe multi-hop UE-to-network relay UE or a 5G ProSe intermediate UE-to-network relay UE.

10.3.6.17 Multi-hop path info

The UE shall include this IE if:

- a) the UE is acting as the source 5G ProSe multi-hop end UE towards a 5G ProSe multi-hop UE-to-UE relay UE;
- b) the UE is acting as a 5G ProSe multi-hop UE-to-UE relay UE towards another 5G ProSe multi-hop UE-to-UE relay UE; or
- c) the UE is acting as a 5G ProSe multi-hop UE-to-UE relay UE towards the target 5G ProSe multi-hop end UE;

to indicate the list of the user info IDs of the 5G ProSe multi-hop UE-to-UE relay UE(s) selected during the multi-hop layer-3 UE-to-UE relay discovery for Ethernet and Unstructured data unit type with model A or model B.

10.3.6.18 Initiating 5G ProSe multi-hop layer-3 UE-to-UE relay UE MAC address

The UE shall include this IE to indicate the MAC address of the initiating 5G ProSe layer-3 UE-to-UE relay UE when the link between any two 5G ProSe multi-hop layer-3 UE-to-UE relay is being modified.

10.3.7 ProSe direct link modification accept

10.3.7.1 Message definition

This message is sent by the UE to another peer UE to indicate that the link modification request is accepted. See table 10.3.7.1.1.

Message type: PROSE DIRECT LINK MODIFICATION ACCEPT

Significance: dual

Direction: UE to peer UE

Table 10.3.7.1.1: PROSE DIRECT LINK MODIFICATION ACCEPT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK MODIFICATION ACCEPT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
79	QoS flow descriptions	PC5 QoS flow descriptions 11.3.5	O	TLV-E	6-65538
7C	QoS rules	PC5 QoS rules 11.3.29	O	TLV-E	7-65538
66	Source end UE info	Application layer ID 11.3.4	O	TLV	3-257
67	Target end UE info	Application layer ID 11.3.4	O	TLV	3-257
2E	Target 5G ProSe layer-3 end UE MAC address	MAC address 11.3.45	O	TLV	8
9-	Relay reselection indication	Relay reselection indication 11.3.46	O	TV	1
34	New 5G ProSe UE-to-UE relay UE info	User info ID 2 11.3.39	O	TLV	8
30	Source end UE IP address	UE IP address 11.3.49	O	TLV	7-19
35	Target end UE IP address	UE IP address 11.3.49	O	TLV	7-19
53	Target end UE IP address for new relay	UE IP address 11.3.49	O	TLV	7-19
40	New LSBs of KNRP ID	LSBs of KNRP ID 2 11.3.53	O	TLV	4
10	End-to-end QoS flow descriptions	PC5 QoS flow descriptions 11.3.5	O	TLV-E	6-65538
12	Multi-hop path info	List of user info ID 11.3.47	O	TLV	8-257
14	Initiating 5G ProSe multi-hop layer-3 UE-to-UE relay UE MAC address	MAC address 11.3.45	O	TLV	8

10.3.7.2 QoS flow descriptions

The UE shall include this IE if the 5G ProSe direct link modification procedure is to:

- a) add new PC5 QoS flow(s) to the existing 5G ProSe direct link;
- b) modify PC5 QoS parameters of the existing PC5 QoS flow(s);
- c) associate new ProSe application(s) with existing PC5 QoS flow(s); or
- d) remove ProSe application(s) from existing PC5 QoS flow(s).

10.3.7.3 QoS rules

The UE may include this IE to indicate the PC5 QoS rules for the PC5 QoS flow(s) to be added or modified.

10.3.7.4 Source end UE info

The UE shall include this IE to indicate the user info of the source 5G ProSe end UE if:

- a) the UE acts as a target 5G ProSe layer-3 end UE or target 5G ProSe layer-2 end UE;
- b) the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE or between the 5G ProSe layer-2 UE-to-UE relay UE and the target 5G ProSe layer-2 end UE; and
- c) one of the following conditions is met:

- 1) multiple source 5G ProSe layer-3 end UEs have established direct communication with the target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
- 2) an additional source 5G ProSe end UE requests to establish direct communication with the target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
- 3) one of the source 5G ProSe layer-3 end UEs requests to release the direct communication with the target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link; or
- 4) an additional source 5G ProSe end UE requests to establish direct communication with the target 5G ProSe layer-2 end UE via the 5G ProSe layer-2 UE-to-UE relay UE using the same 5G ProSe direct link.

The UE may include this IE to indicate the user info of the source 5G ProSe end UE if:

- a) the UE acts as a target 5G ProSe end UE;
- b) the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE; and
- c) only one source 5G ProSe end UE has established direct communication with the target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link.

10.3.7.5 Target end UE info

The UE shall include this IE to indicate the user info of the target 5G ProSe end UE if:

- a) the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE or 5G ProSe layer-2 UE-to-UE relay UE;
- b) the 5G ProSe direct link is between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE or between the source 5G ProSe layer-2 end UE and the 5G ProSe layer-2 UE-to-UE relay UE; and
- c) one of the following conditions is met:
 - 1) the source 5G ProSe layer-3 end UE have established direct communication with multiple target 5G ProSe layer-3 end UEs via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
 - 2) the source 5G ProSe layer-3 end UE requests to establish direct communication with an additional target 5G ProSe layer-3 end UE via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link;
 - 3) the source 5G ProSe layer-3 end UE requests to release the direct communication with one of the target 5G ProSe layer-3 end UEs via the 5G ProSe layer-3 UE-to-UE relay UE using the same 5G ProSe direct link; or
 - 4) the source 5G ProSe layer-2 end UE requests to establish direct communication with an additional target 5G ProSe layer-2 end UE via the 5G ProSe layer-2 UE-to-UE relay UE using the same 5G ProSe direct link.

The UE may include this IE to indicate the user info of the target 5G ProSe end UE if:

- a) the UE acts as a 5G ProSe UE-to-UE relay UE;
- b) the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE; and
- c) the source 5G ProSe end UE has established direct communication with only one target 5G ProSe end UE via the 5G ProSe UE-to-UE relay UE using the 5G ProSe direct link.

The UE shall include this IE to indicate the user info of the target 5G ProSe end UE if:

- a) the UE acts as the target 5G ProSe end UE and the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE.

10.3.7.6 Target 5G ProSe layer-3 end UE MAC address

The UE shall include this IE when the MAC address of the target 5G ProSe layer-3 end UE, or target 5G ProSe multi-hop layer-3 end UE needs to be indicated.

10.3.7.7 Relay reselection indication

The UE shall include this IE if the 5G ProSe direct link modification request for the negotiated 5G ProSe UE-to-UE relay reselection is accepted.

10.3.7.8 New 5G ProSe UE-to-UE relay UE info

The UE shall include this IE if the relay reselection is indicated.

10.3.7.9 Source end UE IP address

The UE shall include this IE to indicate the IP address of the source 5G ProSe layer-3 end UE if relay reselection is indicated, and if:

- a) the UE acts as a target 5G ProSe layer-3 end UE and the 5G ProSe direct link is between the target 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE; or
- b) the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE and the 5G ProSe direct link is between the source 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE.

10.3.7.10 Target end UE IP address

The UE shall include this IE to indicate the IP address of the target 5G ProSe layer-3 end UE if relay reselection is indicated, and if:

- a) the UE acts as a target 5G ProSe layer-3 end UE and the 5G ProSe direct link is between the target 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE; or
- b) the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE and the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the source 5G ProSe layer-3 end UE.

The UE shall include this IE to indicate the IP address of the target 5G ProSe layer-3 end UE, if:

- a) the 5G ProSe direct link modification procedure is to establish 5G ProSe UE-to-UE relay communication with additional target 5G ProSe layer-3 end UE using the existing 5G ProSe direct link between the source 5G ProSe layer-3 end UE and 5G ProSe layer-3 UE-to-UE relay UE;
- b) the UE acts as the 5G ProSe layer-3 UE-to-UE relay UE;
- c) the data unit type is IP; and
- d) the IP address of the additional target 5G ProSe layer-3 end UE is available in the 5G ProSe layer-3 UE-to-UE relay UE.

10.3.7.11 Target end UE IP address for new relay

The UE shall include this IE to indicate the target 5G ProSe end UE IP address to be used with the newly selected 5G ProSe layer-3 UE-to-UE relay UE, if relay reselection is indicated and if:

- a) the UE acts as a target 5G ProSe layer-3 end UE, and the 5G ProSe direct link is between the target 5G ProSe layer-3 end UE and the 5G ProSe layer-3 UE-to-UE relay UE; or
- b) the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE, and the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the source 5G ProSe layer-3 end UE.

10.3.7.12 New LSBs of K_{NRP} ID

The UE shall include this IE if the relay reselection indication is included and the 5G ProSe direct link is between the source 5G ProSe layer-2 end UE and the target 5G ProSe layer-2 end UE.

10.3.7.13 End-to-end QoS flow descriptions

The UE may include this IE to deliver the end-to-end QoS information when the UE is acting as a 5G ProSe multi-hop UE-to-network relay UE or a 5G ProSe intermediate UE-to-network relay UE.

10.3.7.14 Multi-hop path info

The UE shall include this IE if:

- a) the UE is acting as the target 5G ProSe multi-hop end UE towards a 5G ProSe multi-hop UE-to-UE relay UE;
- b) the UE is acting as a 5G ProSe multi-hop UE-to-UE relay UE towards another 5G ProSe multi-hop UE-to-UE relay UE; or
- c) the UE is acting as a 5G ProSe multi-hop UE-to-UE relay UE towards the source 5G ProSe multi-hop end UE;

to indicate the list of the user info IDs of the 5G ProSe multi-hop UE-to-UE relay UE(s) selected during the multi-hop layer-3 UE-to-UE relay discovery for Ethernet and Unstructured data unit type with model A or model B.

10.3.7.15 Initiating 5G ProSe multi-hop layer-3 UE-to-UE relay UE MAC address

The UE shall include this IE to indicate the MAC address of the initiating 5G ProSe layer-3 UE-to-UE relay UE when the link between any two 5G ProSe multi-hop layer-3 UE-to-UE relay is being modified.

10.3.7a ProSe direct link modification ack

10.3.7a.1 Message definition

This message is sent by the UE to another peer UE to acknowledge the direct link modification procedure. See table 10.3.7a.1.1.

Message type: PROSE DIRECT LINK MODIFICATION ACK

Significance: dual

Direction: UE to peer UE

UE to peer UE

Table 10.3.7a.1.1: PROSE DIRECT LINK MODIFICATION ACK message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK MODIFICATION ACK message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	Relay reselection indication	Relay reselection indication 11.3.46	M	TV	1
	Source end UE IP address for new relay	UE IP address 11.3.49	M	LV	6-18
30	Source end UE IP- address	UE IP address 11.3.49	O	TLV	7-19
35	Target end UE IP- address	UE IP address 11.3.49	O	TLV	7-19

10.3.7a.2 Source end UE IP address

The UE shall include this IE to indicate the IP address of the source 5G ProSe layer-3 end UE if the IP communication is used, and if:

- a) the UE acts as a 5G ProSe layer-3 UE-to-UE relay UE, and the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the target 5G ProSe layer-3 end UE.

10.3.7a.3 Target end UE IP address

The UE shall include this IE to indicate the IP address of the target 5G ProSe layer-3 end UE if the IP communication is used, and if:

- a) the UE acts as a source 5G ProSe layer-3 end UE, and the 5G ProSe direct link is between the 5G ProSe layer-3 UE-to-UE relay UE and the source 5G ProSe layer-3 end UE.

10.3.7a.4 New LSBs of K_{NRP} ID

The UE shall include this IE if the relay reselection indication is included and the 5G ProSe direct link is between the source 5G ProSe layer-2 end UE and the target 5G ProSe layer-2 end UE.

10.3.8 ProSe direct link keepalive request

10.3.8.1 Message definition

This message is sent by a UE to another peer UE when a 5G ProSe direct link keep-alive procedure is initiated. See table 10.3.8.1.1.

Message type: PROSE DIRECT LINK KEEPALIVE REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.8.1.1: PROSE DIRECT LINK KEEPALIVE REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK KEEPALIVE REQUEST message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	Keep-alive counter	Keep-alive counter 11.3.20	M	V	4
5F	Maximum inactivity period	Maximum inactivity period 11.3.21	O	TV	5

10.3.8.2 Maximum inactivity period

The UE may include this IE to indicate its maximum inactivity period to the peer UE.

10.3.9 ProSe direct link keepalive response

10.3.9.1 Message definition

This message is sent by a UE to another peer UE to respond to a PROSE DIRECT LINK KEEPALIVE REQUEST message. See table 10.3.9.1.1.

Message type: PROSE DIRECT LINK KEEPALIVE RESPONSE

Significance: dual

Direction: UE to peer UE

Table 10.3.9.1.1: PROSE DIRECT LINK KEEPALIVE RESPONSE message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK KEEPALIVE RESPONSE message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	Keep-alive counter	Keep-alive counter 11.3.20	M	V	4

10.3.10 ProSe direct link authentication request

10.3.10.1 Message definition

This message is sent by a UE to another peer UE when a 5G ProSe direct link authentication procedure is initiated. See table 10.3.10.1.1.

Message type: PROSE DIRECT LINK AUTHENTICATION REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.10.1.1: PROSE DIRECT LINK AUTHENTICATION REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK AUTHENTICATION REQUEST message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	Key establishment information container	Key establishment information container 11.3.9	M	LV-E	3-65537

10.3.11 ProSe direct link authentication response

10.3.11.1 Message definition

This message is sent by a UE to another peer UE to respond to a PROSE DIRECT LINK AUTHENTICATION REQUEST message. See table 10.3.11.1.1.

Message type: PROSE DIRECT LINK AUTHENTICATION RESPONSE

Significance: dual

Direction: UE to peer UE

Table 10.3.11.1.1: PROSE DIRECT LINK AUTHENTICATION RESPONSE message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK AUTHENTICATION RESPONSE message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	Key establishment information container	Key establishment information container 11.3.9	M	LV-E	3-65537

10.3.12 ProSe direct link authentication reject

10.3.12.1 Message definition

This message is sent by a UE to another peer UE to reject a PROSE DIRECT LINK AUTHENTICATION REQUEST message. See table 10.3.12.1.1.

Message type: PROSE DIRECT LINK AUTHENTICATION REJECT

Significance: dual

Direction: UE to peer UE

Table 10.3.12.1.1: PROSE DIRECT LINK AUTHENTICATION REJECT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK AUTHENTICATION REJECT message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	PC5 signalling protocol cause	PC5 signalling protocol cause 11.3.8	M	V	1

10.3.13 ProSe direct link security mode command

10.3.13.1 Message definition

This message is sent by a UE to another peer UE when a 5G ProSe direct link security mode control procedure is initiated. See table 10.3.13.1.1.

Message type: PROSE DIRECT LINK SECURITY MODE COMMAND

Significance: dual

Direction: UE to peer UE

Table 10.3.13.1.1: PROSE DIRECT LINK SECURITY MODE COMMAND message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK SECURITY MODE COMMAND message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	Selected security algorithms	Selected security algorithms 11.3.22	M	V	1
	UE security capabilities	UE security capabilities 11.3.11	M	LV	3-9
59	UE PC5 unicast signalling security policy	UE PC5 unicast signalling security policy 11.3.12	O	TV	2
57	Nonce_2	Nonce 11.3.10	O	TV	17
5D	LSB of KNRP-sess ID	LSB of KNRP-sess ID 11.3.15	O	TV	2
74	Key establishment information container	Key establishment information container 11.3.9	O	TLV-E	4-65538
5A	MSBs of KNRP ID	MSBs of KNRP ID 11.3.16	O	TV	3
7A	GPI	GPI 11.3.35	O	TLV-E	n-65538
70	EAP message	EAP message 11.3.31	O	TLV-E	7-1503

10.3.13.2 Nonce_2

The UE shall include this IE if the selected integrity protection algorithms is not the null integrity protection algorithm.

NOTE: When the 5G ProSe direct link establishment procedure is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the security procedure over user plane is used as specified in 3GPP TS 33.503 [34], the "Nonce_2" is called "KNRP freshness parameter 2" as specified in 3GPP TS 33.503 [34].

10.3.13.3 LSB of KNRP-sess ID

The UE shall include this IE if the selected integrity protection algorithms is not the null integrity protection algorithm.

10.3.13.4 Key establishment information container

The UE shall include this IE if the UE has derived a new K_{NRP} and the authentication method used to generate K_{NRP} requires sending information to complete the authentication procedure and the 5G ProSe direct link is not for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE.

10.3.13.5 MSBs of K_{NRP} ID

The UE shall include this IE if the UE has derived a new K_{NRP} .

10.3.13.6 UE PC5 unicast signalling security policy

The UE shall include this IE if the PROSE DIRECT LINK SECURITY MODE COMMAND message is triggered by the PROSE DIRECT LINK ESTABLISHMENT REQUEST message. The content of the IE is the same as the content of UE PC5 unicast signalling security policy IE in the received PROSE DIRECT LINK ESTABLISHMENT REQUEST message in order to provide protection against bidding down attacks.

10.3.13.7 GPI

The UE shall include this IE if received from the 5G PKMF according to the security procedure over user plane as specified in 3GPP TS 33.503 [34], when the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

10.3.13.8 EAP message

The EAP message IE is included if received from the network according to the security procedure over control plane as specified in 3GPP TS 33.503 [34], when the direct communication is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

10.3.14 ProSe direct link security mode complete

10.3.14.1 Message definition

This message is sent by a UE to another peer UE to respond to a PROSE DIRECT LINK SECURITY MODE COMMAND message. See table 10.3.14.1.1.

Message type: PROSE DIRECT LINK SECURITY MODE COMPLETE

Significance: dual

Direction: UE to peer UE

Table 10.3.14.1.1: PROSE DIRECT LINK SECURITY MODE COMPLETE message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK SECURITY MODE COMPLETE message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	UE PC5 unicast user plane security policy	UE PC5 unicast user plane security policy 11.3.23	M	V	1
79	QoS flow descriptions	PC5 QoS flow descriptions 11.3.5	O	TLV-E	6-65538
62	IP address configuration	IP address configuration 11.3.6	O	TV	2
61	Target link local IPv6 address	Link local IPv6 address 11.3.7	O	TV	17
5B	LSBs of KNRP ID	LSBs of KNRP ID 11.3.17	O	TV	3
7C	QoS rules	PC5 QoS rules 11.3.29	O	TLV-E	7-65538
33	Source 5G ProSe layer-3 end UE MAC address	MAC address 11.3.45	O	TLV	8

10.3.14.2 IP address configuration

The UE shall include this IE if IP communication is used and the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure.

10.3.14.3 Target link local IPv6 address

The UE shall include this IE if IP communication is used, the IP address configuration is set to "address allocation not supported" and the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure.

10.3.14.4 LSBs of K_{NRP} ID

The UE shall include this IE if a new K_{NRP} was derived.

10.3.14.5 QoS rules

The UE may include this IE to indicate the PC5 QoS rules for the PC5 QoS flow(s) to be added.

10.3.14.6 QoS flow descriptions

The UE shall include this IE if:

- a) the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure and is not for 5G ProSe direct communication between a 5G ProSe remote UE and a 5G ProSe UE-to-network relay UE.

The UE may include this IE if:

- a) the 5G ProSe direct link security mode control procedure was triggered during a 5G ProSe direct link establishment procedure and is for 5G ProSe direct communication between the 5G ProSe layer-3 remote UE and the 5G ProSe layer-3 UE-to-network relay UE.

10.3.14.7 Source 5G ProSe layer-3 end UE MAC address

The UE shall include this IE when the MAC address of the source 5G ProSe layer-3 end UE, or source 5G ProSe multi-hop layer-3 end UE needs to be indicated.

10.3.15 ProSe direct link security mode reject

10.3.15.1 Message definition

This message is sent by a UE to another peer UE to reject a PROSE DIRECT LINK SECURITY MODE COMMAND message. See table 10.3.15.1.1.

Message type: PROSE DIRECT LINK SECURITY MODE REJECT

Significance: dual

Direction: UE to peer UE

Table 10.3.15.1.1: PROSE DIRECT LINK SECURITY MODE REJECT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK SECURITY MODE REJECT message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	PC5 signalling protocol cause	PC5 signalling protocol cause 11.3.8	M	V	1
2B	RAND	RAND 11.3.36	O	TV	17
2C	AUTS	AUTS 11.3.37	O	TV	15

10.3.15.2 RAND

The UE shall include this IE if there is a synchronisation error and the 5G ProSe direct link security mode control procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

10.3.15.3 AUTS

The UE shall include this IE if there is a synchronisation error and the 5G ProSe direct link security mode control procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE.

10.3.16 ProSe direct link rekeying request

10.3.16.1 Message definition

This message is sent by a UE to another peer UE when a 5G ProSe direct link re-keying procedure is initiated. See table 10.3.16.1.1.

Message type: PROSE DIRECT LINK REKEYING REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.16.1.1: PROSE DIRECT LINK REKEYING REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK REKEYING REQUEST message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	UE security capabilities	UE security capabilities 11.3.11	M	LV	3-9
74	Key establishment information container	Key establishment information container 11.3.9	O	TLV-E	4-65538
56	Nonce_1	Nonce 11.3.10	O	TV	17
5C	MSB of KNRP-sess ID	MSB of KNRP-sess ID 11.3.13	O	TV	2
55	Re-authentication indication	Re-authentication indication 11.3.24	O	TV	2
64	User security key ID	User security key ID 11.3.32	O	TLV	3-n
2A	HPLMN ID	PLMN ID 11.3.33	O	TLV	5

10.3.16.2 Key establishment information container

The UE shall include this IE if the null integrity protection algorithm is not in use and the 5G ProSe direct link is not for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE.

10.3.16.3 Nonce_1

The UE shall include this IE if the null integrity protection algorithm is not in use.

NOTE 2: When the 5G ProSe direct link re-keying procedure is between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and the security procedure over user plane is used as specified in 3GPP TS 33.503 [34], the "Nonce_1" is called "KNRP freshness parameter 1" as specified in 3GPP TS 33.503 [34].

10.3.16.4 MSB of KNRP-sess ID

The UE shall include this IE if the null integrity protection algorithm is not in use.

10.3.16.5 Re-authentication indication

The UE shall include this IE if the UE wants to derive a new K_{NRP} .

10.3.16.6 User security key ID

The UE shall include this IE if the 5G ProSe direct link re-keying procedure is for direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE or between the 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE, and:

- a) the security procedure over user plane as specified in 3GPP TS 33.503 [34] is used and the UE has a valid UP-PRUK; or
- b) the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used and the UE has a valid CP-PRUK associated with the relay service code of the target UE.

10.3.16.7 HPLMN ID

The UE shall include this IE if the UP-PRUK ID is included and is not in NAI format (see 3GPP TS 33.503 [34]).

10.3.17 ProSe direct link rekeying response

10.3.17.1 Message definition

This message is sent by a UE to another peer UE to respond to a PROSE DIRECT LINK REKEYING REQUEST message. See table 10.3.17.1.1.

Message type: PROSE DIRECT LINK REKEYING RESPONSE

Significance: dual

Direction: UE to peer UE

Table 10.3.17.1.1: PROSE DIRECT LINK REKEYING RESPONSE message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK REKEYING RESPONSE message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1

10.3.18 ProSe direct link identifier update request

10.3.18.1 Message definition

This message is sent by a UE to another peer UE to initiate the direct link identifier update procedure. See table 10.3.18.1.1.

Message type: PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.18.1.1: PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	MSB of KNRP-sess ID	MSB of KNRP-sess ID 11.3.13	M	V	1
	Source layer-2 ID	Layer-2 ID 11.3.25	M	V	3
27	Source user info	Application layer ID 11.3.4	O	TLV	3-257
60	Source link local IPv6 address	Link local IPv6 address 11.3.7	O	TV	17
30	Source end UE IP address	UE IP address 11.3.49	O	TLV	7-19
A-	IP address/prefix needed indication	IP address/prefix needed indication 11.3.42	O	TV	1
69	List of target end UE user info	List of application layer IDs 11.3.57	O	TLV	3-257
6A	List of target end UE IP addresses	List of UE IP addresses 11.3.50	O	TLV	7-257
10	List of source end UE IP addresses	List of UE IP addresses 11.3.50	O	TLV	7-257
9-	Hop limit	Hop limit 11.3.59	O	TV	1

10.3.18.2 Source user info

This IE is included when the UE receives a new application layer ID.

10.3.18.3 Source link local IPv6 address

This IE is included when the link local IPv6 address changes at the UE and the 5G ProSe direct link is not for 5G ProSe direct communication between 5G ProSe layer-2 remote UE and 5G ProSe layer-2 UE-to-network relay UE.

10.3.18.4 IP address/prefix needed indication

This IE is included when the initiating UE acting as a 5G ProSe layer-3 end UE needs a new IP address/prefix to be allocated by the 5G ProSe layer-3 UE-to-UE relay UE.

10.3.18.5 Void

10.3.18.6 List of target End UE user info

This IE is included when the UE acting as a 5G ProSe layer-3 end UE changes its IP address/prefix and its peer UE(s) (i.e. target 5G ProSe End UE(s)) need to be informed of this new IP address/prefix.

10.3.18.7 List of target end UE IP addresses

This IE is included when the UE acting as a 5G ProSe layer-3 end UE or a 5G ProSe multi-hop end UE changes its IP address/prefix and its peer UE(s) (i.e. target 5G ProSe End UE(s)) need to be informed of this new IP address/prefix.

10.3.18.8 Source end UE IP address

This IE is included when the UE acting as a 5G ProSe layer-3 end UE changes its IP address/prefix.

10.3.18.9 List of source end UE IP addresses

This IE is included when the UE acting as a 5G ProSe multi-hop layer-3 end UE needs to inform its static IP address/prefix to its peer UE(s).

10.3.18.10 Hop limit

The UE may include this IE for the 5G ProSe multi-hop layer-3 UE-to-UE relay communication to inform the 5G ProSe multi-hop layer-3 UE-to-UE relay UE or the 5G ProSe multi-hop layer-3 end UE about the new value for the hop limit, when the hop limit value has changed.

10.3.19 ProSe direct link identifier update accept

10.3.19.1 Message definition

This message is sent by the UE to another peer UE to indicate that the link identifier update request is accepted. See table 10.3.19.1.1.

Message type: PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT

Significance: dual

Direction: UE to peer UE

Table 10.3.19.1.1: PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	LSB of KNRP-sess ID	LSB of KNRP-sess ID 11.3.15	M	V	1
	MSB of KNRP-sess ID	MSB of KNRP-sess ID 11.3.13	M	V	1
	Source layer-2 ID	Layer-2 ID 11.3.25	M	V	3
	Target layer-2 ID	Layer-2 ID 11.3.25	M	V	3
28	Target user info	Application layer ID 11.3.4	O	TLV	3-257
61	Target link local IPv6 address	Link local IPv6 address 11.3.7	O	TV	17
27	Source user info	Application layer ID 11.3.4	O	TLV	3-257
60	Source link local IPv6 address	Link local IPv6 address 11.3.7	O	TV	17
30	Source end UE IP address	UE IP address 11.3.49	O	TLV	7-19

10.3.19.2 Target user info

This IE is included if the UE receives the Source user info IE in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message.

10.3.19.3 Target link local IPv6 address

This IE is included if the UE receives the Source link local IPv6 address IE in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message.

10.3.19.4 Source user info

This IE is included when the UE receives a new application layer ID from the upper layers.

10.3.19.5 Source link local IPv6 address

This IE is included when the link local IPv6 address changes at the UE and the 5G ProSe direct link is not for 5G ProSe direct communication between 5G ProSe layer-2 remote UE and 5G ProSe layer-2 UE-to-network relay UE.

10.3.19.6 Source end UE IP address

This IE is included if the UE acting as a 5G ProSe layer-3 UE-to-UE relay UE receives the IP address of the source 5G ProSe end UE in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message, or allocates an IP address to the source 5G ProSe end UE upon reception of an IP address/prefix needed indication in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message.

10.3.20 ProSe direct link identifier update ack

10.3.20.1 Message definition

This message is sent by the initiating UE to target UE to indicate that the initiating UE has received target UE's accept message. See table 10.3.20.1.1.

Message type: PROSE DIRECT LINK IDENTIFIER UPDATE ACK

Significance: dual

Direction: UE to peer UE

Table 10.3.20.1.1: PROSE DIRECT LINK IDENTIFIER UPDATE ACK message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK IDENTIFIER UPDATE ACK message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	LSB of KNRP-sess ID	LSB of KNRP-sess ID 11.3.15	M	V	1
	Target layer-2 ID	Layer-2 ID 11.3.25	M	V	3
28	Target user info	Application layer ID 11.3.4	O	TLV	3-257
61	Target link local IPv6 address	Link local IPv6 address 11.3.7	O	TV	17
30	Source end UE IP address	UE IP address 11.3.49	O	TLV	7-19

10.3.20.2 Target user info

This IE is included when the UE receives the Source user info IE in the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message.

10.3.20.3 Target link local IPv6 address

This IE is included when the UE receives the Source link local IPv6 address IE in the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message.

10.3.20.4 Source end UE IP address

This IE is included if the UE acting as a source 5G ProSe end UE receives the Source end UE IP address IE in the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message.

10.3.21 ProSe direct link identifier update reject

10.3.21.1 Message definition

This message is sent by the target UE to initiating UE to indicate that the link identifier update request is not accepted. See table 10.3.21.1.1.

Message type: PROSE DIRECT LINK IDENTIFIER UPDATE REJECT

Significance: dual

Direction: UE to peer UE

Table 10.3.21.1.1: PROSE DIRECT LINK IDENTIFIER UPDATE REJECT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK IDENTIFIER UPDATE REJECT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	PC5 signalling protocol cause	PC5 signalling protocol cause 11.3.8	M	V	1

10.3.22 ProSe direct link modification reject

10.3.22.1 Message definition

This message is sent by the UE to another peer UE to indicate that the link modification request is not accepted. See table 10.3.22.1.1.

Message type: PROSE DIRECT LINK MODIFICATION REJECT

Significance: dual

Direction: UE to peer UE

Table 10.3.22.1.1: PROSE DIRECT LINK MODIFICATION REJECT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK MODIFICATION REJECT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	PC5 signalling protocol cause	PC5 signalling protocol cause 11.3.8	M	V	1
69	PC5 end UE failure cause	PC5 signalling protocol cause 2 11.3.41	O	TLV	3
66	Source end UE info	Application layer ID 11.3.4	O	TLV	3-257
67	Target end UE info	Application layer ID 11.3.4	O	TLV	3-257

10.3.22.2 PC5 end UE failure cause

The UE may include this IE if:

- a) the UE acts as a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE to indicate the PC5 signalling protocol cause received from the target 5G ProSe end UE.

10.3.22.3 Source end UE info

The UE may include this IE if:

- a) the UE acts as a target 5G ProSe end UE and the 5G ProSe direct link is between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE to indicate the user info of the source 5G ProSe end UE.

10.3.22.4 Target end UE info

The UE may include this IE if:

- a) the UE acts as a 5G ProSe UE-to-UE relay UE and the 5G ProSe direct link is between the source 5G ProSe end UE and the 5G ProSe UE-to-UE relay UE to indicate the user info of the target 5G ProSe end UE.

10.3.23 ProSe direct link authentication failure

10.3.23.1 Message definition

This message is sent by a UE to another peer UE to reject a PROSE DIRECT LINK AUTHENTICATION RESPONSE message. See table 10.3.23.1.1.

Message type: PROSE DIRECT LINK AUTHENTICATION FAILURE

Significance: dual

Direction: UE to peer UE

Table 10.3.23.1.1: PROSE DIRECT LINK AUTHENTICATION FAILURE message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK AUTHENTICATION FAILURE message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
74	Key establishment information container	Key establishment information container 11.3.9	O	TLV-E	4-65538

10.3.23.2 Key establishment information container

The UE shall include this IE if it is provided by upper layers.

10.3.24 ProSe additional parameters announcement request

10.3.24.1 Message definition

This message is sent by the 5G ProSe layer-3 remote UE to 5G ProSe layer-3 UE-to-network relay UE to initiate the ProSe additional parameters announcement request procedure. See table 10.3.24.1.1.

Message type: PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.24.1.1: PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence Number	Sequence Number 11.3.2	M	V	1

10.3.25 ProSe additional parameters announcement response

10.3.25.1 Message definition

This message is sent by the 5G ProSe layer-3 UE-to-network relay UE to the 5G ProSe layer-3 remote UE to acknowledge and respond to the ProSe additional parameters announcement request. See table 10.3.25.1.1.

Message type: PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE

Significance: dual

Direction: UE to peer UE

Table 10.3.25.1.1: PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence Number	Sequence number 11.3.2	M	V	1
	Additional parameters announcement request refresh timer T5106	Binary 11.3.28	M	V	2

10.3.26 ProSe AA message transport request

10.3.26.1 Message definition

This message is sent by:

- a) the 5G ProSe UE-to-network relay UE to the 5G ProSe remote UE; or
- b) the 5G ProSe UE-to-UE relay UE to the 5G ProSe end UE;

to forward the EAP message. See table 10.3.26.1.1.

Message type: PROSE AA MESSAGE TRANSPORT REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.26.1.1: PROSE AA MESSAGE TRANSPORT REQUEST content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE AA MESSAGE TRANSPORT REQUEST identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence Number	Sequence number 11.3.2	M	V	1
70	EAP message	EAP message 11.3.31	O	TLV-E	7-1503

10.3.26.2 EAP message

The EAP message IE is included if the PROSE AA MESSAGE TRANSPORT REQUEST message is used in an EAP based authentication procedure.

10.3.27 ProSe AA message transport response

10.3.27.1 Message definition

This message is sent by:

- a) the 5G ProSe remote UE to the 5G ProSe UE-to-network relay UE; or
- b) the 5G ProSe end UE to the 5G ProSe UE-to-UE relay UE;

to forward the EAP message. See table 10.3.27.1.1.

Message type: PROSE AA MESSAGE TRANSPORT RESPONSE

Significance: dual

Direction: UE to peer UE

Table 10.3.27.1.1: PROSE AA MESSAGE TRANSPORT RESPONSE content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE AA MESSAGE TRANSPORT RESPONSE identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence Number	Sequence number 11.3.2	M	V	1
70	EAP message	EAP message 11.3.31	O	TLV-E	7-1503

10.3.27.2 EAP message

The EAP message IE is included if the PROSE AA MESSAGE TRANSPORT RESPONSE message is used in an EAP based authentication procedure.

10.3.28 ProSe UE to UE relay update request

10.3.28.1 Message definition

This message is sent by a 5G ProSe layer-3 UE-to-UE relay UE which is handling communication between a source end UE and a target end UE to initiate the relay update procedure. See table 10.3.28.1.1.

Message type: PROSE UE TO UE RELAY UPDATE REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.28.1.1: PROSE UE TO UE RELAY UPDATE REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE UE TO UE RELAY UPDATE REQUEST message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	MSB of KNRP-sess ID	MSB of KNRP-sess ID 11.3.13	M	V	1
	Source layer-2 ID	Layer-2 ID 11.3.25	M	V	3
36	Old source end UE IP address	UE IP address 11.3.49	O	TLV	7-19
37	New source end UE IP address	UE IP address 11.3.49	O	TLV	7-19
6C	Old source end UE user info	Application layer ID 11.3.4	O	TLV	3-257
6D	New source end UE user info	Application layer ID 11.3.4	O	TLV	3-257

10.3.28.2 Old source end UE IP address

This IE shall be included if IP communication is used and the IP address changes at the source end UE.

10.3.28.3 New source end UE IP address

This IE shall be included if IP communication is used and the IP address changes at the source end UE.

10.3.28.4 Old source end UE user info

This IE shall be included if the source end UE application layer ID changes.

10.3.28.5 New source end UE user info

This IE shall be included if the source end UE application layer ID changes.

10.3.28.6 Old Source end UE user info

This IE is included when the 5G ProSe layer-3 UE-to-UE relay UE receives the Source user info IE in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message. This IE contains the initiating UE's user info associated to the direct link with the 5G ProSe layer-3 UE-to-UE relay UE.

10.3.28.7 New Source end UE user info

This IE is included when the 5G ProSe layer-3 UE-to-UE relay UE receives the Source user info IE in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message. This IE contains the new initiating UE's user info specified in the Source user info IE in the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message.

10.3.29 ProSe UE to UE relay update accept

10.3.29.1 Message definition

This message is sent by the target end UE to 5G ProSe layer-3 UE-to-UE relay UE to complete the relay update procedure. See table 10.3.29.1.1.

Message type: PROSE UE TO UE RELAY UPDATE ACCEPT

Significance: dual

Direction: UE to peer UE

Table 10.3.29.1.1: PROSE UE TO UE RELAY UPDATE ACCEPT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE UE TO UE RELAY UPDATE ACCEPT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	LSB of KNRP-sess ID	LSB of KNRP-sess ID 11.3.15	M	V	1
	MSB of KNRP-sess ID	MSB of KNRP-sess ID 11.3.13	M	V	1
	Source layer-2 ID	Layer-2 ID 11.3.25	M	V	3
	Target layer-2 ID	Layer-2 ID 11.3.25	M	V	3
36	Old source end UE IP address	UE IP address 11.3.49	O	TLV	7-19
37	New source end UE IP address	UE IP address 11.3.49	O	TLV	7-19
6C	Old source end UE user info	Application layer ID 11.3.4	O	TLV	3-257
6D	New source end UE user info	Application layer ID 11.3.4	O	TLV	3-257

10.3.29.2 Old source end UE IP address

This IE shall be included if the 5G ProSe target end UE receives the Old source end UE IP address IE in the PROSE UE TO UE RELAY UPDATE REQUEST message.

10.3.29.3 New source end UE IP address

This IE shall be included if the 5G ProSe target end UE receives the New source end UE IP address IE in the PROSE UE TO UE RELAY UPDATE REQUEST message.

10.3.29.4 Old source end UE user info

This IE shall be included if the 5G ProSe target end UE receives the Old Source end UE user info IE in the PROSE UE TO UE RELAY UPDATE REQUEST message.

10.3.29.5 New source end UE user info

This IE shall be included if the 5G ProSe target end UE receives the New source end UE user info IE in the PROSE UE TO UE RELAY UPDATE REQUEST message.

10.3.29.6 Old Source end UE user info

This IE is included when the Target UE receives the Old Source user info IE in the PROSE UE TO UE RELAY UPDATE REQUEST message.

10.3.29.7 New Source end UE user info

This IE is included when the Target UE receives the New Source user info IE in the PROSE UE TO UE RELAY UPDATE REQUEST message.

10.3.30 ProSe path switching request

10.3.30.1 Message definition

This message is sent by the UE that requires to initiate the path switching procedure from the direct communication path over PC5 to the direct communication path over Uu. See table 10.3.30.1.1.

Message type: PROSE PATH SWITCHING REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.30.1.1: PROSE PATH SWITCHING REQUEST content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE PATH SWITCHING REQUEST message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence Number	Sequence number 11.3.2	M	V	1
	Required ProSe identifiers	ProSe identifier 11.3.3	M	LV-E	21-65538
7E	Uu QoS flow descriptions	QoS flow descriptions 11.3.40	O	TLV-E	6-65538

10.3.30.2 Uu QoS flow descriptions

The Uu QoS flow descriptions IE is included if the initiating UE derives the requested QoS flow description based on the PC5 QoS parameters of the PC5 QoS flow(s) between the initiating UE and the target UE.

10.3.31 ProSe path switching accept

10.3.31.1 Message definition

This message is sent by the UE to another peer UE to indicate that the ProSe path switching request is accepted. See table 10.3.31.1.1.

Message type: PROSE PATH SWITCHING ACCEPT

Significance: dual

Direction: UE to peer UE

Table 10.3.31.1.1: PROSE PATH SWITCHING ACCEPT content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE PATH SWITCHING ACCEPT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence Number	Sequence number 11.3.2	M	V	1
	Negotiated ProSe identifiers	ProSe identifier 11.3.3	M	LV-E	21-65538

10.3.32 ProSe path switching reject

10.3.32.1 Message definition

This message is sent by the target UE to initiating UE to indicate that the ProSe path switching request is not accepted. See table 10.3.32.1.1.

Message type: PROSE PATH SWITCHING REJECT

Significance: dual

Direction: UE to peer UE

Table 10.3.32.1.1: PROSE PATH SWITCHING REJECT content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE PATH SWITCHING REJECT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence Number	Sequence number 11.3.2	M	V	1
	PC5 signalling protocol cause	PC5 signalling protocol cause 11.3.8	M	V	1

10.3.33 ProSe UE to UE relay update reject

10.3.33.1 Message definition

This message is sent by the target 5G ProSe end UE to 5G ProSe layer-3 UE-to-UE relay UE to reject the relay update procedure. See table 10.3.33.1.1.

Message type: PROSE UE TO UE RELAY UPDATE REJECT

Significance: dual

Direction: UE to peer UE

Table 10.3.33.1.1: PROSE UE TO UE RELAY UPDATE REJECT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE UE TO UE RELAY UPDATE REJECT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	PC5 signalling protocol cause	PC5 signalling protocol cause 11.3.8	M	V	1

10.3.34 ProSe direct link identity request

10.3.34.1 Message definition

This message is sent by the 5G ProSe UE-to-network relay UE to the 5G ProSe remote UE to request the 5G ProSe remote UE to provide specified identity. See table 10.3.34.1.1.

Message type: PROSE DIRECT LINK IDENTITY REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.34.1.1: PROSE DIRECT LINK IDENTITY REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK IDENTITY REQUEST message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	UE identity type	5GS identity type 11.3.50A	M	V	1/2
	Spare half octet	Spare half octet 11.3.51	M	V	1/2

10.3.35 ProSe direct link identity response

10.3.35.1 Message definition

This message is sent by the 5G ProSe remote UE to the 5G ProSe UE-to-network relay UE to provide the requested identity. See table 10.3.35.1.1.

Message type: PROSE DIRECT LINK IDENTITY RESPONSE

Significance: dual

Direction: UE to peer UE

Table 10.3.35.1.1: PROSE DIRECT LINK IDENTITY RESPONSE message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK IDENTITY RESPONSE message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	UE identity	5GS mobile identity 11.3.30	M	LV-E	3-n

10.3.36 ProSe direct link security establishment accept

10.3.36.1 Message definition

This message is sent by a 5G ProSe layer-3 UE-to-UE relay UE to a target 5G ProSe layer-3 end UE to accept a PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message. See table 10.3.36.1.1.

Message type: PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT

Significance: dual

Direction: UE to peer UE

Table 10.3.36.1.1: PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
79	QoS flow descriptions	PC5 QoS flow descriptions 11.3.5	O	TLV-E	6-65538
7C	QoS rules	PC5 QoS rules 11.3.29	O	TLV-E	7-65538
62	IP address configuration	IP address configuration 11.3.6	O	TV	2
61	Target link local IPv6 address	Link local IPv6 address 11.3.7	O	TV	17
33	Source 5G ProSe layer-3 end UE MAC address	MAC address 11.3.45	O	TLV	8

10.3.36.2 IP address configuration

The UE shall include this IE if IP communication is used.

10.3.36.3 Target link local IPv6 address

The UE shall include this IE if IP communication is used and the IP address configuration is set to "address allocation not supported".

10.3.36.4 QoS flow descriptions

The UE shall include this IE if QoS flow descriptions are received from the source 5G ProSe layer-3 end UE.

10.3.36.5 QoS rules

The UE may include this IE if PC5 QoS rules are received from the source 5G ProSe layer-3 end UE.

10.3.36.6 Source 5G ProSe layer-3 end UE MAC address

The UE shall include this IE when the MAC address of the source 5G ProSe layer-3 end UE needs to be indicated.

10.3.37 ProSe direct link security establishment request

10.3.37.1 Message definition

This message is sent by the target 5G ProSe end UE to establish the security between the 5G ProSe UE-to-UE relay UE and the target 5G ProSe end UE. See table 10.3.37.1.1.

Message type: PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST

Significance: dual

Direction: UE to peer UE

Table 10.3.37.1.1: PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	UE security capabilities	UE security capabilities 11.3.11	M	LV	3-9
	UE PC5 unicast signalling security policy	UE PC5 unicast signalling security policy 11.3.12	M	V	1
	Nonce_1	Nonce 11.3.10	M	V	16
	UTC-based counter LSB	UTC-based counter LSB 11.2.11	M	V	1
	Relay service code	Relay service code 11.3.26	M	V	3
5C	MSB of KNRP-sess ID	MSB of KNRP-sess ID 11.3.13	O	TV	2
7D	UE identity	5GS mobile identity 11.3.30	O	TLV-E	4-n
64	User security key ID	User security key ID 11.3.32	O	TLV	3-n
2A	HPLMN ID	PLMN ID 11.3.33	O	TLV	5
4F	MIC	MIC 11.3.38	O	TV	5

10.3.37.2 MSB of KNRP-sess ID

The UE shall include this IE if the UE PC5 unicast signalling security policy is set to "Signalling integrity protection required" or "Signalling integrity protection preferred".

10.3.37.3 UE identity

The UE shall include this IE if the security for 5G ProSe UE-to-UE relay communication uses the security procedure over control plane and the UE does not have a valid CP-PRUK as specified in 3GPP TS 33.503 [34], or, the security for 5G ProSe UE-to-UE relay communication uses the security procedure over user plane and the UE does not have a valid UP-PRUK as specified in 3GPP TS 33.503 [34].

10.3.37.4 User security key ID

The UE shall include this IE if:

- the security procedure over user plane for 5G ProSe UE-to-UE relay is used as specified in 3GPP TS 33.503 [34] and the UE has a valid UP-PRUK; or
- the security procedure over control plane for 5G ProSe UE-to-UE relay is used as specified in 3GPP TS 33.503 [34] and the UE has a valid CP-PRUK associated with the relay service code of the target UE.

10.3.37.5 HPLMN ID

The UE shall include this IE if the UP-PRUK ID of the UE is included and is not in NAI format (see 3GPP TS 33.503 [34]).

10.3.37.6 MIC

The UE shall include this IE if the UE has the DUIK.

10.3.38 ProSe direct link security establishment reject

10.3.38.1 Message definition

This message is sent by the target UE to the initiating UE to indicate that the PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message is not accepted. See table 10.3.38.1.1.

Message type: PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT

Significance: dual

Direction: UE to peer UE

Table 10.3.38.1.1: PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message identity	ProSe PC5 signalling message type 11.3.1	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	PC5 signalling protocol cause	PC5 signalling protocol cause 11.3.8	M	V	1

10.3.39 ProSe direct discovery set transfer ind

10.3.39.1 Message definition

This message is sent by a UE to another peer UE when a 5G ProSe direct discovery set retrieval procedure is initiated. See table 10.3.39.1.1.

Message type: PROSE DIRECT DISCOVERY SET TRANSFER IND

Significance: dual

Direction: UE to peer UE

Table 10.3.39.1.1: PROSE DIRECT DISCOVERY SET TRANSFER IND message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT DISCOVERY SET TRANSFER IND message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1
	Relay service code	Relay service code 11.3.26	M	V	4
	Direct discovery set	Direct discovery set 11.2.17	M	LV	11-n

10.3.40 ProSe direct discovery set transfer ack

10.3.40.1 Message definition

This message is sent by a UE to another peer UE to respond to a PROSE DIRECT DISCOVERY SET TRANSFER IND message. See table 10.3.40.1.1.

Message type: PROSE DIRECT DISCOVERY SET TRANSFER ACK

Significance: dual

Direction: UE to peer UE

Table 10.3.40.1.1: PROSE DIRECT DISCOVERY SET TRANSFER ACK message content

IEI	Information Element	Type/Reference	Presence	Format	Length
	PROSE DIRECT DISCOVERY SET TRANSFER ACK message identity	ProSe PC5 signalling message type 11.3.1.	M	V	1
	Sequence number	Sequence number 11.3.2	M	V	1

10.4 Provisioning of 5G ProSe configuration information signalling messages

10.4.1 UE policy provisioning request

The UE POLICY PROVISIONING REQUEST message is sent by the UE to the PCF to request the PCF to manage ProSeP, see 3GPP TS 24.587 [18] clause 7.2.1 for the message definition.

10.4.2 UE policy provisioning reject

The UE POLICY PROVISIONING REJECT message is sent by the PCF to the UE to report that the PCF rejects the request to manage ProSeP, see 3GPP TS 24.587 [18] clause 7.2.2 for the message definition.

10.5 5G ProSe discovery and security messages over PC3a

10.5.1 General

This clause defines the XML schema and MIME type related to 5G ProSe direct discovery messages.

10.5.2 application/vnd.3gpp-prose-pc3a+xml

The MIME type is used to carry information related to the 5G ProSe discovery operation. It shall be coded as an XML document containing one of the following 5G ProSe discovery messages:

- a) DISCOVERY_REQUEST;
- b) DISCOVERY_RESPONSE;
- c) MATCH_REPORT;
- d) MATCH_REPORT_ACK;
- e) DISCOVERY_UPDATE_REQUEST;
- f) DISCOVERY_UPDATE_RESPONSE;
- g) ANNOUNCING_ALERT_REQUEST;
- h) ANNOUNCING_ALERT_RESPONSE;
- i) PROSE_5GPKMF_ADDRESS_REQUEST;
- j) PROSE_5GPKMF_ADDRESS_RESPONSE;
- k) PROSE_SECURITY_MATERIAL_REQUEST; or
- l) PROSE_SECURITY_MATERIAL_RESPONSE

Each of those messages is presented in the XML document as an XML element named after the corresponding message.

10.5.3 XML schema

Implementations in compliance with the present document shall implement the XML schema defined below for messages used in 5G ProSe direct discovery procedures over PC3a interface.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns="urn:3GPP:ns:5GProSe:Discovery:2021"
  elementFormDefault="qualified"
  targetNamespace="urn:3GPP:ns:5GProSe:Discovery:2021">
  <xs:annotation>
    <xs:documentation>
      Info for 5G ProSe Discovery Control Messages Syntax
    </xs:documentation>
  </xs:annotation>

  <!-- Complex types defined for parameters with complicated structure -->

  <xs:complexType name="AppID-info">
    <xs:sequence>
      <xs:element name="OS-ID">
        <xs:simpleType>
          <xs:restriction base="xs:hexBinary">
            <xs:length value="16"/>
          </xs:restriction>
        </xs:simpleType>
      </xs:element>
      <xs:element name="OS-App-ID" type="xs:string"/>
      <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="PLMN-info">
    <xs:sequence>
      <xs:element name="mcc" type="xs:integer"/>
      <xs:element name="mnc" type="xs:integer"/>
      <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="PLMN-list-type">
    <xs:sequence>
      <xs:element name="PLMN" type="PLMN-info" maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="DiscFilter-info">
    <xs:sequence>
      <xs:element name="ProSe-Application-Code" type="xs:hexBinary"/>
      <xs:element name="ProSe-Application-Mask" type="xs:hexBinary" maxOccurs="unbounded"/>
      <xs:element name="TTL-timer-T5064" type="xs:integer"/>
      <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="MatchingFilter-info">
    <xs:sequence>
      <xs:element name="Code" type="xs:hexBinary"/>
      <xs:element name="Mask" type="xs:hexBinary" maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="DUCK-info">
    <xs:sequence>
```

```

        <xs:element name="discovery-user-confidentiality-key" type="xs:hexBinary"/>
        <xs:element name="encrypted-bitmask" type="xs:hexBinary"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedDiscFilter-info">
    <xs:sequence>
        <xs:element name="filter" type="MatchingFilter-info" maxOccurs="unbounded"/>
        <xs:element name="TTL-timer-T5066" type="xs:integer"/>
        <xs:element name="RPAUID" type="xs:string" minOccurs="0" />
        <xs:element name="metadata-indicator" type="xs:integer" minOccurs="0"/>
        <xs:element name="metadata" type="xs:string" minOccurs="0"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedCodeSuffixRange-info">
    <xs:sequence>
        <xs:element name="beginning-suffix-code" type="xs:hexBinary" />
        <xs:element name="ending-suffix-code" type="xs:hexBinary" minOccurs="0"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedMonitoringUpdate-info">
    <xs:sequence>
        <xs:element name="updated-filter" type="RestrictedDiscFilter-info" maxOccurs="unbounded"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedAnnouncingUpdate-info">
    <xs:sequence>
        <xs:element name="ProSe-Restricted-Code" type="xs:hexBinary" />
        <xs:element name="validity-timer-T5062" type="xs:integer" />
        <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="MonitoringUpdate-info">
    <xs:sequence>
        <xs:element name="updated-filter" type="DiscFilter-info" maxOccurs="unbounded"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="AnnouncingUpdate-info">
    <xs:sequence>
        <xs:element name="ProSe-Application-Code" type="xs:hexBinary" />
        <xs:element name="validity-timer-T5060" type="xs:integer" />
        <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="Update-Option-info">
    <xs:choice>
        <xs:element name="update-info-restricted-announce" type="RestrictedAnnouncingUpdate-info" />
        <xs:element name="update-info-restricted-monitor" type="RestrictedMonitoringUpdate-info" />
        <xs:element name="update-info-open-annnounce" type="AnnouncingUpdate-info" />
        <xs:element name="update-info-open-monitor" type="MonitoringUpdate-info"/>
        <xs:element name="anyExt" type="anyExtType" />
        <xs:any namespace="##other" processContents="lax"/>
    </xs:choice>
</xs:complexType>

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<xs:complexType name="Restricted-Code-Option-info">
  <xs:choice>
    <xs:element name="ProSe-Restricted-Code" type="xs:hexBinary" />
    <xs:element name="ProSe-Response-Code" type="xs:hexBinary" />
    <xs:element name="anyExt" type="anyExtType" />
    <xs:any namespace="##other" processContents="lax"/>
  </xs:choice>
</xs:complexType>

<xs:complexType name="Subquery-info">
  <xs:sequence>
    <xs:element name="ProSe-Rquery-Code" type="xs:hexBinary" />
    <xs:element name="response-filter" type="MatchingFilter-info" maxOccurs="unbounded"/>
    <xs:element name="validity-timer-T5070" type="xs:integer"/>
    <xs:element name="code-sending-security-parameter" type="Restricted-Security-info" />
    <xs:element name="code-receiving-security-parameter" type="Restricted-Security-info"
minOccurs="0" />
    <xs:element name="RPAUID" type="xs:string" minOccurs="0" />
    <xs:element name="metadata" type="xs:string" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="Restricted-Security-info">
  <xs:sequence>
    <xs:element name="DUSK" type="xs:hexBinary" minOccurs="0" />
    <xs:element name="DUIK" type="xs:hexBinary" minOccurs="0" />
    <xs:element name="DUCK" type="DUCK-info" minOccurs="0" />
    <xs:element name="MIC-check-indicator" type="xs:boolean" minOccurs="0" />
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="ApplicationCodeSuffixRange-info">
  <xs:sequence>
    <xs:element name="beginning-suffix-code" type="xs:hexBinary" />
    <xs:element name="ending-suffix-code" type="xs:hexBinary" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="ProSeApplicationCodeACE-info">
  <xs:sequence>
    <xs:element name="ProSe-Application-Code-Prefix" type="xs:hexBinary" />
    <xs:element name="ProSe-Application-Code-Suffix-Range" type="ApplicationCodeSuffixRange-
info" maxOccurs="unbounded" />
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="PC5-Security-Policies-info">
  <xs:sequence>
    <xs:element name="signalling-integrity-protection-policy" type="xs:integer"/>
    <xs:element name="signalling-ciphering-policy" type="xs:integer"/>
    <xs:element name="user-plane-integrity-protection-policy" type="xs:integer"/>
    <xs:element name="user-plane-ciphering-policy" type="xs:integer"/>
    <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="requested-for-type">
  <xs:sequence>
    <xs:element name="remote-UE" type="empty-type" minOccurs="0"/>
    <xs:element name="UNR" type="empty-type" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>

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```

    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <!-- XML elements to be included in the <anyExt> element of "requested-for-type" complex type -->
  <xs:element name="end-UE" type="empty-type"/>
  <xs:element name="UUR" type="empty-type"/>

  <xs:complexType name="PC5-security-policies-type">
    <xs:sequence>
      <xs:element name="signalling-ciphering-policy" type="xs:integer"/>
      <xs:element name="user-plane-integrity-protection-policy" type="xs:integer"/>
      <xs:element name="user-plane-ciphering-policy" type="xs:integer"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="security-parameters-for-remote-UE-type">
    <xs:sequence>
      <xs:element name="expiration-timer" type="xs:integer"/>
      <xs:element name="code-receiving-security-parameters-for-model-A" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
      <xs:element name="code-receiving-security-parameters-for-model-B" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
      <xs:element name="code-sending-security-parameters-for-model-B" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
      <xs:element name="selected-PC5-ciphering-algorithm" type="xs:integer"/>
      <xs:element name="PLMN-ID" type="PLMN-info"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="security-parameters-for-UNR-type">
    <xs:sequence>
      <xs:element name="expiration-timer" type="xs:integer"/>
      <xs:element name="code-sending-security-parameters-for-model-A" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
      <xs:element name="code-receiving-security-parameters-for-model-B" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
      <xs:element name="code-sending-security-parameters-for-model-B" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
      <xs:element name="selected-PC5-ciphering-algorithm" type="xs:integer"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="code-sending-or-receiving-security-parameters-type">
    <xs:sequence>
      <xs:element name="DUSK" type="xs:hexBinary" minOccurs="0" />
      <xs:element name="DUIK" type="xs:hexBinary" minOccurs="0" />
      <xs:element name="DUCK" type="DUCK-type" minOccurs="0" />
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="DUCK-type">
    <xs:sequence>
      <xs:element name="discovery-user-confidentiality-key" type="xs:hexBinary"/>
      <xs:element name="encrypted-bitmask" type="xs:hexBinary"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <!-- Complex types defined for transaction-level -->

  <xs:complexType name="AnnounceRsp-info">
    <xs:sequence>

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    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="ProSe-Application-Code" type="xs:hexBinary" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="ProSe-Application-Code-ACE" type="ProSeApplicationCodeACE-info"
minOccurs="0"/>
    <xs:element name="validity-timer-T5060" type="xs:integer" minOccurs="0" />
    <xs:element name="discovery-key" type="xs:hexBinary" minOccurs="0" />
    <xs:element name="discovery-entry-ID" type="xs:integer" minOccurs="0" />
    <xs:element name="ACE-enabled-indicator" type="xs:integer" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="MonitorRsp-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="discovery-filter" type="DiscFilter-info" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="discovery-entry-ID" type="xs:integer" minOccurs="0" />
    <xs:element name="ACE-enabled-indicator" type="xs:integer" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="DiscReq-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="command" type="xs:integer"/>
    <xs:element name="ProSe-Application-ID" type="xs:string"/>
    <xs:element name="application-identity" type="AppID-info"/>
    <xs:element name="discovery-entry-ID" type="xs:integer" minOccurs="0" />
    <xs:element name="Requested-Timer" type="xs:integer" minOccurs="0" />
    <xs:element name="metadata" type="xs:string" minOccurs="0"/>
    <xs:element name="Announcing-PLMN-ID" type="PLMN-info" minOccurs="0" />
    <xs:element name="ACE-enabled-indicator" type="xs:integer" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedDiscReq-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="command" type="xs:integer"/>
    <xs:element name="RPAUID" type="xs:string"/>
    <xs:element name="application-identity" type="AppID-info"/>
    <xs:element name="discovery-type" type="xs:integer"/>
    <xs:element name="PC5-UE-ciphering-algorithm-capability" type="xs:integer"/>
    <xs:element name="ACE-enabled-indicator" type="xs:integer" minOccurs="0"/>
    <xs:element name="announcing-type" type="xs:integer" minOccurs="0"/>
    <xs:element name="application-level-container" type="xs:hexBinary" minOccurs="0"/>
    <xs:element name="discovery-model" type="xs:integer" minOccurs="0"/>
    <xs:element name="Announcing-PLMN-ID" type="PLMN-info" minOccurs="0" />
    <xs:element name="discovery-entry-ID" type="xs:integer"/>
    <xs:element name="Requested-Timer" type="xs:integer" minOccurs="0" />
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedAnnounceRsp-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="ProSe-Restricted-Code" type="xs:hexBinary" minOccurs="0"/>
    <xs:element name="ProSe-Restricted-Code-Suffix-Range" type="RestrictedCodeSuffixRange-info"
minOccurs="0"/>
    <xs:element name="validity-timer-T5062" type="xs:integer" minOccurs="0"/>
    <xs:element name="ACE-enabled-indicator" type="xs:integer" minOccurs="0" />
    <xs:element name="code-sending-security-parameter" type="Restricted-Security-info" />
    <xs:element name="selected-PC5-ciphering-algorithm" type="xs:integer"/>
    <xs:element name="on-demand-announcing-enabled-indicator" type="xs:boolean" minOccurs="0" />

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    <xs:element name="discovery-entry-ID" type="xs:integer"/>
    <xs:element name="PC5-security-policies" type="PC5-Security-Policies-info" minOccurs="0" />
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedMonitorRsp-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="restricted-discovery-filter" type="RestrictedDiscFilter-info" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="ACE-enabled-indicator" type="xs:integer" minOccurs="0" />
    <xs:element name="application-level-container" type="xs:hexBinary"/>
    <xs:element name="code-receiving-security-parameter" type="Restricted-Security-info"
minOccurs="0" />
    <xs:element name="selected-PC5-ciphering-algorithm" type="xs:integer"/>
    <xs:element name="discovery-entry-ID" type="xs:integer"/>
    <xs:element name="PC5-security-policies" type="PC5-Security-Policies-info" minOccurs="0" />
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedDiscovereeRsp-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="ProSe-Response-Code" type="xs:hexBinary"/>
    <xs:element name="query-filter" type="MatchingFilter-info" maxOccurs="unbounded"/>
    <xs:element name="validity-timer-T5068" type="xs:integer"/>
    <xs:element name="code-sending-security-parameter" type="Restricted-Security-info" />
    <xs:element name="code-receiving-security-parameter" type="Restricted-Security-info"
minOccurs="0" />
    <xs:element name="selected-PC5-ciphering-algorithm" type="xs:integer"/>
    <xs:element name="discovery-entry-ID" type="xs:integer"/>
    <xs:element name="PC5-security-policies" type="PC5-Security-Policies-info" minOccurs="0" />
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedDiscovererRsp-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="subquery-result" type="Subquery-info" minOccurs="1" maxOccurs="unbounded"/>
    <xs:element name="code-sending-security-parameter" type="Restricted-Security-info" />
    <xs:element name="code-receiving-security-parameter" type="Restricted-Security-info"
minOccurs="0" />
    <xs:element name="selected-PC5-ciphering-algorithm" type="xs:integer"/>
    <xs:element name="discovery-entry-ID" type="xs:integer"/>
    <xs:element name="PC5-security-policies" type="PC5-Security-Policies-info" minOccurs="0" />
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RejectRsp-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="PC3a-control-protocol-cause-value" type="xs:integer"/>
    <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="UE-RejectRsp-info">
  <xs:sequence>
    <xs:element name="DDNMF-transaction-ID" type="xs:integer"/>
    <xs:element name="PC3a-control-protocol-cause-value" type="xs:integer"/>
    <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

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<xs:complexType name="MatchRep-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="ProSe-PC5-discovery-message" type="xs:hexBinary"/>
    <xs:element name="Monitored-PLMN-ID" type="PLMN-info"/>
    <xs:element name="VPLMN-ID" type="PLMN-info" minOccurs="0"/>
    <xs:element name="UTC-based-counter" type="xs:hexBinary"/>
    <xs:element name="Metadata-flag" type="xs:boolean"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedMatch-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="discovery-type" type="xs:integer"/>
    <xs:element name="application-identity" type="AppID-info"/>
    <xs:element name="RPAUID" type="xs:string"/>
    <xs:element name="Restricted-Code-Discovered" type="Restricted-Code-Option-info"
minOccurs="0"/>
    <xs:element name="ProSe-PC5-discovery-message" type="xs:hexBinary" minOccurs="0"/>
    <xs:element name="UTC-based-counter" type="xs:hexBinary" minOccurs="0"/>
    <xs:element name="Metadata-flag" type="xs:boolean" />
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="MatchAck-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="ProSe-Application-ID" type="xs:string"/>
    <xs:element name="validity-timer-T5072" type="xs:integer"/>
    <xs:element name="UTC-based-counter" type="xs:hexBinary"/>
    <xs:element name="metadata" type="xs:string" minOccurs="0"/>
    <xs:element name="metadata-index-mask" type="xs:hexBinary" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="match-report-refresh-timer-T5074" type="xs:integer"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RestrictedMatchAck-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="application-identity" type="AppID-info"/>
    <xs:element name="RPAUID" type="xs:string"/>
    <xs:element name="validity-timer-T5076" type="xs:integer"/>
    <xs:element name="UTC-based-counter" type="xs:hexBinary"/>
    <xs:element name="metadata" type="xs:string" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="match-report-refresh-timer-T5077" type="xs:integer"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="MatchReject-info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="PC3a-control-protocol-cause-value" type="xs:integer"/>
    <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="DiscUpdateReq-info">
  <xs:sequence>
    <xs:element name="DDNMF-transaction-ID" type="xs:integer"/>
    <xs:element name="discovery-entry-ID" type="xs:integer"/>
    <xs:element name="update-info" type="Update-Option-info" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>

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        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="DiscUpdateRsp-info">
      <xs:sequence>
        <xs:element name="DDNMF-transaction-ID" type="xs:integer"/>
        <xs:element name="discovery-entry-ID" type="xs:integer"/>
        <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="AnnouncingAlertReq-info">
      <xs:sequence>
        <xs:element name="DDNMF-transaction-ID" type="xs:integer"/>
        <xs:element name="RPAUID" type="xs:string"/>
        <xs:element name="discovery-entry-ID" type="xs:integer"/>
        <xs:element name="ProSe-Restricted-Code" type="xs:hexBinary"/>
        <xs:element name="ProSe-Restricted-Code-Suffix-Range" type="RestrictedCodeSuffixRange-info"
minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="AnnouncingAlertRsp-info">
      <xs:sequence>
        <xs:element name="DDNMF-transaction-ID" type="xs:integer"/>
        <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="PKMFAAddrReq-info">
      <xs:sequence>
        <xs:element name="transaction-ID" type="xs:integer"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="PKMFAAddrRsp-info">
      <xs:sequence>
        <xs:element name="transaction-ID" type="xs:integer"/>
        <xs:element name="PKMF-address" type="xs:string"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="UNR-discovery-security-parameters-request-type">
      <xs:sequence>
        <xs:element name="transaction-ID" type="xs:integer"/>
        <xs:element name="requested-for" type="requested-for-type"/>
        <xs:element name="PC5-UE-security-capabilities" type="xs:integer"/>
        <xs:element name="relay-service-code" type="xs:integer"/>
        <xs:element name="VPLMN-list" type="PLMN-list-type" minOccurs="0"/>
        <xs:element name="discovery-model" type="xs:integer" minOccurs="0"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="UNR-discovery-security-parameters-accept-type">
      <xs:sequence>
        <xs:element name="transaction-ID" type="xs:integer"/>
        <xs:element name="security-parameters-for-remote-UE" type="security-parameters-for-remote-UE-
type" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="PC5-security-policies-for-remote-UE" type="PC5-Security-Policies-info"
minOccurs="0"/>
        <xs:element name="security-parameters-for-UNR" type="security-parameters-for-UNR-type"
minOccurs="0"/>

```

```

        <xs:element name="PC5-security-policies-for-UNR" type="PC5-Security-Policies-info"
minOccurs="0"/>
        <xs:element name="Current-Time" type="xs:dateTime"/>
        <xs:element name="Max-Offset" type="xs:integer"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="UUR-discovery-security-parameters-request-type">
    <xs:sequence>
        <xs:element name="transaction-ID" type="xs:integer"/>
        <xs:element name="requested-for" type="requested-for-type"/>
        <xs:element name="PC5-UE-security-capabilities" type="xs:integer"/>
        <xs:element name="relay-service-code" type="xs:integer"/>
        <xs:element name="VPLMN-list" type="PLMN-list-type" minOccurs="0"/>
        <xs:element name="discovery-model" type="xs:integer" minOccurs="0"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="UUR-discovery-security-parameters-accept-type">
    <xs:sequence>
        <xs:element name="transaction-ID" type="xs:integer"/>
        <xs:element name="security-parameters-for-end-UE" type="security-parameters-for-remote-UE-
type" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="PC5-security-policies-for-end-UE" type="PC5-Security-Policies-info"
minOccurs="0"/>
        <xs:element name="security-parameters-for-UUR" type="security-parameters-for-UNR-type"
minOccurs="0"/>
        <xs:element name="PC5-security-policies-for-UUR" type="PC5-Security-Policies-info"
minOccurs="0"/>
        <xs:element name="Current-Time" type="xs:dateTime"/>
        <xs:element name="Max-Offset" type="xs:integer"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<!-- Complex types defined for Message-level -->

<xs:complexType name="prose-direct-discovery-request">
    <xs:sequence>
        <xs:element name="discovery-request" type="DiscReq-info" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="restricted-discovery-request" type="RestrictedDiscReq-info" minOccurs="0"
maxOccurs="unbounded"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="network-initiated-transaction-method" type="xs:integer"/>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="prose-direct-discovery-response">
    <xs:sequence>
        <xs:element name="Current-Time" type="xs:dateTime"/>
        <xs:element name="Max-Offset" type="xs:integer"/>
        <xs:element name="response-announce" type="AnnounceRsp-info" minOccurs="0"
maxOccurs="unbounded"/>
        <xs:element name="response-monitor" type="MonitorRsp-info" minOccurs="0"
maxOccurs="unbounded"/>
        <xs:element name="restricted-announce-response" type="RestrictedAnnounceRsp-info"
minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="restricted-monitor-response" type="RestrictedMonitorRsp-info" minOccurs="0"
maxOccurs="unbounded"/>
        <xs:element name="restricted-discoveree-response" type="RestrictedDiscovereeRsp-info"
minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="restricted-discoverer-response" type="RestrictedDiscovererRsp-info"
minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="response-reject" type="RejectRsp-info" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="network-initiated-transaction-method" type="xs:integer"/>

```

```

    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="prose-direct-discovery-update-request">
    <xs:sequence>
      <xs:element name="discovery-update-request" type="DiscUpdateReq-info" maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="prose-direct-discovery-update-response">
    <xs:sequence>
      <xs:element name="response-update" type="DiscUpdateRsp-info" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element name="response-reject" type="UE-RejectRsp-info" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="prose-direct-discovery-match-report">
    <xs:sequence>
      <xs:element name="match-report" type="MatchRep-info" minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="restricted-match" type="RestrictedMatch-info" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="prose-direct-discovery-match-report-ack">
    <xs:sequence>
      <xs:element name="Current-Time" type="xs:dateTime"/>
      <xs:element name="match-ack" type="MatchAck-info" minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="match-reject" type="MatchReject-info" minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="restricted-match-ack" type="RestrictedMatchAck-info" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="prose-direct-discovery-announcing-alert-request">
    <xs:sequence>
      <xs:element name="announcing-alert-request" type="AnnouncingAlertReq-info"
maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="prose-direct-discovery-announcing-alert-response">
    <xs:sequence>
      <xs:element name="announcing-alert-response" type="AnnouncingAlertRsp-info"
maxOccurs="unbounded"/>
      <xs:element name="response-reject" type="UE-RejectRsp-info" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="prose-5gpkmf-address-request">
    <xs:sequence>
      <xs:element name="PKMF-address-request" type="PKMFAddrReq-info" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

```

```

</xs:complexType>

<xs:complexType name="prose-5gpkmf-address-response">
  <xs:sequence>
    <xs:element name="PKMF-address-response" type="PKMFAddrRsp-info" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="PKMF-address-reject" type="RejectRsp-info" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="prose-security-material-request">
  <xs:sequence>
    <xs:element name="UNR-discovery-security-parameters-request" type="UNR-discovery-security-
parameters-request-type" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<!-- XML elements to be included in the <anyExt> element of "prose-security-material-request"
complex type -->
  <xs:element name="UUR-discovery-security-parameters-request" type="UUR-discovery-security-
parameters-request-type"/>

  <xs:complexType name="prose-security-material-response">
    <xs:sequence>
      <xs:element name="UNR-discovery-security-parameters-accept" type="UNR-discovery-security-
parameters-accept-type" minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="UNR-discovery-security-parameters-reject" type="reject-type" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <!-- XML elements to be included in the <anyExt> element of "prose-security-material-response"
complex type -->
  <xs:element name="UUR-discovery-security-parameters-accept" type="UUR-discovery-security-
parameters-accept-type"/>
  <xs:element name="UUR-discovery-security-parameters-reject" type="reject-type"/>

  <!-- extension allowed -->
  <xs:complexType name="DiscMsgExtType">
    <xs:sequence>
      <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <!-- XML attribute for any future extensions -->
  <xs:complexType name="anyExtType">
    <xs:sequence>
      <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>

<!-- Top level discovery message definition -->
<xs:element name="prose-discovery-message">
  <xs:complexType>
    <xs:choice>
      <xs:element name="DISCOVERY_REQUEST" type="prose-direct-discovery-request"/>
      <xs:element name="DISCOVERY_RESPONSE" type="prose-direct-discovery-response"/>
      <xs:element name="MATCH_REPORT" type="prose-direct-discovery-match-report"/>
      <xs:element name="MATCH_REPORT_ACK" type="prose-direct-discovery-match-report-ack"/>
      <xs:element name="DISCOVERY_UPDATE_REQUEST" type="prose-direct-discovery-update-request"/>
      <xs:element name="DISCOVERY_UPDATE_RESPONSE" type="prose-direct-discovery-update-response"/>
      <xs:element name="ANNOUNCING_ALERT_REQUEST" type="prose-direct-discovery-announcing-alert-
request"/>
      <xs:element name="ANNOUNCING_ALERT_RESPONSE" type="prose-direct-discovery-announcing-alert-
response"/>
      <xs:element name="PROSE_5GPKMF_ADDRESS_REQUEST" type="prose-5gpkmf-address-request"/>
      <xs:element name="PROSE_5GPKMF_ADDRESS_RESPONSE" type="prose-5gpkmf-address-response"/>
    </xs:choice>
  </xs:complexType>
</xs:element>

```

```

        <xs:element name="PROSE_SECURITY_MATERIAL_REQUEST" type="prose-security-material-request"/>
        <xs:element name="PROSE_SECURITY_MATERIAL_RESPONSE" type="prose-security-material-
response"/>

        <xs:element name="message-ext" type="DiscMsgExtType"/>
        <xs:any namespace="##other" processContents="lax"/>
    </xs:choice>
</xs:complexType>
</xs:element>

<xs:complexType name="empty-type"/>

<xs:complexType name="reject-type">
    <xs:sequence>
        <xs:element name="transaction-ID" type="xs:integer"/>
        <xs:element name="PC3a-control-protocol-cause-value" type="xs:integer"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

</xs:schema>

```

An entity receiving the XML body ignores any unknown XML element and any unknown XML attribute.

10.5.4 Semantics

10.5.4.1 General

The <prose-discovery-message> element is the root element of this XML document and it can be one of the following elements:

- a) <DISCOVERY_REQUEST>;
- b) <DISCOVERY_RESPONSE>;
- c) <MATCH_REPORT>;
- d) <MATCH_REPORT_ACK>;
- e) <DISCOVERY_UPDATE_REQUEST>;
- f) <DISCOVERY_UPDATE_RESPONSE>;
- g) <ANNOUNCE_ALERT_REQUEST>;
- h) <ANNOUNCE_ALERT_RESPONSE>;
- i) <PROSE_5GPKMF_ADDRESS_REQUEST>;
- j) <PROSE_5GPKMF_ADDRESS_RESPONSE>;
- k) <PROSE_SECURITY_MATERIAL_REQUEST>;
- l) <PROSE_SECURITY_MATERIAL_RESPONSE>;
- m) <message-ext> element containing other discovery message defined in future releases; or
- n) an element from other namespaces defined in future releases.

10.5.4.2 Semantics of <DISCOVERY_REQUEST>

The <DISCOVERY_REQUEST> element contains one or more of the following elements:

- a) zero, one or more <discovery-request> element which contains transactions sent from the UE to the 5G DDNMF as announcing or monitoring requests for open 5G ProSe direct discovery. Each <discovery-request> consists of:

- 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) a <command> element containing the parameter defined in clause 11.4.2.2;
 - 3) a <Prose-Application-ID> element containing the parameter defined in clause 11.4.2.4;
 - 4) an <application-identity> element containing the parameter defined in clause 11.4.2.5;
 - 5) a <Discovery-Entry-ID> element containing the parameter defined in clause 11.4.2.26;
 - 6) an optional <Requested-Timer> element containing the parameter defined in clause 11.4.2.20;
 - 7) an optional <metadata> element containing the parameter defined in clause 11.4.2.15;
 - 8) an optional <Announcing-PLMN-ID> element containing the parameter defined in clause 11.4.2.43;
 - 9) zero or one <ACE-enabled-indicator> element containing the parameter defined in clause 11.4.2.31;
 - 10) zero or one <anyExt> element containing elements defined in future releases;
 - 11) zero, one or more elements from other namespaces defined in future releases; and
 - 12) zero, one or more attributes defined in future releases;
- b) zero, one, or more <restricted-discovery-request> element which contains transactions sent from the UE to the 5G DDNMF as announcing or monitoring requests for restricted 5G ProSe directed discovery model A or transactions sent from the UE to the 5G DDNMF as discoveree or discoverer requests for restricted 5G ProSe directed discovery model B. Each <restricted-discovery-request> consists of:
- 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) a <command> element containing the parameter defined in clause 11.4.2.2;
 - 3) a <RPAUID> element containing the parameter defined in clause 11.4.2.23;
 - 4) an <application-identity> element containing the parameter defined in clause 11.4.2.5;
 - 5) a <discovery-type> element containing the parameter defined in clause 11.4.2.18;
 - 6) zero or one <ACE-enabled-indicator> element containing the parameter defined in clause 11.4.2.31;
 - 7) an <announcing-type> element containing the parameter defined in clause 11.4.2.24;
 - 8) an <application-level-container> element containing the parameter defined in clause 11.4.2.25;
 - 9) zero or one <discovery-model> element containing the parameter defined in clause 11.4.2.34;
 - 10) zero or one <Announcing-PLMN-ID> element containing the parameter defined in clause 11.4.2.43;
 - 11) a <discovery-entry-id> element containing the parameter defined in clause 11.4.2.26;
 - 12) an optional <Requested-Timer> element containing the parameter defined in clause 11.4.2.20;
 - 13) a <PC5-UE-ciphering-algorithm-capability> element containing the parameter defined in clause 11.4.2.50;
 - 14) zero or one <anyExt> element containing elements defined in future releases;
 - 15) zero, one or more elements from other namespaces defined in future releases; and
 - 16) zero, one or more attributes defined in future releases;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero, one or more elements from other namespaces defined in future releases;
- e) an optional "network-initiated transaction method" attribute containing the parameter defined in clause 11.4.2.42; and
- f) zero, one or more attributes defined in future releases.

10.5.4.3 Semantics of <DISCOVERY_RESPONSE>

The <DISCOVERY_RESPONSE> element contains one or more of the following elements:

- a) a <Current-Time> element containing the parameter defined in clause 11.4.2.16;
- b) a <Max-Offset> element containing the parameter defined in clause 11.4.2.17;
- c) zero, one or more <response-announce> element which contains transactions sent from the 5G DDNMF to the UE as a response to an announcing request if the 5G DDNMF accepts the request. Each <response-announce> consists of:
 - 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) zero, one or more <ProSe-Application-Code> elements containing the parameter defined in clause 11.4.2.6;
 - 3) zero or one <ProSe application code-ACE> element containing the parameter defined in clause 11.4.2.45;
 - 4) zero, or one <validity-timer-T5060> element containing the parameter defined in 11.4.2.7;
 - 5) zero, or, one <discovery-key> element containing the parameter defined in clause 11.4.2.48;
 - 6) a <discovery-entry-ID> element containing the parameter defined in clause 11.4.2.26;
 - 7) zero or one <ACE-enabled-indicator> element containing the parameter defined in clause 11.4.2.31;
 - 8) zero or one <anyExt> element containing elements defined in future releases;
 - 9) zero, one or more elements from other namespaces defined in future releases; and
 - 10) zero, one or more attributes defined in future releases;
- d) zero, one or more <response-monitor> element which contains transactions sent from the 5G DDNMF to the UE as a response to a monitoring request if the 5G DDNMF accepts the request. Each <response-monitor> consists of:
 - 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) zero, one or more <discovery-filter> elements containing the parameter defined in clause 11.4.2.9;
 - 3) a <discovery-entry-ID> element containing the parameter defined in clause 11.4.2.26;
 - 4) zero or one <ACE-enabled-indicator> element containing the parameter defined in clause 11.4.2.31;
 - 5) zero or one <anyExt> element containing elements defined in future releases;
 - 6) zero, one or more elements from other namespaces defined in future releases; and
 - 7) zero, one or more attributes defined in future releases;
- e) zero, one or more <restricted-announce-response> element which contains transactions sent from the 5G DDNMF to the UE as a response to an announcing request for restricted 5G ProSe direct discovery model A if the 5G DDNMF accepts the request. Each <restricted-announce-response> consists of:
 - 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) zero or one <ProSe-Restricted-Code> element containing the parameter defined in clause 11.4.2.27;
 - 3) zero, one or more <ProSe-Restricted-Code-Suffix-Range> element containing the parameter defined in clause 11.4.2.28;
 - 4) zero or one <validity-timer-T5062> element containing the parameter defined in 11.4.2.32;
 - 5) zero or one <ACE-enabled-indicator> element containing the parameter defined in clause 11.4.2.31;
 - 6) a <code-sending-security-parameter> element containing the parameter defined in clause 11.4.2.33;

- 7) zero or one <on-demand-announcing-enabled-indicator> element containing the parameter defined in clause 11.4.2.29;
 - 8) a <discovery-entry-id> element containing the parameter defined in clause 11.4.2.26;
 - 9) a <selected-PC5-ciphering-algorithm> element containing the parameter defined in clause 11.4.2.51;
 - 10) zero or one <PC5-security-policies> element containing the parameter defined in clause 11.4.2.49;
 - 11) zero or one <anyExt> element containing elements defined in future releases;
 - 12) zero, one or more elements from other namespaces defined in future releases; and
 - 13) zero, one or more attributes defined in future releases;
- f) zero, one or more <restricted-monitor-response> element which contains transactions sent from the 5G DDNMF to the UE as a response to a monitoring request for restricted 5G ProSe direct discovery model A if the 5G DDNMF accepts the request. Each <restricted-monitor-response> consists of:
- 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) one or more <restricted-discovery-filter> elements containing the parameter defined in clause 11.4.2.30;
 - 3) zero or one <ACE-enabled-indicator> element containing the parameter defined in clause 11.4.2.31
 - 4) a <discovery-entry-id> element containing the parameter defined in clause 11.4.2.26;
 - 5) an <application-level-container> element containing the parameter defined in clause 11.4.2.25;
 - 6) one or more <code-receiving-security-parameter> element containing the parameter defined in clause 11.4.2.33;
 - 7) a <selected-PC5-ciphering-algorithm> element containing the parameter defined in clause 11.4.2.51;
 - 8) zero or one <PC5-security-policies> element containing the parameter defined in clause 11.4.2.49;
 - 9) zero or one <anyExt> element containing elements defined in future releases;
 - 10) zero, one or more elements from other namespaces defined in future releases; and
 - 11) zero, one or more attributes defined in future releases;
- g) zero, one or more <restricted-discoveree-response> element which contains transactions sent from the 5G DDNMF to the UE as a response to a discoveree UE's request for restricted 5G ProSe direct discovery model B if the 5G DDNMF accepts the request. Each <restricted-discoveree-response> consists of:
- 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) a <ProSe-Response-Code> element containing the element defined in clause 11.4.2.35;
 - 3) one or more <query-filter> elements containing the parameter defined in clause 11.4.2.36;
 - 4) a <validity-timer-T5068> element containing the parameter defined in clause 11.4.2.37;
 - 5) a <code-sending-security-parameter> element containing the parameter defined in clause 11.4.2.33;
 - 6) one or more <code-receiving-security-parameter> element containing the parameter defined in clause 11.4.2.33;
 - 7) a <discovery-entry-id> element containing the parameter defined in clause 11.4.2.26;
 - 8) zero or one <PC5-security-policies> element containing the parameter defined in clause 11.4.2.49;
 - 9) a <selected-PC5-ciphering-algorithm> element containing the parameter defined in clause 11.4.2.51;
 - 10) zero or one <anyExt> element containing elements defined in future releases;
 - 11) zero, one or more elements from other namespaces defined in future releases; and

- 12) zero, one or more attributes defined in future releases;
- h) zero, one or more <restricted-discoverer-response> element which contains transactions sent from the 5G DDNMF to the UE as a response to a discoverer UE's request for restricted 5G ProSe direct discovery model B if the 5G DDNMF accepts the request. Each <restricted-discoverer-response> consists of:
- 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) one or more <subquery-result> elements containing the parameter defined in clause 11.4.2.38;
 - 3) a <code-sending-security-parameter> element containing the parameter defined in clause 11.4.2.33;
 - 4) one or more <code-receiving-security-parameter> element containing the parameter defined in clause 11.4.2.33;
 - 5) a <discovery-entry-id> element containing the parameter defined in clause 11.4.2.26;
 - 6) zero or one <PC5-security-policies> element containing the parameter defined in clause 11.4.2.49;
 - 7) a <selected-PC5-ciphering-algorithm> element containing the parameter defined in clause 11.4.2.51;
 - 8) zero or one <anyExt> element containing elements defined in future releases;
 - 9) zero, one or more elements from other namespaces defined in future releases; and
- 10) zero, one or more attributes defined in future releases;
- i) zero, one or more <response-reject> element which contains transactions sent from the 5G DDNMF to the UE as a response to an announcing or monitoring requests if the 5G DDNMF cannot accept the request. Each <response-reject> consists of:
- 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) a <PC3a-control-protocol-cause-value> element containing the parameter defined in clause 11.4.2.8.
 - 3) zero, one or more elements defined in future releases; and
 - 4) zero, one or more attributes defined in future releases;
- j) zero or one <anyExt> element containing elements defined in future releases;
- k) zero, one or more elements from other namespaces defined in future releases;
- l) an optional "network-initiated transaction method" attribute containing the parameter defined in clause 11.4.2.42; and
- m) zero, one or more attributes defined in future releases.

10.5.4.4 Semantics of <MATCH_REPORT>

The <MATCH_REPORT> element contains one or more of the following elements:

- a) zero, one or more <match-report> element which contains transactions sent from the UE to the 5G DDNMF to report a matching of the direct discovery. Each <match-report> consists of:
- 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) a <ProSe-PC5-discovery-message> element containing the parameter defined in clause 11.4.2.52;
 - 3) a <Monitored-PLMN-id> element containing the parameter defined in clause 11.4.2.10;
 - 4) an optional <VPLMN-id> element containing the parameter defined in clause 11.4.2.11;
 - 5) a <UTC-based-counter> element containing the parameter defined in clause 11.4.2.12;
 - 6) a <metadata-flag> element containing the parameter defined in clause 11.4.2.14;

- 7) zero or one <anyExt> element containing elements defined in future releases;
 - 8) zero, one or more elements from other namespaces defined in future releases; and
 - 9) zero, one or more attributes defined in future releases;
- b) zero, one or more <restricted-match> element which contain transactions sent from the UE to the 5G DDNMF to report a matching of the restricted direct discovery model A or model B. Each <restricted-match> consists of:
- 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) a <discovery-type> element containing the parameter defined in clause 11.4.2.18
 - 3) an <application-identity> element containing the parameter defined in clause 11.4.2.5
 - 4) an <RPAUID> element containing the parameter defined in clause 11.4.2.23;
 - 5) zero or one <ProSe-PC5-discovery-message> element containing the parameter defined in clause 11.4.2.52, if it is required to check the MIC via the match report procedure;
 - 6) zero or one <Restricted-Code-Discovered> element containing the ProSe Restricted Code parameter defined in clause 11.4.2.27 or ProSe Response Code parameter defined in clause 11.4.2.35, if it is not required to check the MIC via the match report procedure;
 - 7) a <UTC-based-counter> element containing the parameter defined in clause 11.4.2.12, if it is required to check the MIC via the match report procedure;
 - 8) a <metadata-flag> element containing the parameter defined in clause 11.4.2.14;
 - 9) zero or one <anyExt> element containing elements defined in future releases;
 - 10) zero, one or more elements from other namespaces defined in future releases; and
 - 11) zero, one or more attributes defined in future releases.
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero, one or more elements from other namespaces defined in future releases; and
- e) zero, one or more attributes defined in future releases.

10.5.4.5 Semantics of <MATCH_REPORT_ACK>

The <MATCH_REPORT_ACK> element contains one or more of the following elements:

- a) a <Current-Time> element containing the parameter defined in clause 11.4.2.16;
- b) zero, one or more <match-ack> element which contains transactions sent from the 5G DDNMF to the UE as a response to a match report if the 5G DDNMF accepts the report. Each <match-ack> consists of:
 - 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) a <ProSe-Application-ID> element containing the parameter defined in clause 11.4.2.4;
 - 3) a <validity-timer-T5072> element containing the parameter defined in clause 11.4.2.13;
 - 4) an optional <metadata> element containing the parameter defined in clause 11.4.2.15;
 - 5) an optional <metadata-index-mask> element containing the parameter defined in clause 11.4.2.41;
 - 6) a mandatory "match-report-refresh-timer-T5074" attribute containing the parameter defined in clause 11.4.2.19;
 - 7) zero or one <anyExt> element containing elements defined in future releases;
 - 8) zero, one or more elements from other namespaces defined in future releases; and

- 9) zero, one or more attributes defined in future releases;
- c) zero, one or more <restricted-match-ack> element which contain transactions sent from the 5G DDNMF to the UE as a response to a match report if the 5G DDNMF accepts the report. Each <restricted-match-ack> consists of:
 - 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) an <application-identity> element containing the parameter defined in clause 11.4.2.5;
 - 3) an <RPAUID> element containing the parameter defined in clause 11.4.2.23;
 - 4) a <validity-timer-T5076> element containing the parameter defined in clause 11.4.2.39;
 - 5) an optional <metadata> element containing the parameter defined in clause 11.4.2.15;
 - 6) zero or one <anyExt> element containing elements defined in future releases;
 - 7) zero, one or more elements from other namespaces defined in future releases;
 - 8) an optional "match-report-refresh-timer-T5077" attribute containing the parameter defined in clause 11.4.2.40; and
 - 9) zero, one or more attributes defined in future releases;
- d) zero, one or more <match-reject> element which contains transactions sent from the 5G DDNMF to the UE as a response to a match report if the 5G DDNMF cannot accept the match report. Each <match-reject> consists of:
 - 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) a <PC3a-control-protocol-cause-value> element containing the parameter defined in clause 11.4.2.8;
 - 3) zero, one or more elements defined in future releases; and
 - 4) zero, one or more attributes defined in future releases;
- e) zero or one <anyExt> element containing elements defined in future releases;
- f) zero, one or more elements from other namespaces defined in future releases; and
- g) zero, one or more attributes defined in future releases.

10.5.4.6 Semantics of < DISCOVERY_UPDATE_REQUEST>

The < DISCOVERY_UPDATE_REQUEST> element contains one or more of the following elements:

- a) One or more <discovery-update-request> element which contains transactions sent from the 5G DDNMF to the UE as announcing or monitoring requests. Each <discovery-update-request> consists of:
 - 1) a <DDNMF-transaction-ID> element containing the parameter defined in clause 11.4.2.21;
 - 2) a <discovery-entry-id> element containing the parameter defined in clause 11.4.2.26;
 - 3) an optional <update-info> element containing the parameter defined in clause 11.4.2.22;
 - 4) zero or one <anyExt> element containing elements defined in future releases;
 - 5) zero, one or more elements defined in future releases; and
 - 6) zero, one or more attributes defined in future releases;
- b) zero or one <anyExt> element containing elements defined in future releases;
- c) zero, one or more elements from other namespaces defined in future releases; and
- d) zero, one or more attributes defined in future releases.

10.5.4.7 Semantics of <DISCOVERY_UPDATE_RESPONSE>

The <DISCOVERY_UPDATE_RESPONSE> element contains one or more of the following elements:

- a) one or more <response-update> element which contains transactions sent from the UE to the 5G DDNMF as a response if the UE accepts the request. Each <discovery-update-response> consists of:
 - 1) a <DDNMF-transaction-ID> element containing the parameter defined in clause 11.4.2.21;
 - 2) a <discovery-entry-id> element containing the parameter defined in clause 11.4.2.26;
 - 3) zero, one or more elements defined in future releases; and
 - 4) zero, one or more attributes defined in future releases;
- b) zero, one or more <response-reject> element which contains transactions sent from the UE to the 5G DDNMF as a response if the UE cannot accept the request. Each <response-reject> consists of:
 - 1) a <DDNMF-transaction-ID> element containing the parameter defined in clause 11.4.2.21;
 - 2) a <PC3a-control-protocol-cause-value> element containing the parameter defined in clause 11.4.2.8.
 - 3) zero, one or more elements defined in future releases; and
 - 4) zero, one or more attributes defined in future releases;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero, one or more elements from other namespaces defined in future releases; and
- e) zero, one or more attributes defined in future releases.

10.5.4.8 Semantics of <ANNOUNCING_ALERT_REQUEST>

The <ANNOUNCING_ALERT_REQUEST> element contains one or more of the following elements:

- a) One or more <announcing-alert-request> element which contains transactions sent from the UE to the 5G DDNMF as announcing or monitoring requests. Each <announcing-alert-request> consists of:
 - 1) a <DDNMF-transaction-ID> element containing the parameter defined in clause 11.4.2.21;
 - 2) a <RPAUID> element containing the parameter defined in clause 11.4.2.23;
 - 3) a <Discovery-Entry-ID> element containing the parameter defined in clause 11.4.2.26;
 - 4) a <ProSe-Restricted-Code> element containing the parameter defined in clause 11.4.2.27;
 - 5) zero, one or more <ProSe-Restricted-Code-Suffix-Range> element containing the parameter defined in clause 11.4.2.28;
 - 6) zero or one <anyExt> element containing elements defined in future releases;
 - 7) zero, one or more elements from other namespaces defined in future releases; and
 - 8) zero, one or more attributes defined in future releases;
- b) zero or one <anyExt> element containing elements defined in future releases;
- c) zero, one or more elements from other namespaces defined in future releases; and
- d) zero, one or more attributes defined in future releases.

10.5.4.9 Semantics of <ANNOUNCING_ALERT_RESPONSE>

The <ANNOUNCING_ALERT_RESPONSE> element contains one or more of the following elements:

- a) One or more <announcing-alert-response> element which contains transactions sent from the UE to the 5G DDNMF as announcing or monitoring requests. Each <announcing-alert-response> consists of:
 - 1) a <DDNMF-transaction-ID> element containing the parameter defined in clause 11.4.2.21;
 - 2) zero, one or more elements defined in future releases; and
 - 3) zero, one or more attributes defined in future releases;
- b) zero, one or more <response-reject> element which contains transactions sent from the UE to the 5G DDNMF as a response if the UE cannot accept the request. Each <response-reject> consists of:
 - 1) a <DDNMF-transaction-ID> element containing the parameter defined in clause 11.4.2.21;
 - 2) a <PC3a-control-protocol-cause-value> element containing the parameter defined in clause 11.4.2.8.
 - 3) zero, one or more elements defined in future releases; and
 - 4) zero, one or more attributes defined in future releases;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero, one or more elements from other namespaces defined in future releases; and
- e) zero, one or more attributes defined in future releases.

10.5.4.10 Semantics of <PROSE_5GPKMF_ADDRESS_REQUEST>

The <PROSE_5GPKMF_ADDRESS_REQUEST> element contains one or more of the following elements:

- a) zero, one or more <PKMF-address-request> element which contains transactions sent from the UE to the 5G DDNMF. Each <PKMF-address-request> consists of:
 - 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) zero or one <anyExt> element containing elements defined in future releases;
 - 3) zero, one or more elements from other namespaces defined in future releases; and
 - 4) zero, one or more attributes defined in future releases;
- b) zero or one <anyExt> element containing elements defined in future releases;
- c) zero, one or more elements from other namespaces defined in future releases; and
- d) zero, one or more attributes defined in future releases.

10.5.4.11 Semantics of <PROSE_5GPKMF_ADDRESS_RESPONSE>

The <PROSE_5GPKMF_ADDRESS_RESPONSE> element contains one or more of the following elements:

- a) zero, one or more <PKMF-address-response> element which contains transactions sent from the 5G DDNMF to the UE. Each <PKMF-address-response> consists of:
 - 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
 - 2) a <PKMF-address> element containing the parameter defined in clause 11.4.2.53;
 - 3) zero or one <anyExt> element containing elements defined in future releases;
 - 4) zero, one or more elements from other namespaces defined in future releases; and
 - 5) zero, one or more attributes defined in future releases;
- b) zero, one or more <PKMF-address-reject> element which contains transactions sent from the 5G DDNMF to the UE as a response if the 5G DDNMF cannot accept the request. Each <PKMF-address-reject> consists of:

- 1) a <transaction-ID> element containing the parameter defined in clause 11.4.2.1;
- 2) a <PC3a-control-protocol-cause-value> element containing the parameter defined in clause 11.4.2.8.
- 3) zero, one or more elements defined in future releases; and
- 4) zero, one or more attributes defined in future releases;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero, one or more elements from other namespaces defined in future releases; and
- e) zero, one or more attributes defined in future releases.

10.5.4.12 Semantics of <PROSE_SECURITY_MATERIAL_REQUEST>

The semantics of <PROSE_SECURITY_MATERIAL_REQUEST> is same as the semantics of <PROSE_SECURITY_PARAM_REQUEST> defined in clause 10.6.4.2, where 5G PKMF is replaced by 5G DDNMF.

10.5.4.13 Semantics of <PROSE_SECURITY_MATERIAL_RESPONSE>

The semantics of <PROSE_SECURITY_MATERIAL_RESPONSE> is same as the semantics of <PROSE_SECURITY_PARAM_RESPONSE> defined in clause 10.6.4.3, where 5G PKMF is replaced by 5G DDNMF and the <PC8-control-protocol-cause-value> element is replaced by the <PC3a-control-protocol-cause-value> element.

10.6 5G ProSe security messages over PC8

10.6.1 General

This clause defines the XML schema and MIME type related to 5G ProSe security messages.

10.6.2 application/vnd.3gpp-prose-pc8+xml

The MIME type is used to carry information related to the 5G ProSe security operation. It shall be coded as an XML document containing one of the following 5G ProSe security messages:

- a) a PROSE_SECURITY_PARAM_REQUEST message;
- b) a PROSE_SECURITY_PARAM_RESPONSE message;
- c) a PROSE_PRUK_REQUEST message;
- d) a PROSE_PRUK_RESPONSE message;
- e) a PROSE_KEY_REQUEST message; or
- f) a PROSE_KEY_RESPONSE message.

Each of those messages is presented in the XML document as an XML element named after the corresponding message.

10.6.3 XML schema

Implementations in compliance with the present document shall implement the XML schema defined below for messages used in 5G ProSe security procedures over PC8 interface.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns="urn:3GPP:ns:5GProSe:Security:2022"
  elementFormDefault="qualified"
  targetNamespace="urn:3GPP:ns:5GProSe:Security:2022">
  <xs:annotation>
    <xs:documentation>
```

```

        Info for 5G ProSe Security Control Messages Syntax
      </xs:documentation>
    </xs:annotation>

    <xs:complexType name="empty-type"/>

    <xs:complexType name="requested-for-type">
      <xs:sequence>
        <xs:element name="remote-UE" type="empty-type" minOccurs="0"/>
        <xs:element name="UNR" type="empty-type" minOccurs="0"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <!-- XML elements to be included in the <anyExt> element of "requested-for-type" complex type -->
    <xs:element name="end-UE" type="empty-type"/>
    <xs:element name="UUR" type="empty-type"/>

    <xs:complexType name="PLMN-type">
      <xs:sequence>
        <xs:element name="mcc" type="xs:integer"/>
        <xs:element name="mnc" type="xs:integer"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="PLMN-list-type">
      <xs:sequence>
        <xs:element name="PLMN" type="PLMN-type" maxOccurs="unbounded"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="model-type">
      <xs:sequence>
        <xs:element name="model-A" type="empty-type" minOccurs="0"/>
        <xs:element name="model-B" type="empty-type" minOccurs="0"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="DUCK-type">
      <xs:sequence>
        <xs:element name="discovery-user-confidentiality-key" type="xs:hexBinary"/>
        <xs:element name="encrypted-bitmask" type="xs:hexBinary"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="code-sending-or-receiving-security-parameters-type">
      <xs:sequence>
        <xs:element name="DUSK" type="xs:hexBinary" minOccurs="0" />
        <xs:element name="DUIK" type="xs:hexBinary" minOccurs="0" />
        <xs:element name="DUCK" type="DUCK-type" minOccurs="0" />
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

    <xs:complexType name="PLMN-info">
      <xs:sequence>
        <xs:element name="mcc" type="xs:integer"/>
        <xs:element name="mnc" type="xs:integer"/>
        <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:complexType>

```

```

<xs:complexType name="security-parameters-for-remote-UE-type">
  <xs:sequence>
    <xs:element name="expiration-timer" type="xs:integer"/>
    <xs:element name="code-receiving-security-parameters-for-model-A" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
    <xs:element name="code-receiving-security-parameters-for-model-B" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
    <xs:element name="code-sending-security-parameters-for-model-B" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
    <xs:element name="selected-PC5-ciphering-algorithm" type="xs:integer"/>
    <xs:element name="PLMN-ID" type="PLMN-info"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="security-parameters-for-UNR-type">
  <xs:sequence>
    <xs:element name="expiration-timer" type="xs:integer"/>
    <xs:element name="code-sending-security-parameters-for-model-A" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
    <xs:element name="code-receiving-security-parameters-for-model-B" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
    <xs:element name="code-sending-security-parameters-for-model-B" type="code-sending-or-receiving-security-parameters-type" minOccurs="0"/>
    <xs:element name="selected-PC5-ciphering-algorithm" type="xs:integer"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="PC5-security-policies-type">
  <xs:sequence>
    <xs:element name="signalling-ciphering-policy" type="xs:integer"/>
    <xs:element name="user-plane-integrity-protection-policy" type="xs:integer"/>
    <xs:element name="user-plane-ciphering-policy" type="xs:integer"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="PC5-Security-Policies-info">
  <xs:sequence>
    <xs:element name="signalling-integrity-protection-policy" type="xs:integer"/>
    <xs:element name="signalling-ciphering-policy" type="xs:integer"/>
    <xs:element name="user-plane-integrity-protection-policy" type="xs:integer"/>
    <xs:element name="user-plane-ciphering-policy" type="xs:integer"/>
    <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<!-- Complex types defined for transaction-level -->
<xs:complexType name="UNR-discovery-security-parameters-request-type">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="requested-for" type="requested-for-type"/>
    <xs:element name="PC5-UE-security-capabilities" type="xs:integer"/>
    <xs:element name="relay-service-code" type="xs:integer"/>
    <xs:element name="VPLMN-list" type="PLMN-list-type" minOccurs="0"/>
    <xs:element name="model" type="model-type" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="UNR-discovery-security-parameters-accept-type">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="security-parameters-for-remote-UE" type="security-parameters-for-remote-UE-type" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="PC5-security-policies-for-remote-UE" type="PC5-security-policies-type" minOccurs="0"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

```



```

    <xs:element name="security-parameters-for-UNR" type="security-parameters-for-UNR-type"
minOccurs="0"/>
    <xs:element name="PC5-security-policies-for-UNR" type="PC5-security-policies-type"
minOccurs="0"/>

    <xs:element name="Current-Time" type="xs:dateTime"/>
    <xs:element name="Max-Offset" type="xs:integer"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="UUR-discovery-security-parameters-request-type">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="requested-for" type="requested-for-type"/>
    <xs:element name="PC5-UE-security-capabilities" type="xs:integer"/>
    <xs:element name="relay-service-code" type="xs:integer"/>
    <xs:element name="VPLMN-list" type="PLMN-list-type" minOccurs="0"/>
    <xs:element name="discovery-model" type="xs:integer" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="UUR-discovery-security-parameters-accept-type">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="security-parameters-for-end-UE" type="security-parameters-for-remote-UE-
type" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="PC5-security-policies-for-end-UE" type="PC5-Security-Policies-info"
minOccurs="0"/>
    <xs:element name="security-parameters-for-UUR" type="security-parameters-for-UNR-type"
minOccurs="0"/>
    <xs:element name="PC5-security-policies-for-UUR" type="PC5-Security-Policies-info"
minOccurs="0"/>
    <xs:element name="Current-Time" type="xs:dateTime"/>
    <xs:element name="Max-Offset" type="xs:integer"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="PRUK-request-type">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="UP-PRUK-ID" type="xs:string" minOccurs="0" />
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="PRUK-accept-type">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="UP-PRUK-ID" type="xs:string"/>
    <xs:element name="UP-PRUK" type="xs:hexBinary"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="key-request-type">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="relay-service-code" type="xs:integer"/>
    <xs:element name="SUCI" type="xs:string" minOccurs="0"/>
    <xs:element name="UP-PRUK-ID" type="xs:string" minOccurs="0"/>
    <xs:element name="Knrp-freshness-parameter-1" type="xs:hexBinary"/>
    <xs:element name="HPLMN" type="PLMN-type" minOccurs="0"/>
    <xs:element name="AUTS" type="xs:hexBinary" minOccurs="0"/>
    <xs:element name="RAND" type="xs:hexBinary" minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

```

```

        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="key-accept-type">
    <xs:sequence>
        <xs:element name="transaction-ID" type="xs:integer"/>
        <xs:element name="UP-PRUK-ID" type="xs:string"/>
        <xs:element name="Knrp" type="xs:hexBinary"/>
        <xs:element name="Knrp-freshness-parameter-2" type="xs:hexBinary"/>
        <xs:element name="GPI" type="xs:hexBinary" minOccurs="0"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="reject-type">
    <xs:sequence>
        <xs:element name="transaction-ID" type="xs:integer"/>
        <xs:element name="PC8-control-protocol-cause-value" type="xs:integer"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<!-- Complex types defined for Message-level -->
<xs:complexType name="PROSE_SECURITY_PARAM_REQUEST-type">
    <xs:sequence>
        <xs:element name="UNR-discovery-security-parameters-request" type="UNR-discovery-security-parameters-request-type" minOccurs="0" maxOccurs="unbounded"/>

        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<!-- XML elements to be included in the <anyExt> element of "PROSE_SECURITY_PARAM_REQUEST-type" complex type -->
<xs:element name="UUR-discovery-security-parameters-request" type="UUR-discovery-security-parameters-request-type"/>

<xs:complexType name="PROSE_SECURITY_PARAM_RESPONSE-type">
    <xs:sequence>
        <xs:element name="UNR-discovery-security-parameters-accept" type="UNR-discovery-security-parameters-accept-type" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="UNR-discovery-security-parameters-reject" type="reject-type" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<!-- XML elements to be included in the <anyExt> element of "PROSE_SECURITY_PARAM_RESPONSE-type" complex type -->
<xs:element name="UUR-discovery-security-parameters-accept" type="UUR-discovery-security-parameters-accept-type"/>
<xs:element name="UUR-discovery-security-parameters-reject" type="reject-type"/>

<xs:complexType name="PROSE_PRUK_REQUEST-type">
    <xs:sequence>
        <xs:element name="PRUK-request" type="PRUK-request-type" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="PROSE_PRUK_RESPONSE-type">
    <xs:sequence>
        <xs:element name="PRUK-accept" type="PRUK-accept-type" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="PRUK-reject" type="reject-type" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
        <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>

```

```

    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="PROSE_KEY_REQUEST-type">
    <xs:sequence>
      <xs:element name="key-request" type="key-request-type" minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <xs:complexType name="PROSE_KEY_RESPONSE-type">
    <xs:sequence>
      <xs:element name="key-accept" type="key-accept-type" minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="key-reject" type="reject-type" minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
      <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <!-- extension allowed -->
  <xs:complexType name="DiscMsgExtType">
    <xs:sequence>
      <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>

  <!-- XML attribute for any future extensions -->
  <xs:complexType name="anyExtType">
    <xs:sequence>
      <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>

  <!-- Top level Security Message definition -->
  <xs:element name="prose-security-message">
    <xs:complexType>
      <xs:choice>
        <xs:element name="PROSE_SECURITY_PARAM_REQUEST" type="PROSE_SECURITY_PARAM_REQUEST-type"/>
        <xs:element name="PROSE_SECURITY_PARAM_RESPONSE" type="PROSE_SECURITY_PARAM_RESPONSE-type"/>
        <xs:element name="PROSE_PRUK_REQUEST" type="PROSE_PRUK_REQUEST-type"/>
        <xs:element name="PROSE_PRUK_RESPONSE" type="PROSE_PRUK_RESPONSE-type"/>
        <xs:element name="PROSE_KEY_REQUEST" type="PROSE_KEY_REQUEST-type"/>
        <xs:element name="PROSE_KEY_RESPONSE" type="PROSE_KEY_RESPONSE-type"/>

        <xs:element name="message-ext" type="DiscMsgExtType"/>
        <xs:any namespace="##other" processContents="lax"/>
      </xs:choice>
    </xs:complexType>
  </xs:element>

</xs:schema>

```

An entity receiving the XML body ignores any unknown XML element and any unknown XML attribute.

10.6.4 Semantics

10.6.4.1 General

The <prose-security-message> element is the root element of this XML document and it contains one of the following elements:

- a) a <PROSE_SECURITY_PARAM_REQUEST> element;
- b) a <PROSE_SECURITY_PARAM_RESPONSE> element;
- c) a <PROSE_PRUK_REQUEST> element;
- d) a <PROSE_PRUK_RESPONSE> element;

- e) a <PROSE_KEY_REQUEST> element;
- f) a <PROSE_KEY_RESPONSE> element;
- g) <message-ext> element containing other discovery message defined in future releases; or
- h) an element from other namespaces defined in future releases.

10.6.4.2 Semantics of <PROSE_SECURITY_PARAM_REQUEST> element

The <PROSE_SECURITY_PARAM_REQUEST> element contains:

- a) zero or more <UNR-discovery-security-parameters-request> elements which contain transactions sent from the UE to the 5G PKMF;
- b) zero or one <anyExt> element containing:
 - 1) zero or more <UUR-discovery-security-parameters-request> elements which contain transactions sent from the UE to the 5G PKMF;
 - 2) elements defined in future releases; or
 - 3) both;
- c) zero or more elements from other namespaces defined in future releases; and
- d) zero or more attributes defined in future releases.

The <UNR-discovery-security-parameters-request> contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;
- b) a <requested-for> element;
- c) a <PC5-UE-security-capabilities> element containing the parameter defined in clause 11.6.2.4;
- d) a <relay-service-code> element containing the parameter defined in clause 11.6.2.10;
- e) zero or one <VPLMN-list> element;
- f) zero or one <model> element;
- g) zero or one <anyExt> element containing elements defined in future releases;
- h) zero or more elements from other namespaces defined in future releases; and
- i) zero or more attributes defined in future releases.

The <UUR-discovery-security-parameters-request> contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;
- b) a <requested-for> element;
- c) a <PC5-UE-security-capabilities> element containing the parameter defined in clause 11.6.2.4;
- d) a <relay-service-code> element containing the parameter defined in clause 11.6.2.10;
- e) zero or one <VPLMN-list> element;
- f) zero or one <model> element;
- g) zero or one <anyExt> element containing elements defined in future releases;
- h) zero or more elements from other namespaces defined in future releases; and
- i) zero or more attributes defined in future releases.

The <requested-for> element contains:

- a) the following:
 - 1) a <remote-UE> element indicating that the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE are requested;
 - 2) a <UNR> element indicating that the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE are requested; or
 - 3) both;
- b) zero or one <anyExt> element containing:
 - 1) a <end-UE> element indicating that the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE are requested;
 - 2) a <UUR> element indicating that the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE are requested;
 - 3) elements defined in future releases; or
 - 4) any of combination of the above;
- c) zero or more elements from other namespaces defined in future releases; and
- d) zero or more attributes defined in future releases.

The <VPLMN-list> element contains:

- a) one or more <PLMN> elements;
- b) zero or one <anyExt> element containing elements defined in future releases;
- c) zero or more elements from other namespaces defined in future releases; and
- d) zero or more attributes defined in future releases.

The <PLMN> element contains:

- a) an <mcc> elements containing the parameter defined in clause 11.6.2.5;
- b) an <mnc> elements containing the parameter defined in clause 11.6.2.6;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero or more elements from other namespaces defined in future releases; and
- e) zero or more attributes defined in future releases.

The <model> element contains:

- a) a <model-A> elements indicating that security parameters are requested for 5G ProSe UE-to-network relay discovery over PC5 interface model A or an <model-B> elements indicating that security parameters are requested for 5G ProSe UE-to-network relay discovery over PC5 interface model B;
- b) zero or one <anyExt> element containing elements defined in future releases;
- c) zero or more elements from other namespaces defined in future releases; and
- d) zero or more attributes defined in future releases.

10.6.4.3 Semantics of <PROSE_SECURITY_PARAM_RESPONSE> element

The <PROSE_SECURITY_PARAM_RESPONSE> element sent from the 5G PKMF to the UE contains:

- a) zero or more <UNR-discovery-security-parameters-accept> elements which contain accepted transactions;

- b) zero or more <UNR-discovery-security-parameters-reject> elements which contain rejected transactions;
- c) zero or one <anyExt> element containing:
 - 1) zero or more <UUR-discovery-security-parameters-accept> elements which contain accepted transactions;
 - 2) zero or more <UUR-discovery-security-parameters-reject> elements which contain rejected transactions;
 - 3) elements defined in future releases; or
 - 4) any combination of the above;
- d) zero or more elements from other namespaces defined in future releases; and
- e) zero or more attributes defined in future releases.

The <UNR-discovery-security-parameters-accept> contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;
- b) zero or more <security-parameters-for-remote-UE> element indicating the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE;
- c) zero or one <PC5-security-policies-for-remote-UE> element indicating the PC5 security policies for 5G ProSe remote UE;
- d) zero or one <security-parameters-for-UNR> element indicating the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE;
- e) zero or one <PC5-security-policies-for-UNR> element indicating the PC5 security policies for 5G ProSe UE-to-network relay UE;
- f) a <Current-Time> element containing the parameter defined in clause 11.6.2.7;
- g) a <Max-Offset> element containing the parameter defined in clause 11.6.2.8;
- h) zero or one <anyExt> element containing elements defined in future releases;
- i) zero or more elements from other namespaces defined in future releases; and
- j) zero or more attributes defined in future releases.

The <UUR-discovery-security-parameters-accept> contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;
- b) zero or one <security-parameters-for-end-UE> element indicating the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE;
- c) zero or one <PC5-security-policies-for-end-UE> element indicating the PC5 security policies for 5G ProSe end UE;
- d) zero or more <security-parameters-for-UUR> element indicating the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE;
- e) zero or one <PC5-security-policies-for-UUR> element indicating the PC5 security policies for 5G ProSe UE-to-UE relay UE;
- f) a <Current-Time> element containing the parameter defined in clause 11.6.2.7;
- g) a <Max-Offset> element containing the parameter defined in clause 11.6.2.8;
- h) zero or one <anyExt> element containing elements defined in future releases;
- i) zero or more elements from other namespaces defined in future releases; and
- j) zero or more attributes defined in future releases.

The <security-parameters-for-remote-UE> element, the <security-parameters-for-UNR> element, the <security-parameters-for-end-UE> element and the <security-parameters-for-UUR> element contains:

- a) an <expiration-timer> element containing the parameter defined in clause 11.6.2.9;
- b) optionally a <code-receiving-security-parameters-for-model-A> element;
- c) optionally a <code-receiving-security-parameters-for-model-B> element;
- d) optionally a <code-sending-security-parameters-for-model-B> element;
- e) a <selected-PC5-ciphering-algorithm> element containing the parameter defined in clause 11.6.2.11;
- e1) a <PLMN-ID> element, only for the case of <security-parameters-for-remote-UE> and the case of <security-parameters-for-end-UE>, containing the parameter defined in clause 11.6.2.27;
- f) zero or one <anyExt> element containing elements defined in future releases;
- g) zero or more elements from other namespaces defined in future releases; and
- h) zero or more attributes defined in future releases.

The <code-receiving-security-parameters-for-model-A> element, the <code-sending-security-parameters-for-model-A> element, the <code-receiving-security-parameters-for-model-B> element and the <code-sending-security-parameters-for-model-B> element contain:

- a) optionally a <DUSK> element containing the parameter defined in clause 11.6.2.12;
- b) optionally a <DUIK> element containing the parameter defined in clause 11.6.2.13;
- c) optionally a <DUCK> element;
- d) zero or one <anyExt> element containing elements defined in future releases;
- e) zero or more elements from other namespaces defined in future releases; and
- f) zero or more attributes defined in future releases.

The <DUCK> element contains:

- a) a <discovery-user-confidentiality-key> element containing the parameter defined in clause 11.6.2.14;
- b) an <encrypted-bitmask> element containing the parameter defined in clause 11.6.2.15;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero or more elements from other namespaces defined in future releases; and
- e) zero or more attributes defined in future releases.

The <PC5-security-policies-for-remote-UE> element, the <PC5-security-policies-for-UNR> element, the <PC5-security-policies-for-end-UE> element and the <PC5-security-policies-for-UUR> element contain:

- a) a <signalling-ciphering-policy> element containing the parameter defined in clause 11.6.2.17;
- b) a <user-plane-integrity-protection-policy> element containing the parameter defined in clause 11.6.2.18;
- c) a <user-plane-ciphering-policy> element containing the parameter defined in clause 11.6.2.19;
- d) zero or one <anyExt> element containing elements defined in future releases;
- e) zero or more elements from other namespaces defined in future releases; and
- f) zero or more attributes defined in future releases.

The <UNR-discovery-security-parameters-reject> element contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;

- b) a <PC8-control-protocol-cause-value> element containing the parameter defined in clause 11.6.2.20;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero or more elements from other namespaces defined in future releases; and
- e) zero or more attributes defined in future releases.

10.6.4.4 Semantics of <PROSE_PRUK_REQUEST> element

The <PROSE_PRUK_REQUEST> element contains:

- a) zero or more <PRUK-request> elements which contain transactions sent from the UE to the 5G PKMF;
- b) zero or one <anyExt> element containing elements defined in future releases;
- c) zero or more elements from other namespaces defined in future releases; and
- d) zero or more attributes defined in future releases.

The <PRUK-request> element contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;
- b) zero or one <UP-PRUK-ID> element containing the parameter defined in clause 11.6.2.3;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero or more elements from other namespaces defined in future releases; and
- e) zero or more attributes defined in future releases;

10.6.4.5 Semantics of <PROSE_PRUK_RESPONSE> element

The <PROSE_PRUK_RESPONSE> element contains:

- a) zero or more <PRUK-accept> elements which contain the accepted transactions;
- b) zero or more <PRUK-reject> elements which contain the rejected transactions;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero or more elements from other namespaces defined in future releases; and
- e) zero or more attributes defined in future releases.

The <PRUK-accept> element contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;
- b) a <UP-PRUK-ID> element containing the parameter defined in clause 11.6.2.3;
- c) a <UP-PRUK> element containing the parameter defined in clause 11.6.2.2;
- d) zero or one <anyExt> element containing elements defined in future releases;
- e) zero or more elements from other namespaces defined in future releases; and
- f) zero or more attributes defined in future releases.

The <PRUK-reject> element contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;
- b) a <PC8-control-protocol-cause-value> element containing the parameter defined in clause 11.6.2.20;
- c) zero or one <anyExt> element containing elements defined in future releases;

- d) zero or more elements from other namespaces defined in future releases; and
- e) zero or more attributes defined in future releases.

10.6.4.6 Semantics of <PROSE_KEY_REQUEST> element

The <PROSE_KEY_REQUEST> element contains:

- a) zero or more <key-request> elements which contain transactions sent from the UE to the 5G PKMF.
- b) zero or one <anyExt> element containing elements defined in future releases;
- c) zero or more elements from other namespaces defined in future releases; and
- d) zero or more attributes defined in future releases.

The <key-request> element contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;
- b) a <relay-service-code> element containing the parameter defined in clause 11.6.2.10;
- c) zero or one <SUCI> element containing the parameter defined in clause 11.6.2.21;
- d) zero or one <UP-PRUK-ID> element containing the parameter defined in clause 11.6.2.3;
- e) a <Knrp-freshness-parameter-1> element containing the parameter defined in clause 11.6.2.22;
- f) zero or one <HPLMN> element;
- g) zero or one <AUTS> element containing the parameter defined in clause 11.6.2.23;
- h) zero or one <RAND> element containing the parameter defined in clause 11.6.2.24;
- i) zero or one <anyExt> element containing elements defined in future releases;
- j) zero or more elements from other namespaces defined in future releases; and
- k) zero or more attributes defined in future releases.

The <HPLMN> element contains:

- a) an <mcc> elements containing the parameter defined in clause 11.6.2.5;
- b) an <mnc> elements containing the parameter defined in clause 11.6.2.6;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero or more elements from other namespaces defined in future releases; and
- e) zero or more attributes defined in future releases.

10.6.4.7 Semantics of <PROSE_KEY_RESPONSE> element

The <PROSE_KEY_RESPONSE> element sent from the 5G PKMF to the UE contains:

- a) zero or more <key-accept> elements which contain accepted transactions;
- b) zero or more <key-reject> elements which contain rejected transactions;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero or more elements from other namespaces defined in future releases; and
- e) zero or more attributes defined in future releases.

The <key-accept> contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;
- b) a <UP-PRUK-ID> element containing the parameter defined in clause 11.6.2.3;
- c) a <Knrp> element containing the parameter defined in clause 11.6.2.25;
- d) a <Knrp-freshness-parameter-2> element containing the parameter defined in clause 11.6.2.26;
- e) zero or one <GPI> element containing the parameter defined in clause 11.6.2.16;
- f) zero or one <anyExt> element containing elements defined in future releases;
- g) zero or more elements from other namespaces defined in future releases; and
- h) zero or more attributes defined in future releases.

The <key-reject> element contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.6.2.1;
- b) a <PC8-control-protocol-cause-value> element containing the parameter defined in clause 11.6.2.20;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero or more elements from other namespaces defined in future releases; and
- e) zero or more attributes defined in future releases.

10.7 Messages transmitted over the PC3ach interface

10.7.1 General

This clause defines XML schema and MIME type related to messages transmitted over the PC3ach interface.

10.7.2 application/vnd.3gpp-prose-pc3ach+xml

The MIME type is used to carry information related to message transmitted over the PC3ach interface. It shall be coded as an XML document compliant to the XML schema in clause 10.7.3 containing one of the following messages:

- PROSE_USAGE_INFORMATION_REPORT_LIST; or
- PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE.

Each of those messages is presented in the XML document as an XML element named after the corresponding message.

10.7.3 XML Schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns="urn:3GPP:ns:5GProSe:PC3ach:2022"
  elementFormDefault="qualified"
  targetNamespace="urn:3GPP:ns:5GProSe:PC3ach:2022">

  <xs:annotation>
    <xs:documentation>
      Syntax of messages transmitted over the PC3ach interface
    </xs:documentation>
  </xs:annotation>

  <!-- Types defined for parameters with complicate structure -->
  <xs:simpleType name="IPAddress-type">
    <xs:restriction base="xs:string"/>
  </xs:simpleType>

  <xs:simpleType name="Layer2Id-type">
    <xs:restriction base="xs:hexBinary"/>
  </xs:simpleType>
```

```

<xs:simpleType name="NCGI-type">
  <xs:restriction base="xs:hexBinary"/>
</xs:simpleType>

<xs:simpleType name="AppSpecificInfo-type">
  <xs:restriction base="xs:hexBinary"/>
</xs:simpleType>

<xs:simpleType name="RadioResourcesIndicator-type">
  <xs:restriction base="xs:integer"/>
</xs:simpleType>

<xs:simpleType name="RadioFrequency-type">
  <xs:restriction base="xs:hexBinary"/>
</xs:simpleType>

<!-- XML attribute for any future extensions -->
<xs:complexType name="anyExtType">
  <xs:sequence>
    <xs:any namespace="##any" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
</xs:complexType>

<xs:complexType name="UsageInformationReportList-Info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="usage-information-report" type="UsageInformationReport-Info"
      minOccurs="1" maxOccurs="unbounded"/>
    <xs:element name="app-specific-info" type="AppSpecificInfo-type" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="UsageInformationReport-Info">
  <xs:sequence>
    <xs:element name="coverage" type="Coverage-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="group" type="Group-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="unicast" type="Unicast-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="radio-parameter-set" type="RadioParameterSet-info" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="sequence-number" type="xs:integer"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="Coverage-info">
  <xs:sequence>
    <xs:element name="location" type="Location-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="in-coverage" type="xs:boolean"/>
  <xs:attribute name="timestamp" type="xs:dateTime" use="optional"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="Location-info">
  <xs:sequence>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="NCGI" type="NCGI-type" use="optional"/>
  <xs:attribute name="timestamp" type="xs:dateTime" use="optional"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RadioParameterSet-info">
  <xs:sequence>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="timestamp" type="xs:dateTime" use="required"/>

```

```
<xs:attribute name="params" type="xs:hexBinary"/>
<xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="Group-info">
  <xs:sequence>
    <xs:element name="UE-source-IP-address" type="IPAddress-type"/>
    <xs:element name="UE-source-layer2-id" type="Layer2Id-type"/>
    <xs:element name="transmitter" type="Transmitter-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="transmission" type="Transmission-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="reception" type="Reception-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:element name="qos-flow" type="QoSFlow-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="prose-layer2-group-ID" type="Layer2Id-type"/>
  <xs:attribute name="prose-group-IP-multicast-address" type="IPAddress-type"/>
  <xs:attribute name="first-transmission-timestamp" type="xs:dateTime" use="optional"/>
  <xs:attribute name="first-reception-timestamp" type="xs:dateTime" use="optional"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="Unicast-info">
  <xs:sequence>
    <xs:element name="UE-source-IP-address" type="IPAddress-type"/>
    <xs:element name="UE-source-layer2-id" type="Layer2Id-type"/>
    <xs:element name="transmitter" type="Transmitter-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="receiver" type="Receiver-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="transmission" type="Transmission-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="reception" type="Reception-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="relay-UE" type="RelayUE-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="relay" type="Relay-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="qos-flow" type="QoSFlow-info" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="first-transmission-timestamp" type="xs:dateTime" use="optional"/>
  <xs:attribute name="first-reception-timestamp" type="xs:dateTime" use="optional"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="Transmitter-info">
  <xs:sequence>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="source-IP-address" type="IPAddress-type"/>
  <xs:attribute name="source-layer2-id" type="Layer2Id-type"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="Transmission-info">
  <xs:sequence>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="in-coverage" type="xs:boolean"/>
  <xs:attribute name="NCGI" type="NCGI-type" use="optional"/>
  <xs:attribute name="amount" type="xs:integer"/>
  <xs:attribute name="timestamp" type="xs:dateTime" use="optional"/>
  <xs:attribute name="radio-resources-ind" type="RadioResourcesIndicator-type" use="optional"/>
  <xs:attribute name="radio-frequency" type="RadioFrequency-type" use="optional"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="Reception-info">
  <xs:sequence>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="in-coverage" type="xs:boolean"/>
  <xs:attribute name="NCGI" type="NCGI-type" use="optional"/>
  <xs:attribute name="amount" type="xs:integer"/>
  <xs:attribute name="timestamp" type="xs:dateTime" use="optional"/>
  <xs:attribute name="radio-resources-ind" type="RadioResourcesIndicator-type" use="optional"/>
  <xs:attribute name="radio-frequency" type="RadioFrequency-type" use="optional"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
```

```

<xs:complexType name="Receiver-info">
  <xs:sequence>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="target-IP-address" type="IPAddress-type"/>
  <xs:attribute name="target-layer2-id" type="Layer2Id-type"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="RelayUE-info">
  <xs:sequence>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="relay-UE-IP-address" type="IPAddress-type"/>
  <xs:attribute name="relay-UE-layer2-id" type="Layer2Id-type"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="Relay-info">
  <xs:sequence>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="NCGI" type="NCGI-type" use="optional"/>
  <xs:attribute name="amount" type="xs:integer"/>
  <xs:attribute name="timestamp" type="xs:dateTime" use="optional"/>
  <xs:attribute name="radio-resources-ind" type="RadioResourcesIndicator-type" use="optional"/>
  <xs:attribute name="radio-frequency" type="RadioFrequency-type" use="optional"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="QoSFlow-info">
  <xs:sequence>
    <xs:element name="qos-parameter-set" type="QosParameterSet-info" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="timestamp" type="xs:dateTime" use="optional"/>
  <xs:attribute name="qos-flow-id" type="xs:hexBinary" minOccurs="0" maxOccurs="unbounded"/>
  <xs:attribute name="amount" type="xs:integer"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="QosParameterSet-info">
  <xs:sequence>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="pqi" type="xs:hexBinary"/>
  <xs:attribute name="gfbr" type="xs:hexBinary"/>
  <xs:attribute name="mfbr" type="xs:hexBinary"/>
  <xs:attribute name="averaging-window" type="xs:hexBinary"/>
  <xs:attribute name="Resource-type" type="xs:hexBinary"/>
  <xs:attribute name="default-priority-level" type="xs:hexBinary"/>
  <xs:attribute name="packet-delay-budget" type="xs:hexBinary"/>
  <xs:attribute name="packet-error-rate" type="xs:hexBinary"/>
  <xs:attribute name="default-maximum-data-burst-volume" type="xs:hexBinary"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="UsageInformationReportListResponse-Info">
  <xs:sequence>
    <xs:element name="response-accept" type="UsageInformationReportListResponseAccept-Info"
minOccurs="0"/>
    <xs:element name="response-reject" type="UsageInformationReportListResponseReject-Info"
minOccurs="0"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="UsageInformationReportListResponseAccept-Info">
  <xs:sequence>

```

```

    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:complexType name="UsageInformationReportListResponseReject-Info">
  <xs:sequence>
    <xs:element name="transaction-ID" type="xs:integer"/>
    <xs:element name="cause-value" type="xs:integer"/>
    <xs:element name="anyExt" type="anyExtType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

<xs:element name="prose-pC3ach-message">
  <xs:complexType>
    <xs:choice>
      <xs:element name="PROSE_USAGE_INFORMATION_REPORT_LIST" type="UsageInformationReportList-
Info"/>
      <xs:element name="PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE"
type="UsageInformationReportListResponse-Info"/>
      <xs:element name="anyExt" type="anyExtType"/>
      <xs:any namespace="##other" processContents="lax"/>
    </xs:choice>
    <xs:anyAttribute namespace="##any" processContents="lax"/>
  </xs:complexType>
</xs:element>
</xs:schema>

```

10.7.4 Semantics

10.7.4.1 General

The <prose-pC3ach-message> element is the root element of this XML document.

The <prose-pC3ach-message> element contains one of the following:

- a) <PROSE_USAGE_INFORMATION_REPORT_LIST> element;
- b) <PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE> element;
- c) <anyExt> element containing elements defined in future releases; or
- d) one or more elements from other namespace defined in future releases.

The <prose-pC3ach-message> element contains zero, one or more attributes defined in future releases.

10.7.4.2 Semantics of <PROSE_USAGE_INFORMATION_REPORT_LIST>

The <PROSE_USAGE_INFORMATION_REPORT_LIST> element contains:

- a) a <transaction-ID> element containing the parameter defined in clause 11.7.2.1;
- b) one or more <usage-information-report> elements;
- c) zero, one or more <app-specific-info> element;
- d) zero or one <anyExt> element containing elements defined in future releases;
- e) zero, one or more elements from other namespaces defined in future releases; and
- f) zero, one or more attributes defined in future releases.

The <usage-information-report> element carries one usage information report. The <usage-information-report> element contains:

- a) mandatory "sequence-number" attribute containing the parameter defined in clause 11.7.2.2;
- b) zero, one or more <coverage> elements;
- c) zero, one or more <group> element;
- d) zero, one or more <unicast> element;
- e) zero, one or more <radio-parameter-set> elements;
- f) zero or one <anyExt> element containing elements defined in future releases;
- g) zero, one or more elements from other namespaces defined in future releases; and
- h) zero, one or more attributes defined in future releases.

The <coverage> element carries information whether the UE was in NG-RAN coverage or out of NG-RAN coverage. The <coverage> element contains:

- a) mandatory "in-coverage" attribute containing the parameter defined in clause 11.7.2.3;
- b) optional "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time when the information given in the element start being valid;
- c) if the UE was in NG-RAN coverage, zero, one or more <location> elements;
- d) zero or one <anyExt> element containing elements defined in future releases;
- e) zero, one or more elements from other namespaces defined in future releases; and
- f) zero, one or more attributes defined in future releases.

The <location> element carries information about an NG-RAN cell where the UE was camping on or which the UE used in the 5GMM-CONNECTED mode. The <location> element contains:

- a) an optional "NCGI" attribute containing the parameter defined in clause 11.7.2.4;
- b) an optional "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time when the information given in the element start being valid;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero, one or more elements from other namespaces defined in future releases; and
- e) zero, one or more attributes defined in future releases.

The <radio-parameter-set> element carries information about the configured radio parameters for the ProSe direct communication applicable in the geographical area of the UE. The <radio-parameter-set> element contains:

- a) a mandatory "params" attribute containing the parameter defined in clause 11.7.2.5;
- b) a mandatory "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time when the information given in the element start being valid;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero, one or more elements from other namespaces defined in future releases; and
- e) zero, one or more attributes defined in future releases.

The <group> element carries information about a 5G ProSe group. The <group> element contains:

- a) a mandatory "prose-layer2-group-ID" attribute containing the parameter defined in clause 11.7.2.8;
- b) a mandatory "prose-group-IP-multicast-address" attribute containing the parameter defined in clause 11.7.2.10;

- c) an optional "first-transmission-timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first transmission to the ProSe Group IP multicast address in the collection period;
- d) an optional "first-reception-timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first reception from the ProSe Group IP multicast address in the collection period;
- e) a <UE-source-IP-address> element containing the parameter defined in clause 11.7.2.10, of the UE;
- f) a <UE-source-layer2-id> element containing the parameter defined in clause 11.7.2.11, of the UE;
- g) zero, one or more <transmitter> element;
- h) zero, one or more <transmission> element;
- i) zero, one or more <reception> element;
- j) zero, one or more <qos-flow> elements;
- k) zero or one <anyExt> element containing elements defined in future releases;
- l) zero, one or more elements from other namespaces defined in future releases; and
- m) zero, one or more attributes defined in future releases.

The <unicast> element carries information about an unicast mode 5G ProSe direct communication. The <unicast> element contains:

- a) an optional "first-transmission-timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first transmission in the unicast mode 5G ProSe direct communication in the collection period;
- b) an optional "first-reception-timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first reception in the unicast mode 5G ProSe direct communication in the collection period;
- c) a <UE-source-IP-address> element containing the parameter defined in clause 11.7.2.10, of the UE;
- d) a <UE-source-layer2-id> element containing the parameter defined in clause 11.7.2.11, of the UE;
- e) zero, one or more <transmitter> element;
- f) zero, one or more <receiver> element;
- g) zero, one or more <transmission> element;
- h) zero, one or more <reception> element;
- i) zero, one or more <relay-UE> element;
- j) zero, one or more <relay> element;
- k) zero, one or more <qos-flow> elements;
- l) zero or one <anyExt> element containing elements defined in future releases;
- m) zero, one or more elements from other namespaces defined in future releases; and
- n) zero, one or more attributes defined in future releases.

The <transmitter> element carries information about a transmitter in a 5G ProSe group or in an unicast mode 5G ProSe direct communication. The <transmitter> element contains:

- a) a mandatory "source-IP-address" attribute containing the parameter defined in clause 11.7.2.10, of the transmitter;
- b) a mandatory "source-layer2-id" attribute containing the parameter defined in clause 11.7.2.11, of the transmitter;
- c) zero or one <anyExt> element containing elements defined in future releases;

- d) zero, one or more elements from other namespaces defined in future releases; and
- e) zero, one or more attributes defined in future releases.

The <receiver> element carries information about a receiver in an unicast mode 5G ProSe direct communication. The <receiver> element contains:

- a) a mandatory "target-IP-address" attribute containing the parameter defined in clause 11.7.2.10, of the receiver;
- b) a mandatory "target-layer2-id" attribute containing the parameter defined in clause 11.7.2.11, of the receiver;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero, one or more elements from other namespaces defined in future releases; and
- e) zero, one or more attributes defined in future releases.

The <transmission> element carries information about a transmission in a ProSe group or in an unicast mode 5G ProSe direct communication. The <transmission> element contains:

- a) a mandatory "in-coverage" attribute containing the parameter defined in clause 11.7.2.3;
- b) if the UE was in NG-RAN coverage when transmitting the data, an optional "NCGI" attribute containing the parameter defined in clause 11.7.2.5, indicating NG-RAN Cell Global Identification of the NG-RAN cell where the UE was camping on or which the UE used in the 5GMM-CONNECTED mode when transmitting the data;
- c) if the UE was in NG-RAN coverage and the "NCGI" attribute is included:
 - 1) a mandatory "amount" attribute containing the parameter defined in clause 11.7.2.12 indicating the amount of octets transmitted to the ProSe group or in an unicast mode 5G ProSe direct communication:
 - when the UE was camping on a cell identified by the "NCGI" attribute when transmitting the data; or
 - when the UE used in the 5GMM-CONNECTED mode a cell identified by the "NCGI" attribute when transmitting the data; and
 - 2) an optional "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first transmission in the NG-RAN cell;
- d) if the UE was in NG-RAN coverage and the "NCGI" attribute is not included:
 - 1) a mandatory "amount" attribute containing the parameter defined in clause 11.7.2.12 indicating the amount of octets transmitted to the ProSe group or in an unicast mode 5G ProSe direct communication during the in NG-RAN coverage period; and
 - 2) an optional "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first transmission during the in NG-RAN coverage period;
- e) if the UE was out of NG-RAN coverage:
 - 1) a mandatory "amount" attribute containing the parameter defined in clause 11.7.2.12 indicating the amount of octets transmitted to the ProSe group or in an unicast mode 5G ProSe direct communication during the out of NG-RAN coverage period; and
 - 2) an optional "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first transmission during the out of NG-RAN coverage period;
- f) an optional "radio-resources-ind" attribute containing the parameter defined in clause 11.7.2.13;
- g) an optional "radio-frequency" attribute containing the parameter defined in clause 11.7.2.14;
- h) zero or one <anyExt> element containing elements defined in future releases;
- i) zero, one or more elements from other namespaces defined in future releases; and
- j) zero, one or more attributes defined in future releases.

The <reception> element carries information about a reception in a ProSe group or in an unicast mode 5G ProSe direct communication. The <reception> element contains:

- a) a mandatory "in-coverage" attribute containing the parameter defined in clause 11.7.2.3 indicating whether the UE was in NG-RAN coverage when receiving the data;
- b) if the UE was in NG-RAN coverage when receiving the data, an optional "NCGI" attribute containing the parameter defined in clause 11.7.2.4 indicating NG-RAN Cell Global Identification of the NG-RAN cell where the UE was camping on or which the UE used in the 5GMM-CONNECTED mode when receiving the data;
- c) if the UE was in NG-RAN coverage and the "NCGI" attribute is included:
 - 1) a mandatory "amount" attribute containing the parameter defined in clause 11.7.2.12 indicating the amount of octets received from the ProSe group or in an unicast mode 5G ProSe direct communication:
 - when the UE was camping on a cell identified by the "NCGI" attribute when receiving the data; or
 - when the UE used in the 5GMM-CONNECTED mode a cell identified by the "NCGI" attribute when receiving the data; and
 - 2) an optional "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first reception in the NG-RAN cell;
- d) if the UE was in NG-RAN coverage and the "NCGI" attribute is not included:
 - 1) a mandatory "amount" attribute containing the parameter defined in clause 11.7.2.12 indicating the amount of octets received from the ProSe group or in an unicast mode 5G ProSe direct communication during the in NG-RAN coverage period; and
 - 2) an optional "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first reception during the in NG-RAN coverage period;
- e) if the UE was out of NG-RAN coverage:
 - 1) a mandatory "amount" attribute containing the parameter defined in clause 11.7.2.12 indicating the amount of octets received from the ProSe group or in an unicast mode 5G ProSe direct communication during the out of NG-RAN coverage period; and
 - 2) an optional "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first reception during the out of NG-RAN coverage period;
- f) an optional "radio-resources-ind" attribute containing the parameter defined in clause 11.7.2.13;
- g) an optional "radio-frequency" attribute containing the parameter defined in clause 11.7.2.14;
- h) zero or one <anyExt> element containing elements defined in future releases;
- i) zero, one or more elements from other namespaces defined in future releases; and
- j) zero, one or more attributes defined in future releases.

The <relay-UE> element carries information about a 5G ProSe UE-to-network relay UE. The <relay-UE> element contains:

- a) a mandatory "relay-UE-IP-address" attribute containing the parameter defined in clause 11.7.2.10, of the 5G ProSe UE-to-network relay UE;
- b) a mandatory "relay-UE-id" attribute containing the parameter defined in clause 11.7.2.11, of the 5G ProSe UE-to-network relay UE;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero, one or more elements from other namespaces defined in future releases; and
- e) zero, one or more attributes defined in future releases.

The <relay> element carries information about a data relay in an unicast mode 5G ProSe direct communication between the 5G ProSe remote UE and the 5G ProSe UE-to-network relay UE,. The <relay> element contains:

- a) a mandatory "NCGI" attribute containing the parameter defined in clause 11.7.2.4, indicating NG-RAN Cell Global Identification of the NG-RAN cell where the UE was camping on or which the UE used in the 5GMM-CONNECTED mode when relaying the data;
- b) a mandatory "amount" attribute containing the parameter defined in clause 11.7.2.12 indicating the amount of octets relayed by the UE used in the 5GMM-CONNECTED mode a cell identified by the "NCGI" attribute when relaying the data;
- c) a mandatory "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time of the first data relay in the NG-RAN cell;
- d) an optional "radio-resources-ind" attribute containing the parameter defined in clause 11.7.2.13;
- e) an optional "radio-frequency" attribute containing the parameter defined in clause 11.7.2.14;
- f) zero or one <anyExt> element containing elements defined in future releases;
- g) zero, one or more elements from other namespaces defined in future releases; and
- h) zero, one or more attributes defined in future releases.

The <app-specific-info> element contains an application specific data received from upper layers during the collection period.

The <qos-flow> element carries information of PC5 QoS flows used by the UE for 5G ProSe direct communication. The <qos-flow> element contains:

- a) a mandatory "qos-flow-id" attribute containing the parameter defined in clause 11.7.2.15;
- b) zero, one or more "<qos-parameter-set>" element;
- c) an optional "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time when the information given in the element start being valid;
- d) an optional "timestamp" attribute containing the parameter defined in clause 11.7.2.7 indicating date and time when the information given in the element stop being valid;
- e) a mandatory "amount" attribute containing the parameter defined in clause 11.7.2.12 indicating the amount of octets of the QoS flow transmitted or received;
- f) zero or one <anyExt> element containing elements defined in future releases;
- g) zero, one or more elements from other namespaces defined in future releases; and
- h) zero, one or more attributes defined in future releases.

The <qos-parameter-set> element carries information of QoS parameters for the PC5 QoS flows used by the UE for 5G ProSe direct communication. The <qos-parameter-set> element contains:

- a) a mandatory "pqi" attribute containing the parameter defined in clause 11.7.2.16;
- b) an optional "gfbr" attribute containing the parameter defined in clause 11.7.2.17;
- c) an optional "mfbr" attribute containing the parameter defined in clause 11.7.2.18;
- d) an optional "averaging-window" attribute containing the parameter defined in clause 11.7.2.19;
- e) an optional "Resource-type" attribute containing the parameter defined in clause 11.7.2.20;
- f) an optional "default-priority-level" attribute containing the parameter defined in clause 11.7.2.21;
- g) an optional "packet-delay-budget" attribute containing the parameter defined in clause 11.7.2.22;
- h) an optional "packet-error-rate" attribute containing the parameter defined in clause 11.7.2.23;

- i) an optional "default-maximum-data-burst-volume" attribute containing the parameter defined in clause 11.7.2.24;
- j) zero or one <anyExt> element containing elements defined in future releases;
- k) zero, one or more elements from other namespaces defined in future releases; and
- l) zero, one or more attributes defined in future releases.

10.7.4.3 Semantics of <PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE>

The <PROSE_USAGE_INFORMATION_REPORT_LIST_RESPONSE> element contains:

- a) one of <response-accept> element and <response-reject> element;
- b) zero or one <anyExt> element containing elements defined in future releases;
- c) zero, one or more elements from other namespaces defined in future releases; and
- d) zero, one or more attributes defined in future releases.

The <response-accept> element indicates that a related PROSE_USAGE_INFORMATION_REPORT_LIST message was accepted. The <response-accept> element contains:

- a) <transaction-ID> element containing the parameter defined in clause 11.7.2.1 indicating the value of the transaction ID of the related PROSE_USAGE_INFORMATION_REPORT_LIST message;
- b) zero or one <anyExt> element containing elements defined in future releases;
- c) zero, one or more elements from other namespaces defined in future releases; and
- d) zero, one or more attributes defined in future releases.

The <response-reject> element indicates that a related PROSE_USAGE_INFORMATION_REPORT_LIST message was rejected. The <response-reject> element contains:

- a) <transaction-ID> element containing the parameter defined in clause 11.7.2.1 indicating the value of the transaction ID of the related PROSE_USAGE_INFORMATION_REPORT_LIST message;
- b) <cause-value> element containing the parameter defined in clause 11.7.2.6;
- c) zero or one <anyExt> element containing elements defined in future releases;
- d) zero, one or more elements from other namespaces defined in future releases; and
- e) zero, one or more attributes defined in future releases.

10.8 MANET Messages for 5G ProSe Multi-hop UE-to-UE relay

10.8.1 General

This clause defines MANET message(s) for 5G ProSe multi-hop UE-to-UE relay use case based on the packet and message format of MANET specified in IETF RFC 5444 [59] and IETF RFC 8245 [62]. In this document, only the message header and new message TLV blocks are defined. For the rest of the message format, i.e., security protection parameter and address block composition, the same mechanism being used in NHDP (see IETF RFC 6130 [60]) and OLSRv2 (see IETF RFC 7181 [61]) shall be applied.

10.8.2 5G ProSe MANET message

10.8.2.1 Message definition

This message is sent by the 5G ProSe multi-hop UE-to-UE relay UE over the IP PDU type connectivity of PC5 interface toward other 5G ProSe multi-hop UE-to-UE relays in the MANET network.

In this clause, table 10.8.2.1 specifies message TLV block(s) for the 5G ProSe MANET message according to IETF RFC 5444 [59] and IETF RFC 8245 [62]). The message header for the 5G ProSe MANET message shall be set based on the IETF RFC 5444 [59] with following 3GPP specific adaptations:

- a) <msg-type> field is set to the value 240 (decimal) for 5G ProSe MANET message; and
- b) <msg-hop-limit> field and <msg-hop-count> field shall not be present.

NOTE: The value of 240 (decimal) for <msg-type> is from the experimental use range of the Message Type registry defined in IETF RFC 5444 [59].

Table 10.8.2.1: 5G ProSe MANET discovery info message content

Message TLV block	Type/Reference	Presence	Format	Length
Multi-hop UE-to-UE discovery info	Multi-hop UE-to-UE discovery info 11.8.1	M	TLV-E	14-65539

A multi-hop UE-to-UE discovery info is included in the message content to propagate the DNS information of 5G ProSe multi-hop layer-3 end UEs connected to the MANET network.

10.9 5G ProSe broadcasting messages

10.9.1 Message definition

This message is sent by the UE over the PC5 interface for broadcasting messages. See table 10.9.1.1.

Message type: PROSE PC5 BROADCASTING

Significance: dual

Direction: UE to peer UE

Table 10.9.1.1: PROSE PC5 BROADCASTING message content for public warning notification

IEI	Information Element	Type/Reference	Presence	Format	Length
	ProSe broadcasting message type (NOTE 1)	ProSe broadcasting message type 11.9.1	M	V	1
	Hop count	Hop count 11.2.21	M	V	1
	Warning message payload	Warning message content NG-RAN (NOTE 2)	M	LV-E	6-9600
NOTE 1: The type is set to "Public warning notification".					
NOTE 2: The warning message content contains the contents of SIB6, SIB7, or SIB8 as specified in 3GPP TS 38.331 [13].					

11 Information elements coding

11.1 Overview

This clause contains general message format and information elements coding for the messages used in the procedures described in the present document.

Type 6 IE container IE should be used if a message contains many type 6 optional IEs and the IEI values may become exhaustive (see clause 9.11.3.98 in 3GPP TS 24.501 [11]). For the type 6 IE, the IEI values 0x7E and 0x7F are reserved for indicating "comprehension required" scheme, see clause 11.2.5 in 3GPP TS 24.007 [20].

11.2 5G ProSe direct discovery message formats

11.2.1 ProSe direct discovery PC5 message type

This parameter is used to indicate the type of ProSe direct discovery message over PC5 interface.

This parameter is coded as shown in figure 11.2.1.1 and table 11.2.1.1. Content type '1101' shall be used to represent the presence of the extended content types as described in clause 11.2.1a.

The ProSe direct discovery PC5 message type is a type 3 information element, with the length of 1 octet.

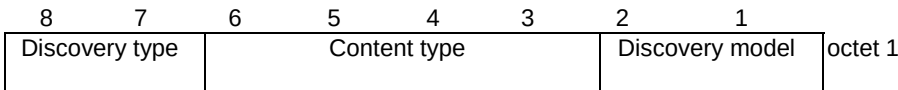


Figure 11.2.1.1: ProSe direct discovery PC5 message type parameter

Table 11.2.1.1: ProSe direct discovery PC5 message type parameter

Discovery type value (octet 1):				
Bit				
8	7			
0	0	Reserved		
0	1	Open discovery		
1	0	Restricted discovery		
1	1	Reserved		
Content type value (octet 1):				
Bit				
6	5	4	3	
0	0	0	0	Announcement/response
0	0	0	1	Solicitation
0	0	1	0	UE-to-UE relay discovery announcement/UE-to-UE relay discovery response
0	0	1	1	UE-to-UE relay discovery solicitation
0	1	0	0	UE-to-network relay discovery announcement/UE-to-network relay discovery response
0	1	0	1	UE-to-network relay discovery solicitation
0	1	1	0	Group member discovery announcement/group member discovery response
0	1	1	1	Group member discovery solicitation
1	0	0	0	Relay discovery additional information
1	0	0	1	Ranging and sidelink positioning UE discovery announcement/Ranging and sidelink positioning UE discovery response
1	0	1	0	Ranging and sidelink positioning UE discovery solicitation
1	0	1	1	Group member discovery announcement for ranging and sidelink positioning/group member discovery response for ranging and sidelink positioning
1	1	0	0	Group member discovery solicitation for ranging and sidelink positioning
1	1	0	1	Extended content type
The other values are reserved.				
Discovery model value (octet 1):				
Bit				
2	1			
0	0	Reserved		
0	1	Model A		
1	0	Model B		
1	1	Reserved		

NOTE 1: Content type '0000' (announce/response) is used for model A announcing and for model B discoveree operation.

NOTE 2: Content type '0100' (UE-to-network relay discovery announcement or UE-to-network relay discovery response) is used for model A announcing and for model B discoveree operation.

NOTE 3: Content type '0110' (group member discovery announcement or group member discovery response) is used for model A announcing and for model B discoveree operation.

NOTE 4: Content type '1001' (ranging and sidelink positioning UE discovery announcement/Ranging and sidelink positioning UE discovery response) is used for model A announcing and for model B discoveree operation.

NOTE 5: Content type '1011' (group member discovery announcement for ranging and sidelink positioning/group member discovery response for ranging and sidelink positioning) is used for model A announcing and for model B discoveree operation.

11.2.1a ProSe direct discovery PC5 message content type extensions

This parameter is used to indicate the extended content types of the ProSe direct discovery message over PC5 interface.

This parameter is coded as shown in figure 11.2.1a.1 and table 11.2.1a.1.

The ProSe direct discovery PC5 message type is a type 3 information element, with the length of 1 octet.

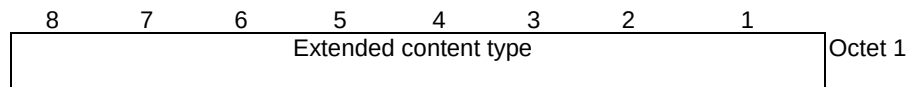


Figure 11.2.1a.1: ProSe direct discovery PC5 message content type extensions parameter

Table 11.2.1a.1: ProSe direct discovery PC5 message content type extensions parameter

Extended content type value (octet 1):								
Bit								
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Multi-hop UE-to-network relay discovery announcement
0	0	0	0	0	0	0	1	Multi-hop UE-to-network relay discovery additional information
0	0	0	0	0	0	1	0	Multi-hop UE-to-network relay discovery solicitation
0	0	0	0	0	0	1	1	Multi-hop UE-to-network relay discovery response
0	0	0	0	0	1	0	0	Multi-hop UE-to-UE relay discovery announcement for IP data unit type
0	0	0	0	0	1	0	1	Multi-hop UE-to-UE relay discovery solicitation for IP data unit type
0	0	0	0	0	1	1	0	Multi-hop UE-to-UE relay discovery response for IP data unit type
0	0	0	0	0	1	1	1	Multi-hop UE-to-UE relay discovery announcement for Ethernet and unstructured data unit type
0	0	0	0	1	0	0	0	Multi-hop UE-to-UE relay discovery solicitation for Ethernet and unstructured data unit type
0	0	0	0	1	0	0	1	Multi-hop UE-to-UE relay discovery response for Ethernet and unstructured data unit type

The other values are reserved.

11.2.2 ProSe application code

This parameter is used to contain a ProSe application code. The format of the ProSe application code is as follows:

- a) if the ProSe application code is included in a PROSE PC5 DISCOVERY message and application-controlled extension is used, the ProSe application code is encoded as a 184 bitstring composed of:
 - 1) the ProSe application code prefix; and
 - 2) the ProSe application code suffix; or
- b) in all other cases, the ProSe application is encoded as a 184 bitstring as defined in 3GPP TS 23.003 [12].

11.2.3 ProSe restricted code

This parameter is used to contain a ProSe restricted code. The format of the ProSe restricted code is as follows:

- a) if the ProSe restricted code is included in a PROSE PC5 DISCOVERY message and application-controlled extension is not used, the ProSe restricted code is encoded as a 184 bitstring composed of:
 - 1) the ProSe restricted code in the 64 most significant bits; and
 - 2) the remaining 120 bits set to zero;
- b) if the ProSe restricted code is included in a PROSE PC5 DISCOVERY message and application-controlled extension is used, the ProSe restricted code is encoded as a 184 bitstring composed of
 - 1) the ProSe restricted code prefix in the 64 most significant bits;
 - 2) the ProSe restricted code suffix; and

- 3) any remaining unused least significant bits set to zero; or
- c) in all other cases, the ProSe restricted code is encoded as a 64 bitstring as defined in 3GPP TS 23.003 [12].

11.2.4 MIC

This parameter is used to carry the MIC (Message Integrity Check) associated with the ProSe application code contained in a PROSE PC5 DISCOVERY message.

11.2.5 UTC-based counter

This parameter is used to indicate the UTC time associated with the discovery transmission opportunity in which a PROSE PC5 DISCOVERY message is sent. It is expressed in unit of seconds and coded in binary format as the 32 least significant bits of the Coordinated Universal Time as defined in 3GPP TS 38.331 [13].

11.2.6 Application layer group ID

The application layer group ID parameter carries an identifier of an application layer group that the UE belongs to.

The application layer group ID information element is coded as shown in figure 11.2.6.1 and table 11.2.6.1.

The application layer group ID is a type 4 information element.

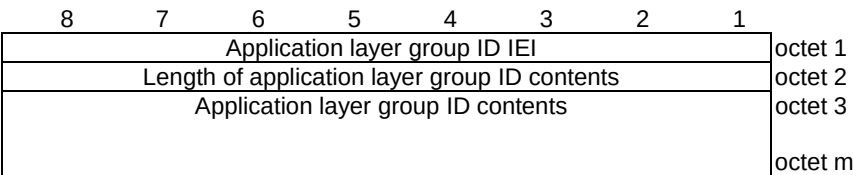


Figure 11.2.6.1: Application layer group ID information element

Table 11.2.6.1: Application layer group ID information element

The length of application layer group ID contents field contains the binary coded representation of the length of the application layer group ID contents field. The application layer group ID contents field contains the octets indicating the application layer group ID. The format of the application layer group ID parameter is out of scope of this specification.

11.2.7 User info ID

The user info ID parameter carries a user info ID as specified in 3GPP TS 23.304 [2]. The user info ID parameter contains a 48-bit long bit string (6 octets). The composition of the contents of the user info ID parameter is out of scope of this specification.

NOTE: Depending on operation, user info ID is indicated as the announcer info parameter, the discoverer info parameter or the discoveree info parameter.

The User info ID is a type 3 information element with a length of 7 octets.

The User info ID IE is coded as shown in figure 11.2.7.1 and table 11.2.7.1.

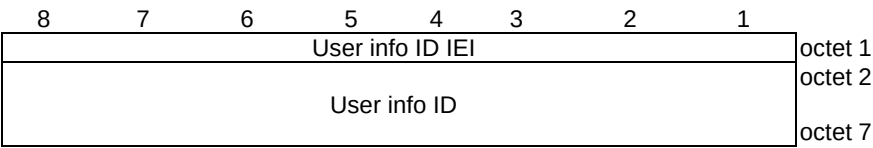


Figure 11.2.7.1: User info ID information element

Table 11.2.7.1: User info ID information element

User info ID (octet 2 to 7)
This field contains the 48-bit User info ID value. The composition of the contents of the user info ID parameter is out of scope of this specification.

11.2.8 Relay service code

The relay service code parameter is used to indicate the connectivity service that:

- a) the 5G ProSe UE-to-network relay provides to the 5G ProSe remote UE in the UE-to-network relay direct discovery.; or
- b) the 5G ProSe UE-to-UE relay provides to the 5G ProSe end UE in the UE-to-UE relay direct discovery; or
- c) the 5G ProSe multi-hop UE-to-UE relay provides to the 5G ProSe end UE and other 5G ProSe multi-hop UE-to-UE relays in the multi-hop UE-to-UE relay direct discovery for IP data unit type.

The value of the relay service code parameter is 24-bit long bit string. The format of the relay service code parameter is out of scope of this specification.

The relay service code is a type 3 information element with a length of 4 octets.

The relay service code IE is coded as shown in figure 11.2.8.1 and table 11.2.8.1.

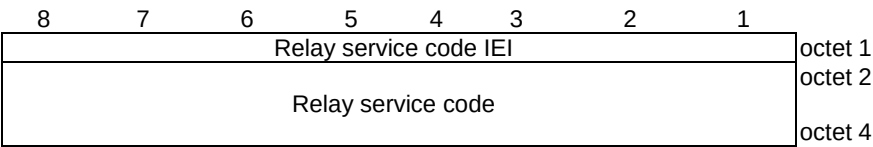


Figure 11.2.8.1: Relay service code information element

Table 11.2.8.1: Relay service code information element

Relay service code (octet 2 to 4)
This field contains the 24-bit relay service code.

11.2.9 Status indicator

The status indicator parameter is used to indicate the status of 5G ProSe UE-to-network relay UE, 5G ProSe UE-to-UE relay UE, or 5G ProSe multi-hop UE-to-network relay UE.

The status indicator is a type 3 information element with a length of 2 octets.

The status indicator IE is coded as shown in figure 11.2.9.1 and table 11.2.9.1.

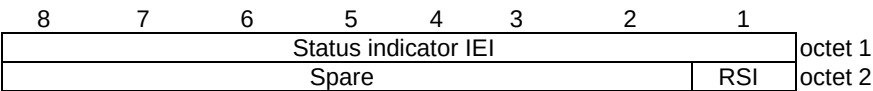


Figure 11.2.9.1: Status indicator information element

Table 11.2.9.1: Status indicator information element

Resource status indicator (RSI) (octet 2, bit 1)	
The bit is used to indicate whether or not the UE has resources available to provide a connectivity service for additional ProSe-enabled UEs.	
Bit	
1	
0	the UE does not have resources available to provide a connectivity service for additional ProSe-enabled UEs
1	the UE has resources available to provide a connectivity service for additional ProSe-enabled UEs
Bits 2 to 8 of octet 1 are spare and shall be coded as zero.	

11.2.10 TAI

The TAI information element is coded as the 5GS tracking area identity specified in clause 9.11.3.8 of 3GPP TS 24.501 [11].

11.2.11 UTC-based counter LSB

This parameter is used to carry the four least significant bits of the UTC-based counter associated with the discovery transmission opportunity used by the UE.

The UTC-based counter LSB IE is a type 3 information element with a length of 2 octets.

The UTC-based counter LSB IE is coded as shown in figures 11.2.11.1, figure 11.2.11.2 and table 11.2.11.1.

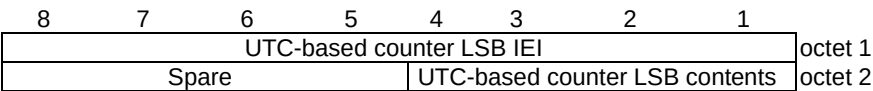


Figure 11.2.11.1: UTC-based counter LSB parameter for open 5G ProSe direct discovery

Table 11.2.11.1: UTC-based counter LSB information element

UTC-based counter LSB contents (bits 1 to 4 of octet 2)	
Bits 1 to 4 of octet 2 are set to the four least significant bits of the UTC-based counter encoded as specified in clause 11.2.5.	
Bits 5 to 8 of octet 2 are spare and shall be coded as zero.	

11.2.12 NCGI

The NCGI information element is used to indicate the NCGI of the serving cell where the 5G ProSe UE-to-network relay UE is camping.

The NCGI is a type 3 information element with a length of 9 octets.

The NCGI information element is coded as shown in figure 11.2.12.1 and table 11.2.12.2.

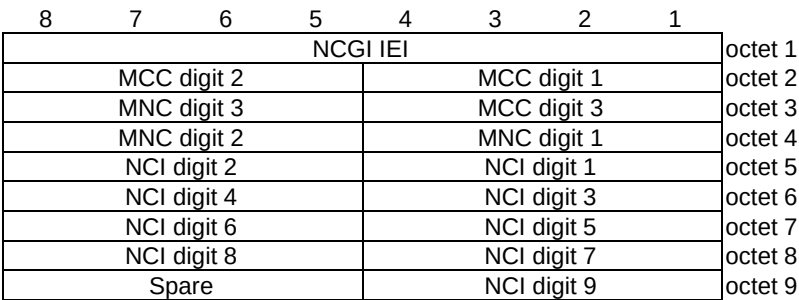


Figure 11.2.12.1: UE-to-network relay NCGI parameter

Table 11.2.12.1: UE-to-network relay NCGI parameter

MCC, Mobile country code (octet 2, octet 3 bits 1 to 4) The MCC field is coded as in ITU-T Rec. E.212 [27], Annex A.
MNC, Mobile network code (octet 3 bits 5 to 8, octet 4) The coding of this field is the responsibility of each administration but BCD coding shall be used. If MNC consists of 2 digits, Bits 5 to 8 of octet 2 is coded as "1111".
NCI, NR cell identity (octet 5, octet 6, octet 7, octet 8, octet 9 bits 1 to 4) The NCI field is coded as in 3GPP TS 23.003 [12].
Spare (octet 9 bits 5 to 8) The Spare field is coded as zeros.

11.2.13 Metadata

The Metadata parameter carries the application layer metadata information.

The Metadata information element is coded as shown in figure 11.2.13.1 and table 11.2.13.1.

The Metadata is a type 6 information element.

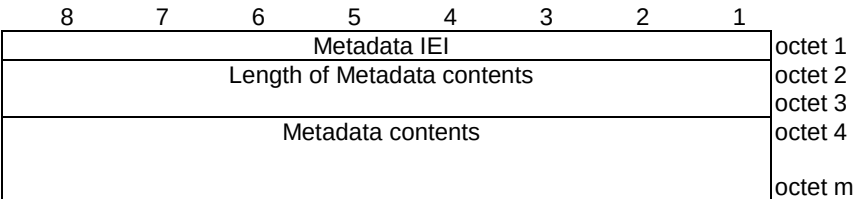


Figure 11.2.13.1: Metadata information element

Table 11.2.13.1: Metadata information element

The length of Metadata contents field contains the binary coded representation of the length of the Metadata contents field.
The Metadata contents field contains the octets indicating the Metadata parameter. The format of the Metadata parameter is out of scope of this specification.

11.2.14 RRC container

The RRC container information element is used to indicate the RRC container information received from the lower layers.

The RRC container is a type 4 information element.

The RRC container information element is coded as shown in figure 11.2.14.1 and table 11.2.14.1.

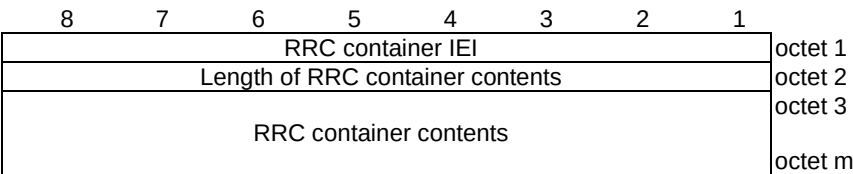


Figure 11.2.14.1: RRC container information element

Table 11.2.14.1: RRC container information element

The length of RRC container contents field contains the binary coded representation of the length of the RRC container contents field.
RRC container contents (octet 3 to m)
The RRC container contents field is coded as SL-AccessInfo-L2U2N in clause 9.4 of 3GPP TS 38.331 [13].

11.2.15 Application layer ID

The purpose of the application layer ID parameter information element carries an application layer ID as specified in 3GPP TS 23.304 [2].

The application layer ID information element is coded as shown in figure 11.2.15.1 and table 11.2.15.1.

The application layer ID is a type 4 information element.

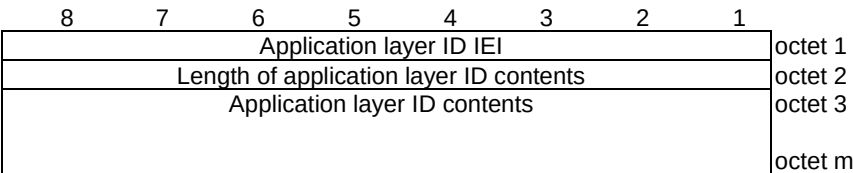


Figure 11.2.15.1: Application layer ID information element

Table 11.2.15.1: Application layer ID information element

The length of application layer ID contents field contains the binary coded representation of the length of the application layer ID contents field.
The application layer ID contents field contains the octets indicating the application layer ID. The format of the application layer ID parameter is out of scope of this specification.

11.2.16 Void

11.2.17 Direct discovery set

The purpose of the direct discovery set information element is to carry the direct discovery set as specified in 3GPP TS 33.503 [34].

The direct discovery set information element is a type 6 information element with the minimum length of 12 octets and the maximum length of 520 octets.

The direct discovery set information element is coded as shown in figure 11.2.17.1 and table 11.2.17.1.

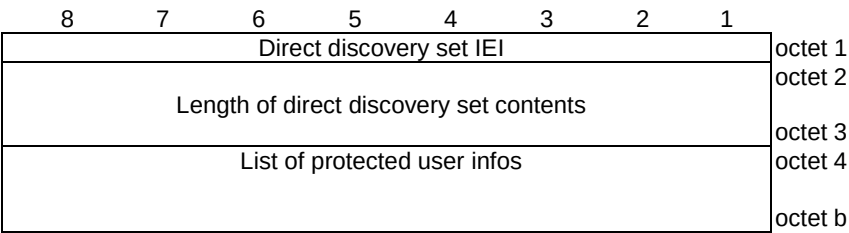


Figure 11.2.17.1: Direct discovery set information element

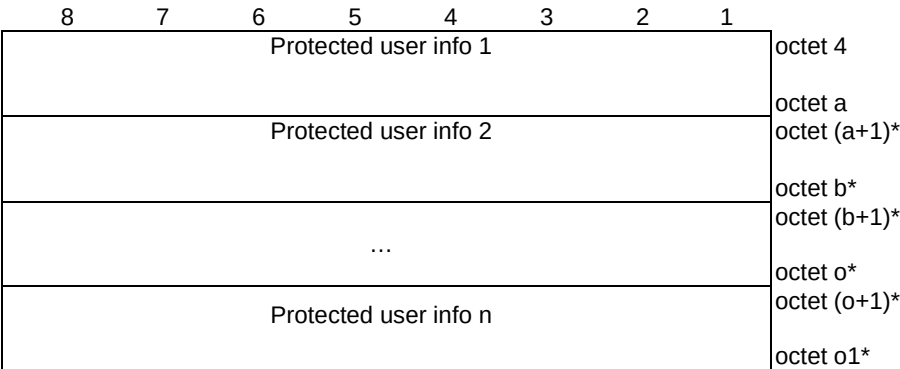


Figure 11.2.17.2: List of Protected user infos

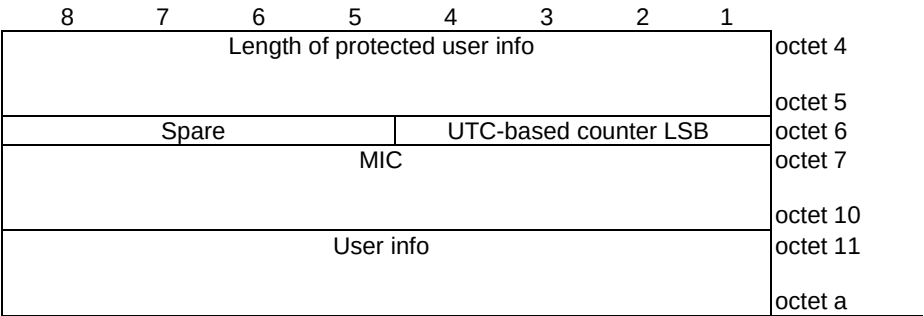


Figure 11.2.17.3: Protected user info

Table 11.2.17.1: Direct discovery set information element

UTC-based counter LSB (bits 1 to 4 of octet 6) The UTC-based counter LSB field contains the four least significant bits of the UTC-based counter associated with the discovery transmission opportunity used by the UE. UTC-based counter LSB field is coded as the value part of UTC-based counter LSB information element as specified in clause 11.2.11.
Bits 5 to 8 of octet 6 are spare and shall be coded as zero.
MIC (octet 7 to 10) The MIC field contains the MIC (Message Integrity Check) for integrity protection of the direct discovery set. MIC field is coded as the value part of MIC information element as specified in clause 11.3.38.
User info (octet 11 to a) In case of the candidate 5G ProSe UE-to-UE relay discovery procedure, the Application layer ID is coded as zero. The user info field is coded as the length and value part of Application layer ID information element as specified in clause 11.2.15 starting with the second octet, and then is protected as specified in clause 6.1.3.2.3 of 3GPP TS 33.503 [34] and clause 8a.2.1.3.2.2.

11.2.18 Void

11.2.19 Announce prohibited indication

The announce prohibited indication parameter is used to indicate whether, or not, a 5G ProSe UE-to-UE relay UE is prohibited from broadcasting the user info of an end UE included in the direct discovery set during the procedure of 5G ProSe UE-to-UE relay discovery over PC5 interface with model A.

The announce prohibited indication is a type 1 information element with a length of 1 octet.

The announce prohibited indication IE is coded as shown in figure 11.2.19.1 and table 11.2.19.1.

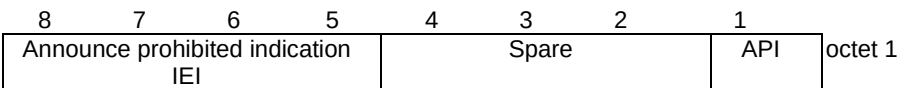


Figure 11.2.19.1: Announce prohibited indication information element

Table 11.2.19.1: Announce prohibited indication information element

Announce prohibited indication (API) (octet 1, bit 1)	
The bit is used to indicate whether or not the UE's user info can be broadcasted during the 5G ProSe UE-to-UE relay discovery over PC5 interface with model A.	
Bit	
1	
0	It is not prohibited to broadcast the user info.
1	It is prohibited to broadcast the user info.
Bits 2 to 4 of octet 1 are spare and shall be coded as zero.	

11.2.20 PLMN ID

The PLMN ID information element is used to indicate the PLMN ID of the 5G ProSe UE-to-network relay UE, the 5G ProSe multi-hop UE-to-network relay UE, the 5G ProSe multi-hop remote UE, the 5G ProSe intermediate UE-to-network relay UE, the 5G ProSe UE-to-UE relay UE, the 5G ProSe end UE, the 5G ProSe multi-hop UE-to-UE relay

UE, or the 5G ProSe multi-hop end UE for which the relay service code is associated, and is coded as the PLMN identity information element specified in clause 9.11.3.85 of 3GPP TS 24.501 [11] starting from octet 3 to octet 5.

11.2.21 Hop count

The purpose of the Hop count information element is to provide the number of PC5 hops required for the 5G ProSe multi-hop remote UE to reach the network. It is set to 1 by the 5G ProSe multi-hop UE-to-network relay UE and is incremented by 1 every time the message is forwarded by a 5G ProSe intermediate UE-to-network relay UE(s) toward the 5G ProSe multi-hop remote UE.

The Hop count information element is an integer in the 1-15 range.

The Hop count is a type 1 information element, with a length of 1 octet.

The Hop count IE is coded as shown in figure 11.2.21.1 and table 11.2.21.1.

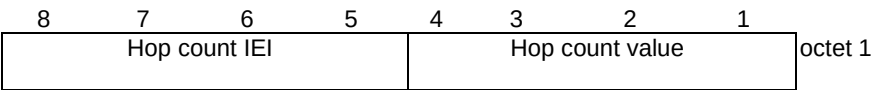


Figure 11.2.21.1: Hop count information element

Table 11.2.21.1: Hop count information element

Hop count value (octet 1)
Hop count value contains an integer in the 1-15 range.

11.2.22 Hop limit

The purpose of the Hop limit information element is to limit the maximum number of hops for the 5G ProSe multi-hop remote UE to reach the network. The Hop limit is set by the announcing 5G ProSe multi-hop UE-to-network relay UE to a value less than or equal to the configured maximum number of hops to limit the number of hops.

The value of Hop limit is an integer in the 1-15 range.

The Hop limit IE is a type 1 information element, with a length of 1 octet.

The Hop limit IE is coded as shown in figure 11.2.22.1 and table 11.2.22.1.

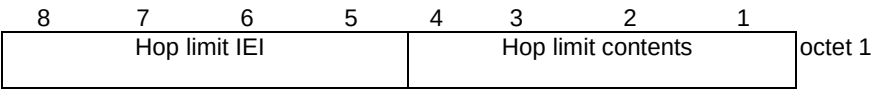


Figure 11.2.22.1: Hop limit information element

Table 11.2.22.1: Hop limit information element

Hop limit contents (octet 1)
Hop limit contains an integer in the 1-15 range. The integer value "zero" shall not be used.

11.2.23 NID

The NID information element is used to identify the SNPN and is coded as the NID information element specified in clause 9.2.7 of 3GPP TS 24.502 [26].

11.2.24 List of multi-hop UE-to-UE relay paths

The purpose of the list of multi-hop UE-to-UE relay paths information element is to carry the direct discovery set as specified in 3GPP TS 33.503 [34].

The list of multi-hop UE-to-UE relay paths information element is a type 6 information element.

The list of multi-hop UE-to-UE relay paths information element is coded as shown in figure 11.2.24.1 and table 11.2.24.1.

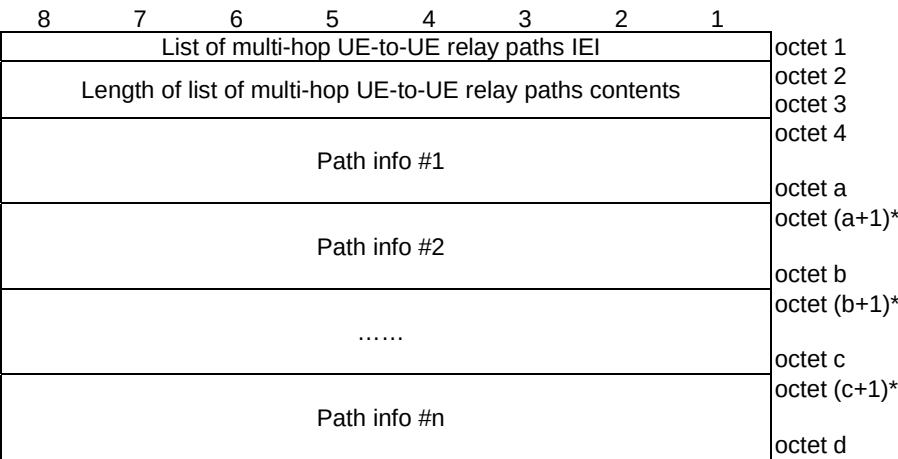


Figure 11.2.24.1: List of multi-hop UE-to-UE relay paths information element

Table 11.2.24.1: List of multi-hop UE-to-UE relay paths information element

Path info (octet 3 to a)
The path info is coded as in figure 11.2.24.2 and in table 11.2.24.2. Each path info represents the path information to one or more 5G ProSe multi-hop layer-3 end UE(s).

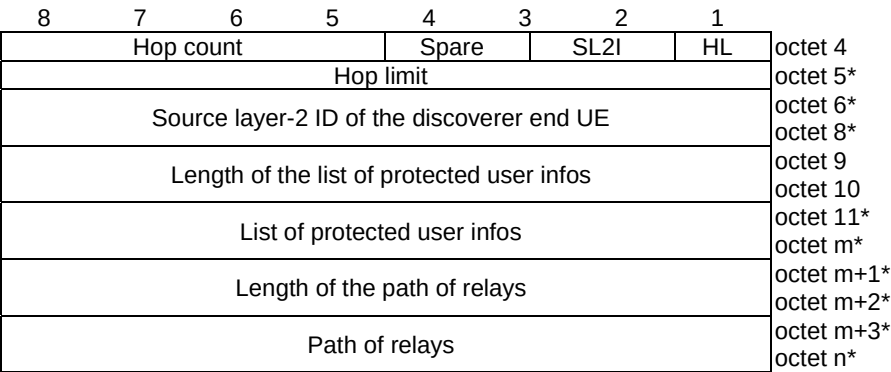


Figure 11.2.24.2: Path info

Table 11.2.24.2: Path info

HL (bit 1 of octet 4)	
Bit 1	
0	Hop limit field is not present
1	Hop limit field is present
SL2I (bit 2 of octet 4)	
0	Source layer-2 ID of the discoverer end UE is not present
1	Source layer-2 ID of the discoverer end UE is present
Hop count (bit 5 to 8 of octet 4)	
The hop count field indicates the number of hops that the message is already relayed.	
Source layer-2 ID of the discoverer UE (octet 6 to 8)	
This field indicates the source layer-2 ID of the discoverer end UE.	
List of protected user infos (octet 8 to m)	
The list of protected user infos field contains the protected user info(s) of the 5G ProSe multi-hop layer-3 end UE(s) that can be reached via the path of relays as indicated in "Path of relays" field (octet m+1 to n) and is coded as in figure 11.2.17.1 starting from octet 4.	
Path of relays (octet m+3 to n)	
The path of relays field indicates is a list of intermediate 5G ProSe multi-hop layer-3 UE-to-UE relays that need to be traversed to reach the 5G ProSe multi-hop layer-3 end UE(s) as indicated in list of protected user infos field (octet 8 to m) and is coded as in figure 11.3.47.1 starting from octet 3. The order of the list starts from the current 5G ProSe multi-hop layer-3 UE-to-UE relay and ends with the last hop before reaching the 5G ProSe multi-hop layer-3 end UE(s).	

11.2.25 NCGI info set

The NCGI info set information element is used to indicate the NCGI of the cell serving the 5G ProSe intermediate UE-to-network relay UE and its user info ID.

The NCGI info set information element is a type 4 information element with a length of 16 octets.

The NCGI info set information element is coded as shown in figure 11.2.25.1 and table 11.2.25.1.

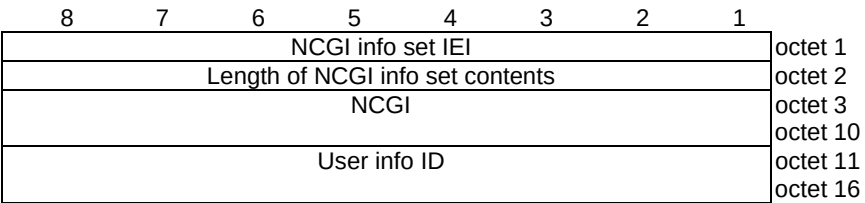


Figure 11.2.25.1: NCGI info set information element

Table 11.2.25.1: NCGI info set information element

NCGI (octet 3 to 10)	
The NCGI field is coded as the value part of NCGI information element as defined in clause 11.2.12.	
User info ID (octet 11 to 16)	
The user info ID field is coded as the 48-bit User info ID value as defined in clause 11.2.7 of this specification.	

11.2.26 List of user info ID

The List of user info ID information element is same as specified in clause 11.3.47.

11.2.27 PC5 QoS flow descriptions

The PC5 QoS flow descriptions information element is same as specified in clause 11.3.5.

11.3 PC5 signalling message formats

11.3.1 ProSe PC5 signalling message type

The purpose of the ProSe PC5 signalling message type information element is to indicate the type of messages used in ProSe PC5 signalling protocol.

The value part of the ProSe PC5 signalling message type information element used in the ProSe PC5 signalling messages is coded as shown in table 11.3.1.1.

The ProSe PC5 signalling message type is a type 3 information element, with the length of 1 octet.

Table 11.3.1.1: ProSe PC5 signalling message type

Bits								
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	1	PROSE DIRECT LINK ESTABLISHMENT REQUEST
0	0	0	0	0	0	1	0	PROSE DIRECT LINK ESTABLISHMENT ACCEPT
0	0	0	0	0	0	1	1	PROSE DIRECT LINK ESTABLISHMENT REJECT
0	0	0	0	0	1	0	0	PROSE DIRECT LINK MODIFICATION REQUEST
0	0	0	0	0	1	0	1	PROSE DIRECT LINK MODIFICATION ACCEPT
0	0	0	0	0	1	1	0	PROSE DIRECT LINK MODIFICATION REJECT
0	0	0	0	0	1	1	1	PROSE DIRECT LINK RELEASE REQUEST
0	0	0	0	1	0	0	0	PROSE DIRECT LINK RELEASE ACCEPT
0	0	0	0	1	0	0	1	PROSE DIRECT LINK KEEPALIVE REQUEST
0	0	0	0	1	0	1	0	PROSE DIRECT LINK KEEPALIVE RESPONSE
0	0	0	0	1	0	1	1	PROSE DIRECT LINK AUTHENTICATION REQUEST
0	0	0	0	1	1	0	0	PROSE DIRECT LINK AUTHENTICATION RESPONSE
0	0	0	0	1	1	0	1	PROSE DIRECT LINK AUTHENTICATION REJECT
0	0	0	0	1	1	1	0	PROSE DIRECT LINK SECURITY MODE COMMAND
0	0	0	0	1	1	1	1	PROSE DIRECT LINK SECURITY MODE COMPLETE
0	0	0	1	0	0	0	0	PROSE DIRECT LINK SECURITY MODE REJECT
0	0	0	1	0	0	0	1	PROSE DIRECT LINK REKEYING REQUEST
0	0	0	1	0	0	1	0	PROSE DIRECT LINK REKEYING RESPONSE
0	0	0	1	0	0	1	1	PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST
0	0	0	1	0	1	0	0	PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT
0	0	0	1	0	1	0	1	PROSE DIRECT LINK IDENTIFIER UPDATE ACK
0	0	0	1	0	1	1	0	PROSE DIRECT LINK IDENTIFIER UPDATE REJECT
0	0	0	1	0	1	1	1	PROSE DIRECT LINK AUTHENTICATION FAILURE
0	0	0	1	1	0	0	0	PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT REQUEST
0	0	0	1	1	0	0	1	PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE
0	0	0	1	1	0	1	0	PROSE AA MESSAGE TRANSPORT REQUEST
0	0	0	1	1	0	1	1	PROSE AA MESSAGE TRANSPORT RESPONSE
0	0	0	1	1	1	0	0	PROSE UE TO UE RELAY UPDATE REQUEST
0	0	0	1	1	1	0	1	PROSE UE TO UE RELAY UPDATE ACCEPT
0	0	0	1	1	1	1	0	PROSE UE TO UE RELAY UPDATE REJECT
0	0	0	1	1	1	1	1	PROSE PATH SWITCHING REQUEST
0	0	1	0	0	0	0	0	PROSE PATH SWITCHING ACCEPT
0	0	1	0	0	0	0	1	PROSE PATH SWITCHING REJECT
0	0	1	0	0	0	1	0	PROSE DIRECT LINK MODIFICATION ACK
0	0	1	0	0	0	1	1	PROSE DIRECT LINK IDENTITY REQUEST
0	0	1	0	0	1	0	0	PROSE DIRECT LINK IDENTITY RESPONSE
0	0	1	0	0	1	0	1	PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST
0	0	1	0	0	1	1	0	PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT
0	0	1	0	0	1	1	1	PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT
0	0	1	0	1	0	0	0	PROSE DIRECT DISCOVERY SET TRANSFER IND
0	0	1	0	1	0	0	1	PROSE DIRECT DISCOVERY SET TRANSFER ACK

11.3.2 Sequence number

The purpose of the Sequence number information element is to uniquely identify a ProSe PC5 signalling message being sent or received. The sending UE will increment the sequence number for each outgoing new ProSe PC5 signalling message.

The Sequence number information element is an integer in the 0-255 range.

The Sequence number is a type 3 information element, with a length of 1 octet.

11.3.3 ProSe identifier

The purpose of the ProSe identifier parameter is to carry the identifier of a ProSe application.

The ProSe identifier information element is coded as shown in figure 11.3.3.1 and table 11.3.3.1.

The ProSe identifier is a type 6 information element with a minimum length of 21 octets.

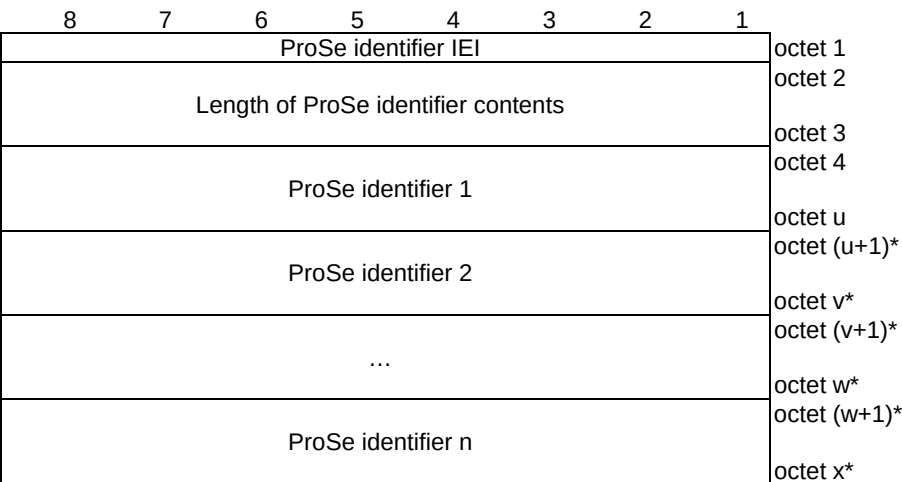


Figure 11.3.3.1: ProSe identifier information element

Table 11.3.3.1: ProSe identifier information element

ProSe identifier: The ProSe identifier field contains a sequence of a sixteen octet OS Id field, a one octet OS App Id length field and an OS App Id field. The OS Id field shall be transmitted first. The OS Id field contains a Universally Unique Identifier (UUID) as specified in IETF RFC 4122 [30].
NOTE: Further definition of the format of OS App Id is beyond the scope of this specification.

11.3.4 Application layer ID

The purpose of the application layer ID information element carries an application layer ID as specified in 3GPP TS 23.304 [2].

The application layer ID information element is coded as shown in figure 11.3.4.1 and table 11.3.4.1.

The application layer ID is a type 4 information element.

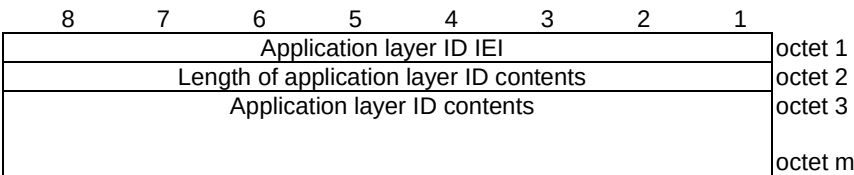


Figure 11.3.4.1: Application layer ID information element

Table 11.3.4.1: Application layer ID information element

The length of application layer ID contents field contains the binary coded representation of the length of the application layer ID contents field. The application layer ID contents field contains the octets indicating the application layer ID. The format of the application layer ID parameter is out of scope of this specification.							
NOTE: If the application layer ID information element carries a user info ID e.g. in case of 5G ProSe UE-to-network relay, the length of application layer ID contents shall be set to the length of the user info ID contents and the application layer ID contents shall be set to the user info ID contents. The format of the user info ID is out of scope of this specification.							

11.3.5 PC5 QoS flow descriptions

The purpose of the PC5 QoS flow descriptions information element is to indicate a set of PC5 QoS flow descriptions to be used by the UE over the direct link, where each PC5 QoS flow description is a set of parameters as described in clause 5.6 of 3GPP TS 23.304 [2].

The PC5 QoS flow descriptions is a type 6 information element with a minimum length of 6 octets. The maximum length for the information element is 65538 octets.

The PC5 QoS flow descriptions information element is coded as shown in figure 11.3.5.1, figure 11.3.5.2, figure 11.3.5.3, figure 11.3.5.4 and table 11.3.5.1.

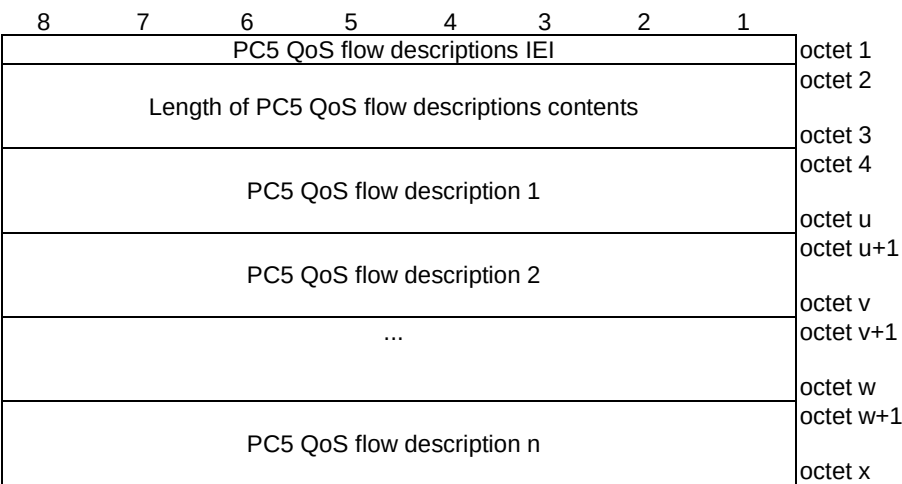


Figure 11.3.5.1: PC5 QoS flow descriptions information element

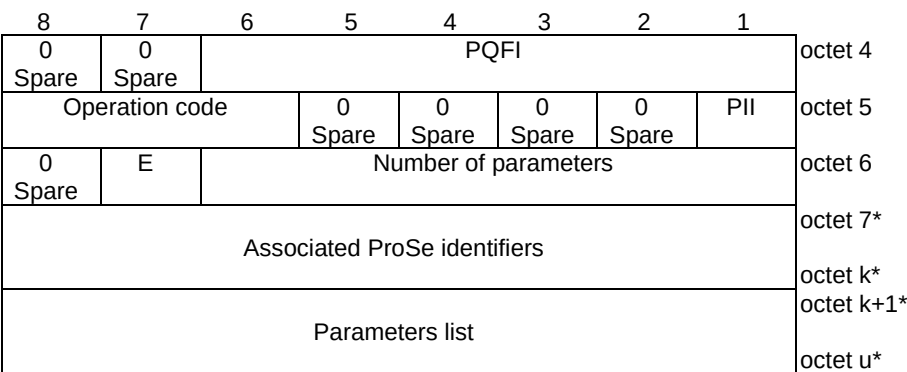


Figure 11.3.5.2: PC5 QoS flow description

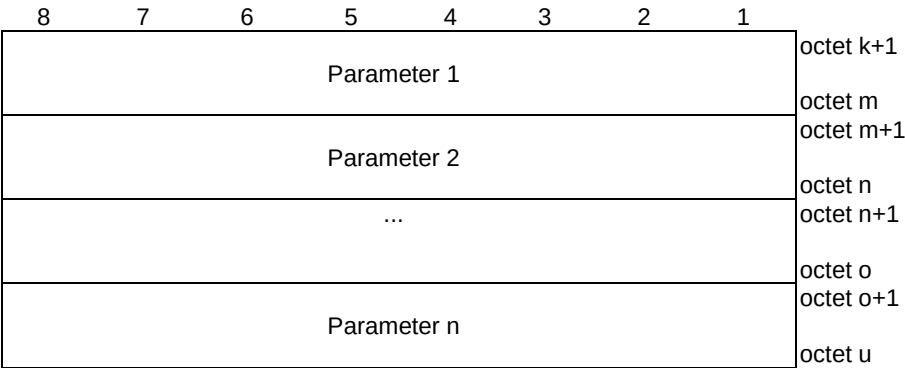


Figure 11.3.5.3: Parameters list

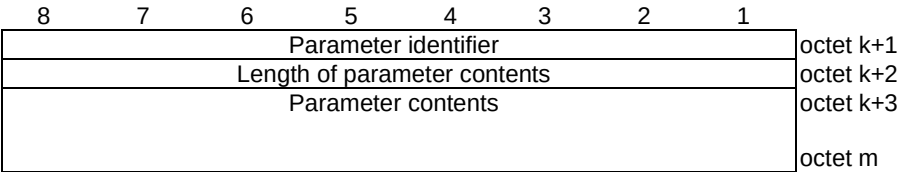


Figure 11.3.5.4: Parameter

Table 11.3.5.1: PC5 QoS flow descriptions information element

PC5 QoS flow identifier (PQFI) (bits 6 to 1 of octet 4) PQFI field contains the PC5 QoS flow identifier. Bits 6 5 4 3 2 1 0 0 0 0 0 1 PQFI 1 to 1 1 1 1 1 1 PQFI 63 The UE shall not set the PQFI value to 0.
ProSe identifiers indication (PII) (bit 1 of octet 5) The PII indicates whether the Associated ProSe identifiers field is included Bit 1 0 Associated ProSe identifiers field is not included 1 Associated ProSe identifiers field is included
Operation code (bits 8 to 6 of octet 5) Bits 8 7 6 0 0 1 Create new PC5 QoS flow description 0 1 0 Delete existing PC5 QoS flow description 0 1 1 Modify existing PC5 QoS flow description All other values are reserved.

E bit (bit 7 of octet 6)

For the "create new PC5 QoS flow description" operation, the E bit is encoded as follows:

Bit

7

0 reserved

1 parameters list is included

For the "Delete existing PC5 QoS flow description" operation, the E bit is encoded as follows:

Bit

7

0 parameters list is not included

1 reserved

For the "modify existing PC5 QoS flow description" operation, the E bit is encoded as follows:

Bit

7

0 extension of previously provided parameters

1 replacement of all previously provided parameters

If the E bit is set to "parameters list is not included", the number of parameters field has zero value. If the E bit is set to "parameters list is included", the number of parameters field has non-zero value. If the E bit is set to "extension of previously provided parameters" or "replacement of all previously provided parameters", the number of parameters field has non-zero value. If the E bit is set to "extension of previously provided parameters" and one of the parameters in the new parameters list already exists in the previously provided parameters, the parameter shall be set to the new value.

Number of parameters (bits 6 to 1 of octet 6)

The number of parameters field contains the binary coding for the number of parameters in the parameters list field. The number of parameters field is encoded in bits 6 through 1 of octet 6 where bit 6 is the most significant and bit 1 is the least significant bit.

Associated ProSe identifiers (octet 7 to k)

The associated ProSe identifiers field contains a variable number of ProSe identifiers associated with the PC5 QoS flow. Associated ProSe identifiers field is coded as the length and value part of ProSe identifier information element as specified in clause 11.3.3 starting with the second octet.

Parameters list (octets k+1 to u)

The parameters list contains a variable number of parameters.

Each parameter included in the parameters list is of variable length and consists of:

- a parameter identifier (1 octet);
- the length of the parameter contents (1 octet); and
- the parameter contents itself (variable amount of octets).

The parameter identifier field is used to identify each parameter included in the parameters list and it contains the hexadecimal coding of the parameter identifier. Bit 8 of the parameter identifier field contains the most significant bit and bit 1 contains the least significant bit. In this version of the protocol, the following parameter identifiers are specified:

- 01H (PQI);
- 02H (GFBR); (see NOTE)
- 03H (MFBR); (see NOTE)
- 04H (Averaging window) ;
- 05H (Resource type);
- 06H (Default priority level);
- 07H (Packet delay budget);
- 08H (Packet error rate);
- 09H (Default maximum data burst volume).

If the parameters list contains a parameter identifier that is not supported by the receiving entity the corresponding parameter shall be discarded.

The length of parameter contents field contains the binary coded representation of the length of the parameter contents field. The first bit in transmission order is the most significant bit.

When the parameter identifier indicates PQI, the parameter contents field contains the binary representation of PQI that is one octet in length.

PQI:

Bits

8 7 6 5 4 3 2 1

0 0 0 0 0 0 0 0 Reserved

0 0 0 0 0 0 0 1

to Spare

0 0 0 1 0 1 0 0

0 0 0 1 0 1 0 1 PQI 21

0 0 0 1 0 1 1 0 PQI 22

0 0 0 1 0 1 1 1 PQI 23

0 0 0 1 1 0 0 0 PQI 24

0 0 0 1 1 0 0 1 PQI 25

0 0 0 1 1 0 1 0 PQI 26

0 0 0 1 1 0 1 1

to Spare

0 0 1 1 0 1 1 0

0 0 1 1 0 1 1 1 PQI 55

0 0 1 1 1 0 0 0 PQI 56

0 0 1 1 1 0 0 1 PQI 57

0 0 1 1 1 0 1 0 PQI 58

0 0 1 1 1 0 1 1 PQI 59

0 0 1 1 1 1 0 0 PQI 60

0 0 1 1 1 1 0 1 PQI 61

0 0 1 1 1 1 1 0

to Spare

0 1 0 1 1 0 0 1

0 1 0 1 1 0 1 0 PQI 90

0 1 0 1 1 0 1 1 PQI 91

0 1 0 1 1 1 0 0 PQI 92

0 1 0 1 1 1 0 1 PQI 93

0 1 0 1 1 1 1 0

to Spare

0 1 1 1 1 1 1 1

1 0 0 0 0 0 0 0

to Operator-specific PQIs

1 1 1 1 1 1 1 0

1 1 1 1 1 1 1 1 Reserved

The UE shall consider all other values not explicitly defined in this version of the protocol as unsupported.

When the parameter identifier indicates "GFBR", the parameter contents field contains one octet indicating the unit of the guaranteed flow bit rate followed by two octets containing the value of the guaranteed flow bit rate.

Unit of the guaranteed flow bit rate (octet 1)

Bits

8 7 6 5 4 3 2 1

0 0 0 0 0 0 0 0 value is not used

0 0 0 0 0 0 0 1 value is incremented in multiples of 1 Kbps

0 0 0 0 0 0 1 0 value is incremented in multiples of 4 Kbps

0 0 0 0 0 0 1 1 value is incremented in multiples of 16 Kbps

0 0 0 0 0 1 0 0 value is incremented in multiples of 64 Kbps

0 0 0 0 0 1 0 1 value is incremented in multiples of 256 Kbps

0 0 0 0 0 1 1 0 value is incremented in multiples of 1 Mbps

0 0 0 0 0 1 1 1 value is incremented in multiples of 4 Mbps

0 0 0 0 1 0 0 0 value is incremented in multiples of 16 Mbps

0 0 0 0 1 0 0 1 value is incremented in multiples of 64 Mbps

0 0 0 0 1 0 1 0 value is incremented in multiples of 256 Mbps

0 0 0 0 1 0 1 1 value is incremented in multiples of 1 Gbps

0 0 0 0 1 1 0 0 value is incremented in multiples of 4 Gbps

0 0 0 0 1 1 0 1 value is incremented in multiples of 16 Gbps

0 0 0 0 1 1 1 0 value is incremented in multiples of 64 Gbps

0 0 0 0 1 1 1 1	value is incremented in multiples of 256 Gbps
0 0 0 1 0 0 0 0	value is incremented in multiples of 1 Tbps
0 0 0 1 0 0 0 1	value is incremented in multiples of 4 Tbps
0 0 0 1 0 0 1 0	value is incremented in multiples of 16 Tbps
0 0 0 1 0 0 1 1	value is incremented in multiples of 64 Tbps
0 0 0 1 0 1 0 0	value is incremented in multiples of 256 Tbps
0 0 0 1 0 1 0 1	value is incremented in multiples of 1 Pbps
0 0 0 1 0 1 1 0	value is incremented in multiples of 4 Pbps
0 0 0 1 0 1 1 1	value is incremented in multiples of 16 Pbps
0 0 0 1 1 0 0 0	value is incremented in multiples of 64 Pbps
0 0 0 1 1 0 0 1	value is incremented in multiples of 256 Pbps

Other values shall be interpreted as multiples of 256 Pbps in this version of the protocol.

Value of the guaranteed flow bit rate (octets 2 and 3)

Octets 2 and 3 represent the binary coded value of the guaranteed flow bit rate in units defined by the unit of the guaranteed flow bit rate.

When the parameter identifier indicates "GFBR downlink", the parameter contents field contains one octet indicating the unit of the guaranteed flow bit rate for downlink followed by two octets containing the value of the guaranteed flow bit rate for downlink.

When the parameter identifier indicates "MFBR ", the parameter contents field contains the one octet indicating the unit of the maximum flow bit rate followed by two octets containing the value of maximum flow bit rate.

Unit of the maximum flow bit rate (octet 1)

The coding is identical to that of the unit of the guaranteed flow bit rate.

Value of the maximum flow bit rate (octets 2 and 3)

Octets 2 and 3 represent the binary coded value of the maximum flow bit rate in units defined by the unit of the maximum flow bit rate.

When the parameter identifier indicates "averaging window", the parameter contents field contains the binary representation of the averaging window for both uplink and downlink in milliseconds and the parameter contents field is two octets in length.

When the parameter identifier indicates "resource type", the parameter contents field contains the binary representation of the resource type that is one octet in length.	
Resource type:	
Bits	
8 7 6 5 4 3 2 1	
0 0 0 0 0 0 0 0	Reserved
0 0 0 0 0 0 0 1	Non-GBR
0 0 0 0 0 0 1 0	GBR
0 0 0 0 0 0 1 1	Delay critical GBR
0 0 0 0 0 1 0 0	
to Spare	
1 1 1 1 1 1 1 1	
When the parameter identifier indicates "default priority level", the parameter contents field contains the binary representation of the default priority level that is one octet in length.	
Default priority level:	
Bits	
8 7 6 5 4 3 2 1	
0 0 0 0 0 0 0 0	Reserved
0 0 0 0 0 0 0 1	1
0 0 0 0 0 0 1 0	2
0 0 0 0 0 0 1 1	3
0 0 0 0 0 1 0 0	4
0 0 0 0 0 1 0 1	5
0 0 0 0 0 1 1 0	6
0 0 0 0 0 1 1 1	7
0 0 0 0 1 0 0 0	8
0 0 0 0 1 0 0 1	
to Spare	
1 1 1 1 1 1 1 1	
When the parameter identifier indicates "packet delay budget", the parameter contents field contains the binary representation of the packet delay budget for both uplink and downlink in milliseconds and the parameter contents field is two octets in length.	
When the parameter identifier indicates "packet error rate", the parameter contents field contains the binary representation of the power of 10 ⁻¹ for both uplink and downlink and the parameter contents field is one octet in length.	
When the parameter identifier indicates "default maximum data burst volume", the parameter contents field contains the binary representation of the default maximum data burst volume for both uplink and downlink in bytes and the parameter contents field is two octets in length.	
NOTE: The GFBR and MFBR apply to both directions of the 5G ProSe direct link.	

11.3.6 IP address configuration

The purpose of the IP address configuration information element is to indicate the configuration options for IP address used by the UE over this direct link.

The IP address configuration is a type 3 information element with the length of 2 octets.

The IP address configuration information element is coded as shown in figure 11.3.6.1 and table 11.3.6.1.

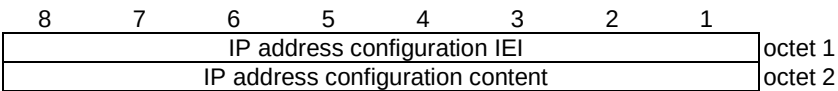


Figure 11.3.6.1: IP address configuration information element

Table 11.3.6.1: IP address configuration information element

IP address configuration value (octet 2)				
Bits				
4	3	2	1	
0	0	0	1	IPv6 Router
0	0	1	0	address allocation not supported
0	0	1	1	DHCPv4 server
0	1	0	0	DHCPv4 server & IPv6 Router
All other values are reserved.				
Bit 5 to 8 of octet 2 are spare and shall be coded as zero.				

11.3.7 Link local IPv6 address

The purpose of the Link local IPv6 address information element is to indicate the link local IPv6 address.

The Link local IPv6 address is a type 3 information element with the length of 17 octets.

The Link local IPv6 address information element is coded as shown in figure 11.3.7.1 and table 11.3.7.1.

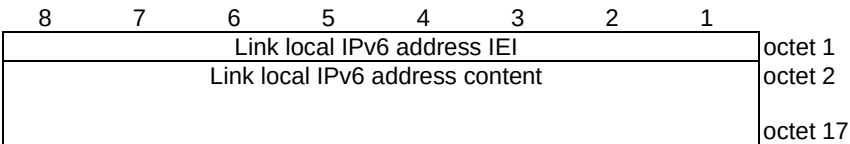


Figure 11.3.7.1: Link local IPv6 address information element

Table 11.3.7.1: Link local IPv6 address information element

Link local IPv6 address value (octet 2 to 17)							
This contains the 128-bit IPv6 address. This IPv6 address is encoded as a 128-bit address according to IETF RFC 4291 [15].							

11.3.8 PC5 signalling protocol cause

The purpose of the PC5 signalling protocol cause information element is to indicate the cause used in the PC5 signalling protocol procedures.

The PC5 signalling protocol cause is a type 3 information element with a length of 2 octets.

The PC5 signalling protocol cause information element is coded as shown in figure 11.3.8.1 and table 11.3.8.1.

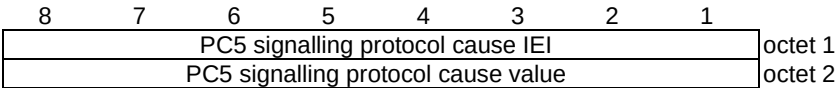


Figure 11.3.8.1: PC5 signalling protocol cause information element

Table 11.3.8.1: PC5 signalling protocol cause information element

PC5 signalling protocol cause value (octet 2)								
Bits								
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	1	Direct communication to the target UE not allowed
0	0	0	0	0	0	1	0	Direct communication to the target UE no longer needed
0	0	0	0	0	0	1	1	Conflict of layer-2 ID for unicast communication is detected
0	0	0	0	0	1	0	0	Direct connection is not available anymore
0	0	0	0	0	1	0	1	Lack of resources for 5G ProSe direct link
0	0	0	0	0	1	1	0	Authentication failure
0	0	0	0	0	1	1	1	Integrity failure
0	0	0	0	1	0	0	0	UE security capabilities mismatch
0	0	0	0	1	0	0	1	LSB of K _{NRP-session} ID conflict
0	0	0	0	1	0	1	0	UE PC5 unicast signalling security policy mismatch
0	0	0	0	1	0	1	1	Required service not allowed
0	0	0	0	1	1	0	0	Security policy not aligned
0	0	0	0	1	1	0	1	Congestion situation
0	0	0	0	1	1	1	0	Authentication synchronisation error
0	0	0	0	1	1	1	1	Security procedure failure of 5G ProSe UE-to-network relay
0	0	0	1	0	0	0	0	Unknown target UE's IP address/prefix or target UE's Application layer ID
0	0	0	1	0	0	0	1	Unknown initiating end UE's IP address/prefix or initiating UE's Application layer ID
0	0	0	1	0	0	1	0	Path switching is not allowed for the ProSe applications
0	0	0	1	0	0	1	1	Communication path over Uu is not available for path switching
0	0	0	1	0	1	0	0	Failure from 5G ProSe end UE
0	0	0	1	0	1	0	1	5G ProSe direct link already exists
0	0	0	1	0	1	1	0	security procedure failure of 5G ProSe UE-to-UE relay
0	0	0	1	0	1	1	1	MAC address not unique
0	0	0	1	1	0	0	0	Relay UE is not selected for link setup with integrated discovery
0	0	0	1	1	0	0	1	triggering security procedure not possible
0	1	1	0	1	1	1	1	Protocol error, unspecified
Any other value received by the UE shall be treated as 0110 1111, "protocol error, unspecified".								

11.3.9 Key establishment information container

The Key establishment information container information element contains information for 5G ProSe direct link key establishment.

The Key establishment information container is a type 6 information element with a minimum length of 4 octets.

The Key establishment information container information element is coded as shown in figure 11.3.9.1 and table 11.3.9.1.

8	7	6	5	4	3	2	1	
Key establishment information container IEI								octet 1
Length of key establishment information container contents								octet 2
Key establishment information container contents								octet 3
								octet 4
								octet n

Figure 11.3.9.1: Key establishment information container information element

Table 11.3.9.1: Key establishment information container information element

Key establishment information container contents (octet 4 to n)
This field contains the key establishment information container.

11.3.10 Nonce

The Nonce information element contains a 128-bit nonce used during 5G ProSe direct link security establishment.

The Nonce information element is a type 3 information element, with a length of 17 octets.

The Nonce information element is coded as shown in figure 11.3.10.1 and table 11.3.10.1.

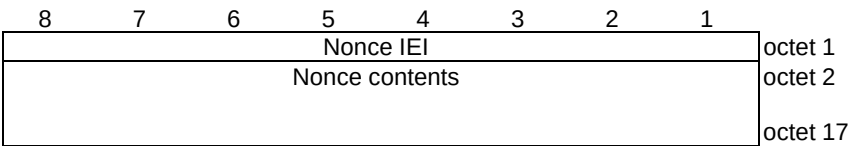


Figure 11.3.10.1: Nonce information element

Table 11.3.10.1: Nonce information element

Nonce contents (octet 2 to 17)
This field contains the 128-bit nonce value.

11.3.11 UE security capabilities

The UE security capabilities information element is used to indicate which security algorithms are supported by the UE.

The UE security capabilities is a type 4 information element with a minimum length of 4 octets and a maximum length of 10 octets.

The UE security capabilities information element is coded as shown in figure 11.3.11.1 and table 11.3.11.1.

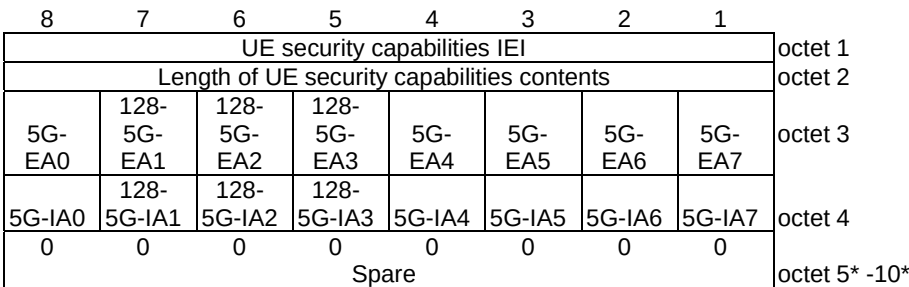


Figure 11.3.11.1: UE security capabilities information element

Table 11.3.11.1: UE security capabilities information element

5GS encryption algorithms supported (octet 3)

5GS encryption algorithm 5G-EA0 supported (octet 3, bit 8)

0 5GS encryption algorithm 5G-EA0 not supported
1 5GS encryption algorithm 5G-EA0 supported

5GS encryption algorithm 128-5G-EA1 supported (octet 3, bit 7)

0 5GS encryption algorithm 128-5G-EA1 not supported
1 5GS encryption algorithm 128-5G-EA1 supported

5GS encryption algorithm 128-5G-EA2 supported (octet 3, bit 6)

0 5GS encryption algorithm 128-5G-EA2 not supported
1 5GS encryption algorithm 128-5G-EA2 supported

5GS encryption algorithm 128-5G-EA3 supported (octet 3, bit 5)

0 5GS encryption algorithm 128-5G-EA3 not supported
1 5GS encryption algorithm 128-5G-EA3 supported

5GS encryption algorithm 5G-EA4 supported (octet 3, bit 4)

0 5GS encryption algorithm 5G-EA4 not supported
1 5GS encryption algorithm 5G-EA4 supported

5GS encryption algorithm 5G-EA5 supported (octet 3, bit 3)

0 5GS encryption algorithm 5G-EA5 not supported
1 5GS encryption algorithm 5G-EA5 supported

5GS encryption algorithm 5G-EA6 supported (octet 3, bit 2)

0 5GS encryption algorithm 5G-EA6 not supported
1 5GS encryption algorithm 5G-EA6 supported

5GS encryption algorithm 5G-EA7 supported (octet 3, bit 1)

0 5GS encryption algorithm 5G-EA7 not supported
1 5GS encryption algorithm 5G-EA7 supported

5GS integrity algorithms supported (octet 4)

5GS integrity algorithm 5G-IA0 supported (octet 4, bit 8)

0 5GS integrity algorithm 5G-IA0 not supported
1 5GS integrity algorithm 5G-IA0 supported

5GS integrity algorithm 128-5G-IA1 supported (octet 4, bit 7)

0 5GS integrity algorithm 128-5G-IA1 not supported
1 5GS integrity algorithm 128-5G-IA1 supported

5GS integrity algorithm 128-5G-IA2 supported (octet 4, bit 6)

0 5GS integrity algorithm 128-5G-IA2 not supported
1 5GS integrity algorithm 128-5G-IA2 supported

5GS integrity algorithm 128-5G-IA3 supported (octet 4, bit 5)

0 5GS integrity algorithm 128-5G-IA3 not supported
1 5GS integrity algorithm 128-5G-IA3 supported

5GS integrity algorithm 5G-IA4 supported (octet 4, bit 4)

0 5GS integrity algorithm 5G-IA4 not supported
1 5GS integrity algorithm 5G-IA4 supported

5GS integrity algorithm 5G-IA5 supported (octet 4, bit 3)

0 5GS integrity algorithm 5G-IA5 not supported
1 5GS integrity algorithm 5G-IA5 supported

5GS integrity algorithm 5G-IA6 supported (octet 4, bit 2)

0 5GS integrity algorithm 5G-IA6 not supported
1 5GS integrity algorithm 5G-IA6 supported

5GS integrity algorithm 5G-IA7 supported (octet 4, bit 1)

0 5GS integrity algorithm 5G-IA7 not supported
1 5GS integrity algorithm 5G-IA7 supported

11.3.12 UE PC5 unicast signalling security policy

The purpose of the UE PC5 unicast signalling security policy information element is to indicate the UE's configuration for integrity protection and ciphering of PC5 signalling messages.

The UE PC5 unicast signalling security policy is a type 3 information element with a length of 2 octets.

The UE PC5 unicast signalling security policy information element is coded as shown in figure 11.3.12.1.1 and table 11.3.12.1.

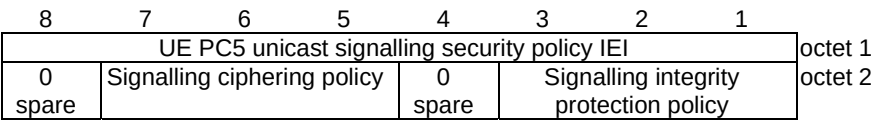


Figure 11.3.12.1: UE 5G ProSe direct signalling security policy information element

Table 11.3.12.1: UE PC5 unicast signalling security policy information element

Signalling integrity protection policy (octet 2, bit 1 to 3)			
Bits			
3	2	1	
0	0	0	Signalling integrity protection not needed
0	0	1	Signalling integrity protection preferred
0	1	0	Signalling integrity protection required
0	1	1	
			to Spare
1	1	0	
1	1	1	Reserved

If the UE receives a signalling integrity protection policy value that the UE does not understand, the UE shall interpret the value as 010 "Signalling integrity protection required".

Signalling ciphering policy (octet 2, bit 5 to 7)			
Bits			
7	6	5	
0	0	0	Signalling ciphering not needed
0	0	1	Signalling ciphering preferred
0	1	0	Signalling ciphering required
0	1	1	
			to Spare
1	1	0	
1	1	1	Reserved

If the UE receives a signalling ciphering policy value that the UE does not understand, the UE shall interpret the value as 010 "Signalling ciphering required".

Bit 4 and 8 of octet 2 are spare and shall be coded as zero.

11.3.13 MSB of K_{NRP-*sess*} ID

The purpose of the MSB of K_{NRP-*sess*} ID information element is to carry the 8 most significant bits of the K_{NRP-*sess*} ID.

The MSB of K_{NRP-*sess*} ID information element is a type 3 information element with a length of 2 octets.

The MSB of K_{NRP-*sess*} ID information element is coded as shown in figure 11.3.13.1 and table 11.3.13.1.

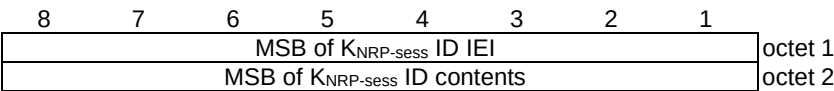


Figure 11.3.13.1: MSB of $K_{\text{NRP-sess}}$ ID information element

Table 11.3.13.1: MSB of $K_{\text{NRP-sess}}$ ID information element

MSB of $K_{\text{NRP-sess}}$ ID contents (octet 2)
This field contains the 8 most significant bits of $K_{\text{NRP-sess}}$ ID.

11.3.14 K_{NRP} ID

The purpose of the K_{NRP} ID information element is to carry the identity of the K_{NRP} held by a UE.

The K_{NRP} ID is a type 3 information element with a length of 5 octets.

The K_{NRP} ID information element is coded as shown in figure 11.3.14.1 and table 11.3.14.1.

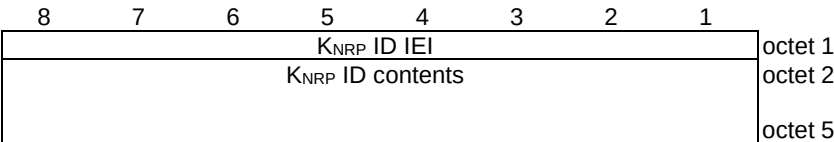


Figure 11.3.14.1: K_{NRP} ID information element

Table 11.3.14.1: K_{NRP} ID information element

K_{NRP} ID contents (octet 2 to 5)
This field contains the 32-bit identifier of a K_{NRP} .

11.3.15 LSB of $K_{\text{NRP-sess}}$ ID

The purpose of the LSB of $K_{\text{NRP-sess}}$ ID information element is to carry the 8 least significant bits of the $K_{\text{NRP-sess}}$ ID.

The LSB of $K_{\text{NRP-sess}}$ ID is a type 3 information element with a length of 2 octets.

The LSB of $K_{\text{NRP-sess}}$ ID information element is coded as shown in figure 11.3.15.1 and table 12.3.15.1.

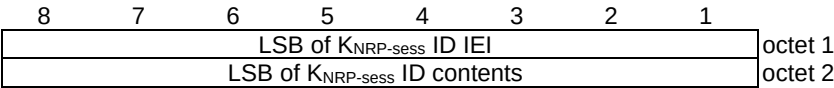


Figure 11.3.15.1: LSB of $K_{\text{NRP-sess}}$ ID information element

Table 11.3.15.1: LSB of $K_{\text{NRP-sess}}$ ID information element

LSB of $K_{\text{NRP-sess}}$ ID contents (octet 2)
This field contains the 8 least significant bits of $K_{\text{NRP-sess}}$ ID.

11.3.16 MSBs of K_{NRP} ID

The purpose of the MSBs of K_{NRP} ID information element is to carry the 16 most significant bits of the K_{NRP} ID.

The MSBs of K_{NRP} ID is a type 3 information element with a length of 3 octets.

The MSBs of K_{NRP} ID information element is coded as shown in figure 11.3.16.1 and table 11.3.16.1.

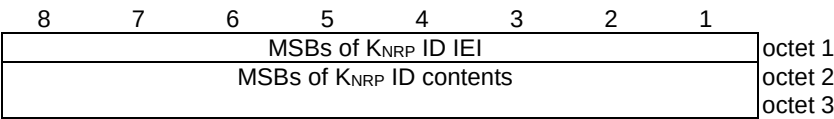


Figure 11.3.16.1: MSBs of K_{NRP} ID information element

Table 11.3.16.1: MSBs of K_{NRP} ID information element

MSBs of K _{NRP} ID contents (octet 2 to 3)
This field contains the 16 most significant bits of K _{NRP} ID.

11.3.17 LSBs of K_{NRP} ID

The purpose of the LSBs of K_{NRP} ID information element is to carry the 16 least significant bits of the K_{NRP} ID.

The LSBs of K_{NRP} ID is a type 3 information element with a length of 3 octets.

The LSBs of K_{NRP} ID information element is coded as shown in figure 11.3.17.1 and table 11.3.17.1.

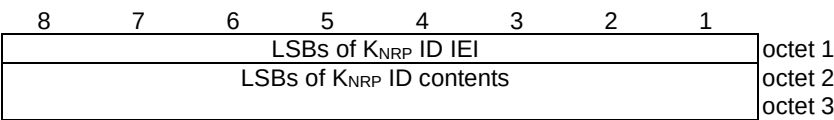


Figure 11.3.17.1: LSBs of K_{NRP} ID information element

Table 11.3.17.1: LSBs of K_{NRP} ID information element

LSBs of K _{NRP} ID contents (octet 2 to 3)
This field contains the 16 least significant bits of K _{NRP} ID.

11.3.18 Configuration of UE PC5 unicast user plane security protection

The purpose of the configuration of UE PC5 unicast user plane security protection information element is to indicate the agreed configuration for security protection of PC5 user plane data between UEs over the 5G ProSe direct link.

The configuration of UE PC5 unicast user plane security protection is a type 3 information element with a length of 2 octets.

The configuration of UE PC5 unicast user plane security protection information element is coded as shown in figure 11.3.18.1 and table 11.3.18.1.

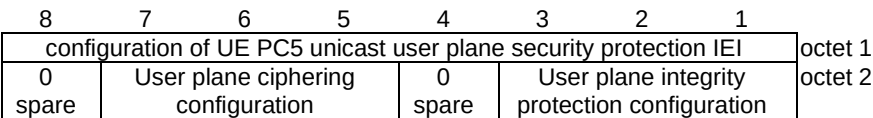


Figure 11.3.18.1: Configuration of UE PC5 unicast user plane security protection information element

Table 11.3.18.1: Configuration of UE PC5 unicast user plane security protection information element

User plane integrity protection configuration (octet 2, bit 1 to 3)			
Bits			
3	2	1	
0	0	0	Off
0	0	1	Off or On
0	1	0	On
0	1	1	
			to Spare
1	1	0	
1	1	1	Reserved

User plane ciphering configuration (octet 2, bit 5 to 7)			
Bits			
7	6	5	
0	0	0	Off
0	0	1	Off or On
0	1	0	On
0	1	1	
			to Spare
1	1	0	
1	1	1	Reserved

Bit 4 and 8 of octet 2 are spare and shall be coded as zero.

11.3.19 Link modification operation code

The purpose of the Link modification operation code information element is to indicate what the operation of the 5G ProSe direct link modification procedure triggered by initiating UE is.

The Link modification operation code is a type 3 information element, with a length of 2 octets.

The Link modification operation code information element is coded as shown in figure 11.3.19.1 and table 11.3.19.1.

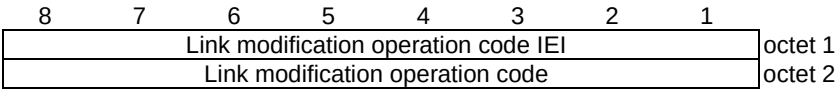


Figure 11.3.19.1: Link modification operation code information element

Table 11.3.19.1: Link modification operation code information element

Link modification operation code (octet 2)				
Bits				
4	3	2	1	
0	0	0	1	void
0	0	1	0	void
0	0	1	1	Add new PC5 QoS flow(s) to the existing 5G ProSe direct link
0	1	0	0	Modify PC5 QoS parameters of the existing PC5 QoS flow(s)
0	1	0	1	Remove existing PC5 QoS flow(s) from the existing 5G ProSe direct link
0	1	1	0	Associate new ProSe application(s) with existing PC5 QoS flow(s)
0	1	1	1	Remove ProSe application(s) from existing PC5 QoS flow(s)
1	0	0	0	Add new 5G ProSe layer-3 end UE to the existing 5G ProSe direct link
1	0	0	1	Remove 5G ProSe layer-3 end UE from the existing 5G ProSe direct link
1	0	1	0	Add new 5G ProSe layer-2 end UE to the existing 5G ProSe direct link
1	0	1	1	
to				Spare
1	1	1	0	
1	1	1	1	Reserved

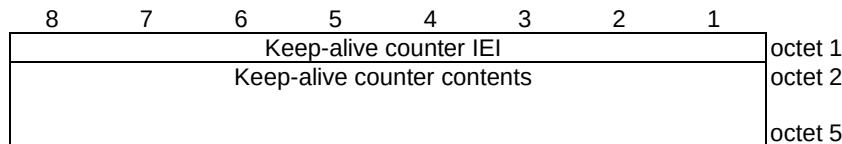
Bit 5 to 8 of octet 2 are spare and shall be coded as zero.

11.3.20 Keep-alive counter

The purpose of the Keep-alive counter information element is to indicate the keep-alive counter which is a 32-bit counter used for the 5G ProSe direct link keep-alive procedure.

The Keep-alive counter is a type 3 information element with a length of 5 octets.

The Keep-alive counter information element is coded as shown in figure 11.3.20.1 and table 11.3.20.1.

**Figure 11.3.20.1: Keep-alive counter information element****Table 11.3.20.1: Keep-alive counter information element**

Keep-alive counter contents (octet 2 to 5)
This field contains the 32-bit keep-alive counter.

11.3.21 Maximum inactivity period

The purpose of the Maximum inactivity period information element is to indicate the maximum inactivity period of the initiating UE during a 5G ProSe direct link keep-alive procedure.

The Maximum inactivity period is a type 3 information element, with a length of 5 octets.

The Maximum inactivity period information element is coded as shown in figure 11.3.21.1 and table 11.3.21.1.

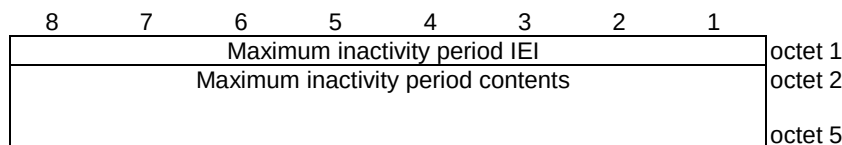
**Figure 11.3.21.1: Maximum inactivity period information element**

Table 11.3.21.1: Maximum inactivity period information element

Maximum inactivity period contents (octet 2 to 5)
This field contains the binary encoding of the maximum inactivity period expressed in units of seconds.

11.3.22 Selected security algorithms

The purpose of the Selected security algorithms information element is to indicate the algorithms to be used for ciphering and integrity protection.

The Selected security algorithms is a type 3 information element with a length of 2 octets.

The Selected security algorithms information element is coded as shown in figure 11.3.22.1 and table 11.3.22.1.

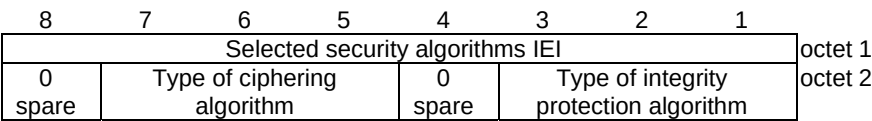


Figure 11.3.22.1: Selected security algorithms information element

Table 11.3.22.1: Selected security algorithms information element

Type of integrity protection algorithm (octet 2, bit 1 to 3)			
Bits			
3	2	1	
0	0	0	5GS integrity algorithm 5G-IA0 (null integrity protection algorithm)
0	0	1	5GS integrity algorithm 128-5G-IA1
0	1	0	5GS integrity algorithm 128-5G-IA2
0	1	1	5GS integrity algorithm 128-5G-IA3
1	0	0	5GS integrity algorithm 5G-IA4
1	0	1	5GS integrity algorithm 5G-IA5
1	1	0	5GS integrity algorithm 5G-IA6
1	1	1	5GS integrity algorithm 5G-IA7
Type of ciphering algorithm (octet 2, bit 5 to 7)			
Bits			
7	6	5	
0	0	0	5GS encryption algorithm 5G-EA0 (null ciphering algorithm)
0	0	1	5GS encryption algorithm 128-5G-EA1
0	1	0	5GS encryption algorithm 128-5G-EA2
0	1	1	5GS encryption algorithm 128-5G-EA3
1	0	0	5GS encryption algorithm 5G-EA4
1	0	1	5GS encryption algorithm 5G-EA5
1	1	0	5GS encryption algorithm 5G-EA6
1	1	1	5GS encryption algorithm 5G-EA7
Bit 4 and 8 of octet 2 are spare and shall be coded as zero.			

11.3.23 UE PC5 unicast user plane security policy

The purpose of the UE PC5 unicast user plane security policy information element is to indicate the UE's configuration for integrity protection and ciphering of PC5 user plane data.

The UE PC5 unicast user plane security policy is a type 3 information element with a length of 2 octets.

The UE PC5 unicast user plane security policy information element is coded as shown in figure 11.3.23.1 and table 11.3.23.1.

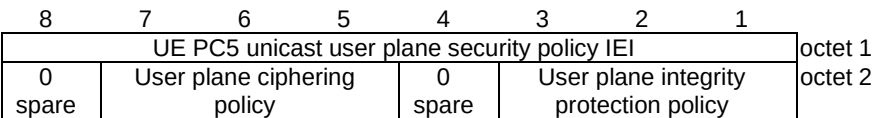


Figure 11.3.23.1: UE PC5 unicast user plane security policy information element

Table 11.3.23.1: UE PC5 unicast user plane security policy information element

User plane integrity protection policy (octet 2, bit 1 to 3)			
Bits			
3	2	1	
0	0	0	User plane integrity protection not needed
0	0	1	User plane integrity protection preferred
0	1	0	User plane integrity protection required
0	1	1	
to Spare			
1	1	0	
1	1	1	Reserved

If the UE receives a user plane integrity protection policy value that the UE does not understand, the UE shall interpret the value as 010 "user plane integrity protection required".

User plane ciphering policy (octet 2, bit 5 to 7)			
Bits			
7	6	5	
0	0	0	User plane ciphering not needed
0	0	1	User plane ciphering preferred
0	1	0	User plane ciphering required
0	1	1	
to Spare			
1	1	0	
1	1	1	Reserved

If the UE receives a user plane ciphering protection policy value that the UE does not understand, the UE shall interpret the value as 010 "user plane ciphering protection required".

Bit 4 and 8 of octet 2 are spare and shall be coded as zero.

11.3.24 Re-authentication indication

The purpose of the Re-authentication indication information element is to indication that K_{NRP} needs to be refreshed.

The Re-authentication indication information element is a type 3 information element, with a length of 2 octets.

The Re-authentication indication information element is coded as shown in figure 11.3.24.1 and table 11.3.24.1.

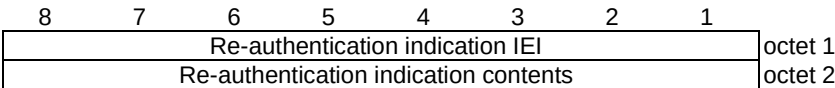


Figure 11.3.24.1: Re-authentication indication information element

Table 11.3.24.1: Re-authentication indication information element

Re-authentication indication contents (octet 2)	
Bits	
1	
0	Reserved
1	K _{NR} P is requested to be refreshed
Bits 2 to 8 of octet 2 are spare and shall be coded as zero.	

11.3.25 Layer-2 ID

The purpose of the layer-2 ID information element is to indicate the layer-2 ID that is used by UE.

The layer-2 ID is a type 3 information element with a length of 4 octets.

The layer-2 ID information element is coded as shown in figure 11.3.25.1 and table 11.3.25.1.

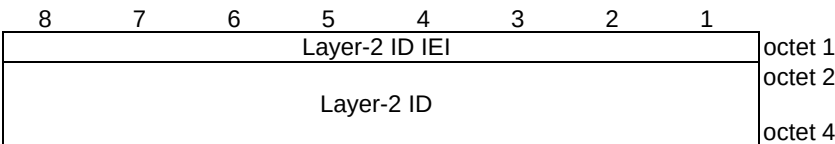


Figure 11.3.25.1: Layer-2 ID information element

Table 11.3.25.1: Layer-2 ID information element

Layer-2 ID (octet 2 to 4)
This field contains the 24-bit layer-2 ID.

11.3.26 Relay service code

The purpose of the relay service code information element is to identify a connectivity service the 5G ProSe UE-to-network relay or the 5G ProSe UE-to-UE relay UE provides.

The relay service code information element is coded as shown in figure 11.3.26.1 and table 11.3.26.1.

The relay service code is a type 3 information element with a length of 4 octets.

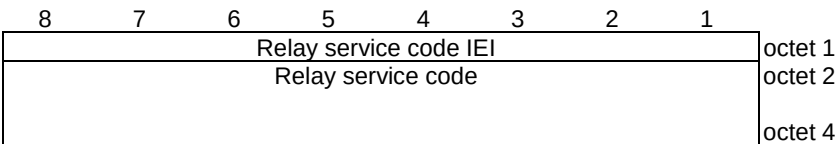


Figure 11.3.26.1: Relay service code information element

Table 11.3.26.1: Relay service code information element

Relay service code value (octet 2 to 4)
This contains the 24-bit relay service code.

11.3.27 GPRS timer

See clause 10.5.7.3 in 3GPP TS 24.008 [31].

11.3.28 Additional parameters announcement request refresh timer T5106

This parameter is used to carry the value of Additional parameters announcement request refresh timer. It is an integer in the 1-1440 range representing the timer value in unit of minutes.

The Additional parameters announcement request refresh timer T5106 is a type 3 information element with a length of 2 octets.

The Additional parameters announcement request refresh timer T5106 IE is coded as shown in figure 11.3.28.1 and table 11.3.28.1.

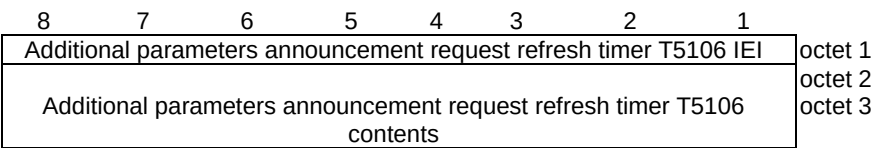


Figure 11.3.28.1: Additional parameters announcement request refresh timer T5106 information element

Table 11.3.28.1: Additional parameters announcement request refresh timer T5106 information element

Additional parameters announcement request refresh timer T5106 (octet 1 to 2)
This field contains the 16-bit Additional parameters announcement request refresh timer T5106.

11.3.29 PC5 QoS rules

The purpose of the PC5 QoS rules information element is to indicate a set of PC5 QoS rules to be used by the UE over the direct link, where each PC5 QoS rule is a set of parameters as described in clause 5.6.1 of 3GPP TS 23.304 [2].

The PC5 QoS rules information element is a type 6 information element with a minimum length of 7 octets. The maximum length for the information element is 65538 octets.

The PC5 QoS flow rules information element is coded as shown in figure 11.3.29.1, figure 11.3.29.2, figure 11.3.29.3, figure 11.3.29.4 and table 11.3.29.1.

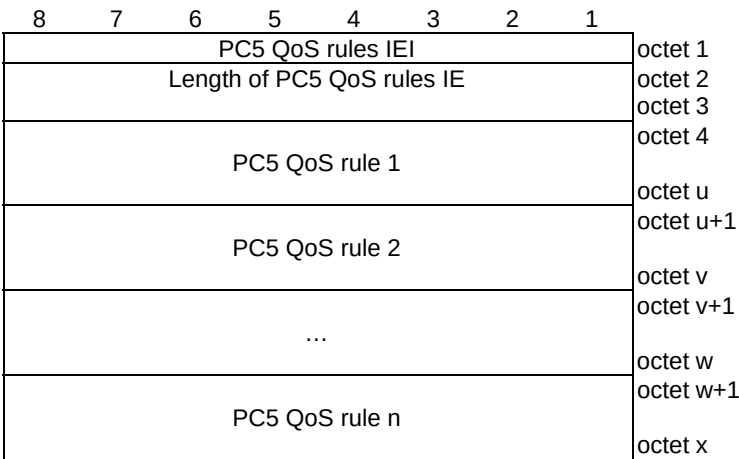


Figure 11.3.29.1: PC5 QoS rules information element

8	7	6	5	4	3	2	1	
PC5 QoS rule identifier								octet 4
Length of PC5 QoS rule								octet 5
								octet 6
Rule operation code			DQR bit	Number of packet filters				octet 7
Packet filter list								octet 8*
								octet a*
PC5 QoS rule precedence								octet a+1*
0	0	PC5 QoS flow identifier (PQFI)					octet a+2*	
Spare	Spare							
ProSe identifier								octet a+3*
								octet b*

Figure 11.3.29.2: PC5 QoS rule (u=a+2 or u=b)

8	7	6	5	4	3	2	1	
0	0	0	0	Packet filter identifier 1				octet 8
Spare								
0	0	0	0	Packet filter identifier 2				octet 9
Spare								
...								
0	0	0	0	Packet filter identifier N				octet N+7
Spare								

Figure 11.3.29.3: Packet filter list when the rule operation is "modify existing PC5 QoS rule and delete packet filters" (m=N+7)

8	7	6	5	4	3	2	1					
0	0	0	0	Packet filter identifier 1				octet 8				
Spare												
Length of packet filter contents 1								octet 9				
Packet filter contents 1								octet 10				
								octet m				
0	0	0	0	Packet filter identifier 2				octet m+1				
Spare												
Length of packet filter contents 2								octet m+2				
Packet filter contents 2								octet m+3				
								octet n				
...								octet n+1				
								octet y				
0	0	0	0	Packet filter identifier N				octet y+1				
Spare												
Length of packet filter contents N								octet y+2				
Packet filter contents N								octet y+3				
								octet z				

Figure 11.3.29.4: Packet filter list when the rule operation is "create new PC5 QoS rule", or "modify existing PC5 QoS rule and add packet filters" or "modify existing PC5 QoS rule and replace all packet filters"

Table 11.3.29.1: PC5 QoS rules information element

PC5 QoS rule identifier (octet 4)

The PC5 QoS rule identifier field is used to identify the PC5 QoS rule.

Bits

8 7 6 5 4 3 2 1

0 0 0 0 0 0 0 0 no PC5 QoS rule identifier assigned

0 0 0 0 0 0 0 1 PQRI 1

to

1 1 1 1 1 1 1 1 PQRI 255

The target UE shall not set the PQRI value to 0.

PC5 QoS rule precedence (octet a+1)

The PC5 QoS rule precedence field is used to specify the precedence of the PC5 QoS rule among all PC5 QoS rules associated with the PC5 direct link of the PC5 QoS flow. This field includes the binary coded value of the PC5 QoS rule precedence in the range from 0 to 255 (decimal). The higher the value of the PC5 QoS rule precedence field, the lower the precedence of that PC5 QoS rule is. For the "delete existing PC5 QoS rule" operation, the PC5 QoS rule precedence value field shall not be included. For the "create new PC5 QoS rule" operation, the PC5 QoS rule precedence value field shall be included.

PC5 QoS flow identifier (PQFI) (bits 6 to 1 of octet a+2) (see NOTE 1)

The PC5 QoS flow identifier (PQFI) field contains the PC5 QoS flow identifier.

Bits

6 5 4 3 2 1

0 0 0 0 0 0 no PC5 QoS flow identifier assigned

0 0 0 0 0 1 PQFI 1

to

1 1 1 1 1 1 PQFI 63

The target UE shall not set the PQFI value to 0.

For the "delete existing PC5 QoS rule" operation, the PC5 QoS flow identifier value field shall not be included. For the "create new PC5 QoS rule" operation, the PC5 QoS flow identifier value field shall be included.

DQR bit (bit 5 of octet 7)

The DQR bit indicates whether the PC5 QoS rule is the default PC5 QoS rule and it is encoded as follows:

Bit

5

0 the PC5 QoS rule is not the default PC5 QoS rule.

1 the PC5 QoS rule is the default PC5 QoS rule.

Rule operation code (bits 8 to 6 of octet 7)

Bits

8 7 6

0 0 0 Reserved

0 0 1 Create new PC5 QoS rule

0 1 0 Delete existing PC5 QoS rule

0 1 1 Modify existing PC5 QoS rule and add packet filters

1 0 0 Modify existing PC5 QoS rule and replace all packet filters

1 0 1 Modify existing PC5 QoS rule and delete packet filters

1 1 0 Modify existing PC5 QoS rule without modifying packet filters

1 1 1 Reserved

ProSe identifier (octets a+3 to b) (NOTE 2)

The ProSe identifier field is used to carry the identifier of a ProSe application and shall be encoded as defined in clause 11.3.3.

Number of packet filters (bits 4 to 1 of octet 7)

The number of packet filters contains the binary coding for the number of packet filters in the packet filter list. The number of packet filters field is encoded in bits 4 through 1 of octet 7 where bit 4 is the most significant and bit 1 is the least significant bit. For the "delete existing PC5 QoS rule" operation and for the "modify existing PC5 QoS rule without modifying packet filters" operation, the number of packet filters shall be coded as 0. For the "create new PC5 QoS rule" operation and the "modify existing PC5 QoS rule and replace all packet filters" operation, the number of packet filters shall be greater than or equal to 0 and less than or equal to

15. For all other operations, the number of packet filters shall be greater than 0 and less than or equal to 15.

Packet filter list (octets 8 to m)

The packet filter list contains a variable number of packet filters.

For the "delete existing PC5 QoS rule" operation, the length of PC5 QoS rule field is set to one.

For the "delete existing PC5 QoS rule" operation and the "modify existing PC5 QoS rule without modifying packet filters" operation, the packet filter list shall be empty.

For the "modify existing PC5 QoS rule and delete packet filters" operation, the packet filter list shall contain a variable number of packet filter identifiers. This number shall be derived from the coding of the number of packet filters field in octet 7.

For the "create new PC5 QoS rule" operation and for the "modify existing PC5 QoS rule and replace all packet filters" operation, the packet filter list shall contain 0 or a variable number of packet filters. This number shall be derived from the coding of the number of packet filters field in octet 7.

For the "modify existing PC5 QoS rule and add packet filters" operation, the packet filter list shall contain a variable number of packet filters. This number shall be derived from the coding of the number of packet filters field in octet 7.

Each packet filter is of variable length and consists of

- a packet filter identifier (4 bits);
- the length of the packet filter contents (1 octet); and
- the packet filter contents itself (variable amount of octets).

The packet filter identifier field is used to identify each packet filter in a PC5 QoS rule. The least significant 4 bits are used. When the UE requests to "create new PC5 QoS rule", "modify existing PC5 QoS rule and replace all packet filters" or "modify existing PC5 QoS rule and add packet filters", the packet filter identifier values shall be set to 0.

The length of the packet filter contents field contains the binary coded representation of the length of the packet filter contents field of a packet filter. The first bit in transmission order is the most significant bit.

The packet filter contents field is of variable size and contains a variable number (at least one) of packet filter components. Each packet filter component shall be encoded as a sequence of a one octet packet filter component type identifier and a fixed length packet filter component value field. The packet filter component type identifier shall be transmitted first.

In each packet filter, there shall not be more than one occurrence of each packet filter component type. Among the "IPv4 remote address type" and "IPv6 remote address/prefix length type" packet filter components, only one shall be present in one packet filter. Among the "IPv4 local address type" and "IPv6 local address/prefix length type" packet filter components, only one shall be present in one packet filter. Among the "single local port type" and "local port range type" packet filter components, only one shall be present in one packet filter. Among the "single remote port type" and "remote port range type" packet filter components, only one shall be present in one packet filter. If the "match-all type" packet filter component is present in the packet filter, no other packet filter component shall be present in the packet filter and the length of the packet filter contents field shall be set to one. If the "Ethernet type" packet filter component is present in the packet filter and the "Ethernet type" packet filter component value is neither "0x0800" (for IPv4) nor "0x86DD" (for IPv6), no IP packet filter component shall be present in the packet filter.

The term "IP packet filter component" refers to "IPv4 remote address type", "IPv4 local address type", "IPv6 remote address/prefix length type", "IPv6 local address/prefix length type", "Protocol identifier/Next header type", "Single local port type", "Local port range type", "Single remote port type", "Remote port range type",

"Security parameter index type", "Type of service/Traffic class type" and "Flow label type".

The term local refers to the initiating UE. The term remote refers to an external network entity if the initiating UE is acting as a 5G ProSe layer-3 UE-to-network relay UE. Otherwise, the term remote refers to the peer UE of the 5G ProSe direct link.

Packet filter component type identifier

Bits

8 7 6 5 4 3 2 1

0 0 0 0 0 0 0 1	Match-all type
0 0 0 1 0 0 0 0	IPv4 remote address type
0 0 0 1 0 0 0 1	IPv4 local address type
0 0 1 0 0 0 0 1	IPv6 remote address/prefix length type
0 0 1 0 0 0 1 1	IPv6 local address/prefix length type
0 0 1 1 0 0 0 0	Protocol identifier/Next header type
0 1 0 0 0 0 0 0	Single local port type
0 1 0 0 0 0 0 1	Local port range type
0 1 0 1 0 0 0 0	Single remote port type
0 1 0 1 0 0 0 1	Remote port range type
0 1 1 0 0 0 0 0	Security parameter index type
0 1 1 1 0 0 0 0	Type of service/Traffic class type
1 0 0 0 0 0 0 0	Flow label type
1 0 0 0 0 0 0 1	Destination MAC address type
1 0 0 0 0 0 1 0	Source MAC address type
1 0 0 0 0 0 1 1	802.1Q C-TAG VID type
1 0 0 0 0 1 0 0	802.1Q S-TAG VID type
1 0 0 0 0 1 0 1	802.1Q C-TAG PCP/DEI type
1 0 0 0 0 1 1 0	802.1Q S-TAG PCP/DEI type
1 0 0 0 0 1 1 1	Ethertype type
1 0 0 0 1 0 0 0	Destination MAC address range type
1 0 0 0 1 0 0 1	Source MAC address range type
1 0 0 0 1 0 1 0	ProSe identifier (NOTE 2)
1 0 0 0 1 0 1 1	Source layer-2 ID
1 0 0 0 1 1 0 0	Destination layer-2 ID
1 0 0 0 1 1 0 1	Application layer ID

All other values are reserved.

The description and valid combinations of packet filter component type identifiers in a packet filter are defined in clause 7.2.7.

For "match-all type", the packet filter component shall not include the packet filter component value field.

For "IPv4 remote address type", the packet filter component value field shall be encoded as a sequence of a four octet IPv4 address field and a four octet IPv4 address mask field. The IPv4 address field shall be transmitted first.

For "IPv4 local address type", the packet filter component value field shall be encoded as defined for "IPv4 remote address type".

For "IPv6 remote address/prefix length type", the packet filter component value field shall be encoded as a sequence of a sixteen octet IPv6 address field and one octet prefix length field. The IPv6 address field shall be transmitted first.

For "IPv6 local address/prefix length type", the packet filter component value field shall be encoded as defined for "IPv6 remote address /prefix length".

For "protocol identifier/Next header type", the packet filter component value field shall be encoded as one octet which specifies the IPv4 protocol identifier or Ipv6 next header.

For "single local port type" and "single remote port type", the packet filter component value field shall be encoded as two octets which specify a port number.

For "local port range type" and "remote port range type", the packet filter component value field shall be encoded as a sequence of a two octet port range low limit field and a two octet port range high limit field. The port range low limit field shall be transmitted first.

For "security parameter index", the packet filter component value field shall be encoded as four octets which specify the IPsec security parameter index.

For "type of service/traffic class type", the packet filter component value field shall be encoded as a sequence of a one octet type-of-service/traffic class field and a one octet type-of-service/traffic class mask field. The type-of-service/traffic class field shall be transmitted first.

For "flow label type", the packet filter component value field shall be encoded as three octets which specify the IPv6 flow label. The bits 8 through 5 of the first octet shall be spare whereas the remaining 20 bits shall contain the IPv6 flow label.

For "destination MAC address type" and "source MAC address type", the packet filter component value field shall be encoded as 6 octets which specify a MAC address. When the packet filter direction field indicates "bidirectional", the destination MAC address is the remote MAC address and the source MAC address is the local MAC address.

For "802.1Q C-TAG VID type", the packet filter component value field shall be encoded as two octets which specify the VID of the customer-VLAN tag (C-TAG). The bits 8 through 5 of the first octet shall be spare whereas the remaining 12 bits shall contain the VID.

For "802.1Q S-TAG VID type", the packet filter component value field shall be encoded as two octets which specify the VID of the service-VLAN tag (S-TAG). The bits 8 through 5 of the first octet shall be spare whereas the remaining 12 bits shall contain the VID. If there are more than one S-TAG in the Ethernet frame header, the outermost S-TAG is evaluated.

For "802.1Q C-TAG PCP/DEI type", the packet filter component value field shall be encoded as one octet which specifies the 802.1Q C-TAG PCP and DEI. The bits 8 through 5 of the octet shall be spare, the bits 4 through 2 contain the PCP and bit 1 contains the DEI.

For "802.1Q S-TAG PCP/DEI type", the packet filter component value field shall be encoded as one octet which specifies the 802.1Q S-TAG PCP. The bits 8 through 5 of the octet shall be spare, the bits 4 through 2 contain the PCP and bit 1 contains the DEI. If there are more than one S-TAG in the Ethernet frame header, the outermost S-TAG is evaluated.

For "EtherType type", the packet filter component value field shall be encoded as two octets which specify an EtherType.

For "destination MAC address range type", the packet filter component value field shall be encoded as a sequence of a 6 octet destination MAC address range low limit field and a 6 octet destination MAC address range high limit field. The destination MAC address range low limit field shall be transmitted first. When the packet filter direction field indicates "bidirectional", the destination MAC address range is the remote MAC address range.

For "source MAC address range type", the packet filter component value field shall be encoded as a sequence of a 6 octet source MAC address range low limit field and a 6 octet source MAC address range high limit field. The source MAC address range low limit field shall be transmitted first. When the packet filter direction field indicates "bidirectional", the source MAC address is the local MAC address range.

For "ProSe identifier", the packet filter component value field shall be encoded as defined in clause 11.3.3.

For "source layer-2 ID" and "destination layer-2 ID", the packet filter component value field shall be encoded as defined in clause 11.3.25.

For "application layer ID", the packet filter component value field shall be encoded as defined in clause 11.3.4.
NOTE 1: Octet a+2 shall not be included without octet a+1.
NOTE 2: ProSe identifier (octets a+3 to b) can exist only when there is no packet filter including the ProSe identifier packet filter component.

11.3.30 5GS mobile identity

See clause 9.11.3.4 in 3GPP TS 24.501 [11] with Type of identity set to "SUCI", "IMEI" or "IMEISV".

11.3.31 EAP message

The purpose of the EAP message information element is to transport an EAP message as specified in IETF RFC 3748 [39].

The EAP message information element is coded as specified in clause 9.11.2.2 of 3GPP TS 24.501 [11].

11.3.32 User security key ID

The purpose of the User security key ID information element is to carry the identity of the UP-PRUK or the CP-PRUK or SLPK.

The User security key ID is a type 4 information element with a minimal length of 3 octets and a maximum length of 255 octets.

The User security key ID information element is coded as shown in figure 11.3.32.1 and table 11.3.32.1.

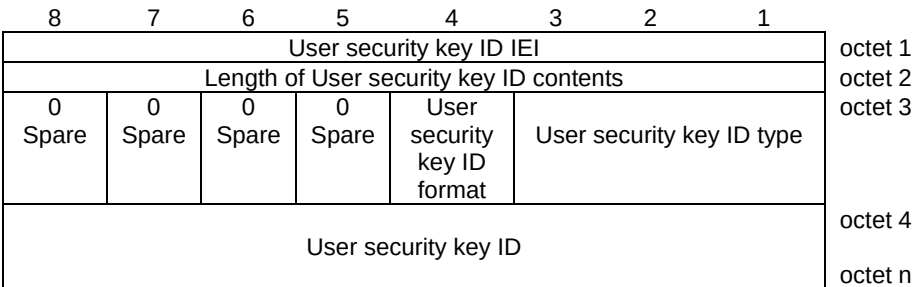


Figure 11.3.32.1: User security key ID information element

Table 11.3.32.1: User security key ID information element

User security key ID type (bit 1 to 3 of octet 3)			
The user security key ID type indicates the type of the user security key ID.			
Bits			
3	2	1	
0	0	1	UP-PRUK ID
0	1	0	CP-PRUK ID
0	1	1	SLPK ID
All other values are reserved.			
User security key ID format (bit 4 of octet 3) (NOTE)			
Bit			
4			
0	network access identifier (NAI)		
1	64-bit string		
Bits 5 to 8 of octet 3 are spare and shall be coded as zero.			
User security key ID (octet 4 to octet n)			
The user security key ID field contains the UP-PRUK ID or the CP-PRUK ID or the SLPK ID. If the user security key ID format field indicates "NAI", the UP-PRUK ID or the CP-PRUK ID or SLPK ID in the user security key ID field is in the NAI format as defined in 3GPP TS 23.003 [12], encoded as UTF-8 string. If the user security key ID format field indicates "64-bit string", the UP-PRUK ID or SLPK ID in the user security key ID field is a 64-bit string, encoded using binary encoding.			
NOTE: When user security key ID type is set to CP-PRUK ID, the user security key ID format shall be always set to "NAI".			

11.3.33 PLMN ID

The PLMN ID information element is coded as the PLMN identity information element specified in clause 9.11.3.85 of 3GPP TS 24.501 [11].

11.3.34 Void

11.3.35 GPI

The GPI information element contains the GBA Push Information used for the security procedure over user plane as specified in 3GPP TS 33.503 [34].

The Key GPI is a type 6 information element.

The GPI information element is coded as shown in figure 11.3.35.1 and table 11.3.35.1.

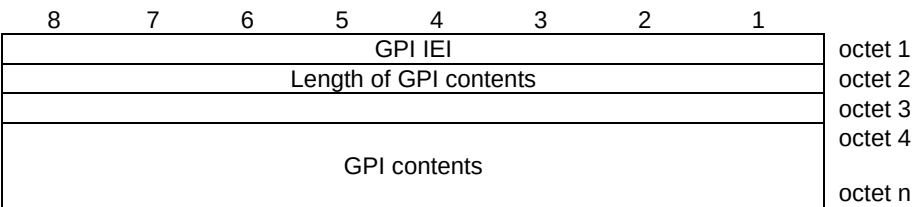


Figure 11.3.35.1: GPI information element

Table 11.3.35.1: GPI information element

GPI contents (octet 4 to n)
This field contains the GPI which is encoded as specified in clause 5.3.5 of 3GPP TS 33.223 [44].

11.3.36 RAND

The purpose of the RAND information element is to provide the UE with a non-predictable challenge (see 3GPP TS 33.503 [34]).

The RAND information element is coded as shown in figure 11.3.36.1 and table 11.3.36.1.

The RAND is a type 3 information element with a length of 17 octets.

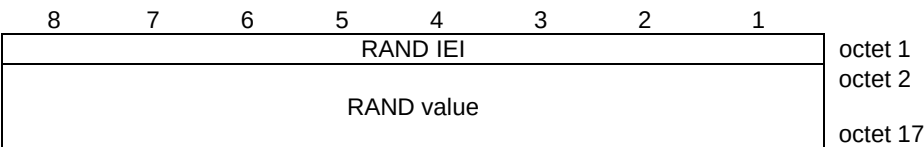


Figure 11.3.36.1: RAND information element

Table 11.3.36.1: RAND information element

RAND value (octet 2 to 17)
The RAND value consists of 128 bits (see 3GPP TS 33.503 [34]).

11.3.37 AUTS

The purpose of the AUTS information element is to provide the network with the necessary information to begin a re-synchronisation (see 3GPP TS 33.503 [34]).

The AUTS information element is coded as shown in figure 11.3.37.1 and table 11.3.37.1.

The AUTS is a type 3 information element with a length of 15 octets.

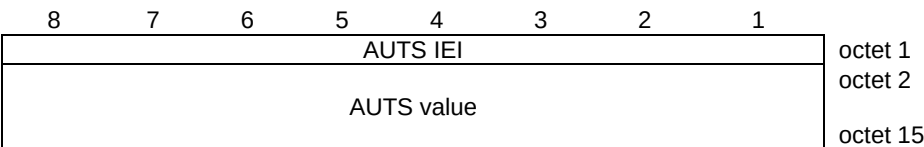


Figure 11.3.37.1: AUTS information element

Table 11.3.37.1: AUTS information element

AUTS value (octet 2 to 15)
This contains AUTS (see 3GPP TS 33.503 [34]).

11.3.38 MIC

This parameter is used to carry the MIC value for integrity protection of the PROSE DIRECT LINK ESTABLISHMENT REQUEST message.

The MIC information element is coded as shown in figure 11.3.38.1 and table 11.3.38.1.

The MIC IE is a type 3 information element with a length of 5 octets.

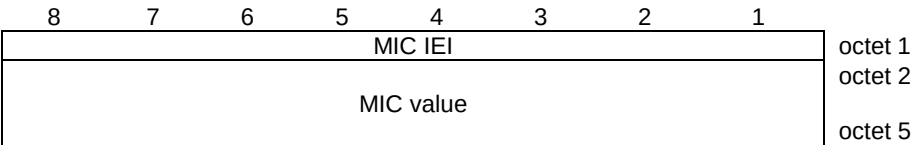


Figure 11.3.38.1: MIC information element

Table 11.3.38.1: MIC information element

MIC value (octet 2 to 5)
The MIC value field consists of the MIC value for integrity protection.

11.3.39 User info ID 2

The purpose of the User info ID 2 information element is to carry a user info ID value as specified in 3GPP TS 23.304 [2]. The user info ID parameter contains a 48-bit long bit string (6 octets). The composition of the contents of the user info ID is out of scope of this specification.

The User info ID 2 is a type 4 information element with the length of 8 octets.

NOTE: Semantically, the contents of the User info ID 2 is identical to the contents of the User info ID (see clause 11.2.7). Protocol-wise however the respective IE types and the IE formats are different.

The User info ID 2 information element is coded as shown in figure 11.3.39.1 and table 11.3.39.1.

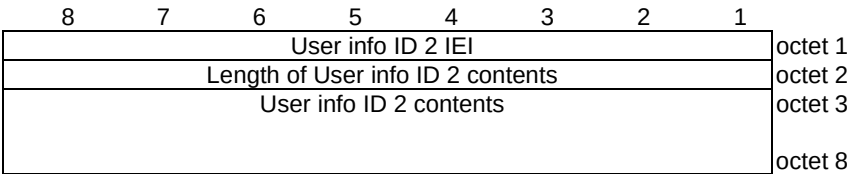


Figure 11.3.39.1: User info ID 2 information element

Table 11.3.39.1: User info ID 2 information element

The User info ID 2 contents field contains the value of the User info ID. The composition of the contents of the User info ID is out of scope of this specification.

11.3.40 QoS flow descriptions

The QoS flow descriptions information element is coded as the QoS flow descriptions specified in clause 9.11.4.12 of 3GPP TS 24.501 [11].

11.3.41 PC5 signalling protocol cause 2

The purpose of the PC5 signalling protocol cause 2 information element is to indicate the cause used in the PC5 signalling protocol procedures.

The PC5 signalling protocol cause 2 is a type 4 information element with 3 octets length.

The PC5 signalling protocol cause information element 2 is coded as shown in figure 11.3.41.1 and table 11.3.41.1.

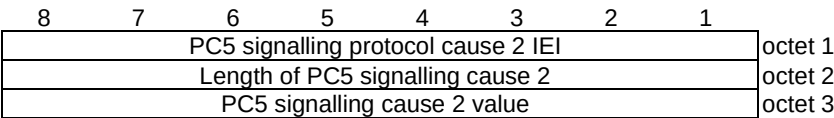


Figure 11.3.41.1: PC5 signalling protocol cause 2 information element

Table 11.3.41.1: PC5 signalling protocol cause 2 information element

PC5 signalling protocol cause 2 value is coded as octet 2 of the <i>PC5 signalling protocol cause</i> information element.

11.3.42 IP address/prefix needed indication

The purpose of the IP address/prefix needed indication information element is to indicate that a new IP address/prefix to be allocated by the 5G ProSe layer-3 UE-to-UE relay UE.

The IP address/prefix needed indication information element is a type 1 information element, with a length of 1 octets.

The IP address/prefix needed indication information element is coded as shown in figure 11.3.42.1 and table 11.3.42.1.

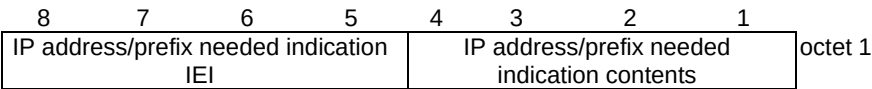


Figure 11.3.42.1: IP address/prefix needed indication information element

Table 11.3.42.1: IP address/prefix needed indication information element

IP address/prefix needed indication contents (octet 1)				
Bit				
4	3	2	1	
0	0	0	0	Reserved
0	0	0	1	IP address/prefix needs to be changed and allocated by the 5G ProSe UE-to-UE relay UE
All other values are spare and shall be coded as zero.				

11.3.43 Void

11.3.44 Void

11.3.45 MAC address

The purpose of the MAC address information element is to signal the MAC address of the UE when the 5G ProSe direct link is for Ethernet traffic.

The MAC address information element is coded as shown in figure 11.3.45.1 and table 11.3.45.1.

The MAC address is a type 4 information element with a length of 8 octets.

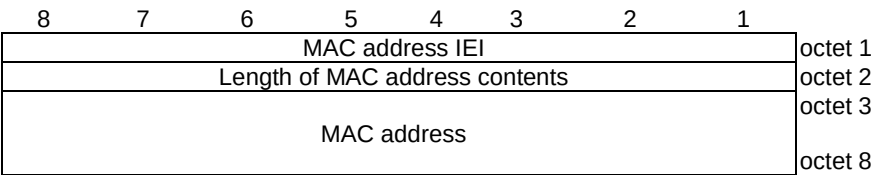


Figure 11.3.45.1: MAC address information element

Table 11.3.45.1: MAC address information element

MAC address (octets 3 to 8)
The MAC address field contains the binary representation of the MAC address of the UE, starting with the least significant bit of the first octet of the MAC address included in bit 1 of octet 3.

11.3.46 Relay reselection indication

The relay reselection indication parameter is used to indicate whether the direct link modification procedure is for the negotiated 5G ProSe UE-to-UE relay reselection or multi-hop UE-to-network relay reselection procedure.

The relay reselection indication is a type 1 information element with a length of 1 octet.

The relay reselection indication IE is coded as shown in figure 11.3.46.1 and table 11.3.46.1.

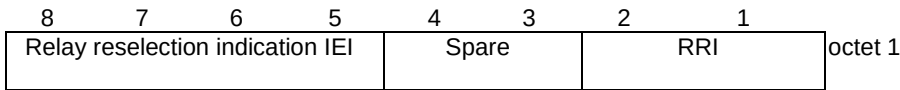


Figure 11.3.46.1: Relay reselection indication information element

Table 11.3.46.1: Relay reselection indication information element

Relay reselection indication (RRI) (octet 1, bits 1 and 2)		
Bits		
2	1	
0	0	Spare
0	1	Relay reselection due to the link failure
1	0	Relay reselection due to link quality degradation
1	1	Relay reselection due to other reason
Bits 3 to 4 of octet 1 are spare and shall be coded as zero.		

11.3.47 List of user info ID

The list of user info ID parameter contains a list of user info IDs.

The list of user info ID information element is a type 4 information element with the minimum length of 8 octets and the maximum length of 257 octets.

The list of user info ID information element is coded as shown in figure 11.3.37.1 and table 11.3.37.1.

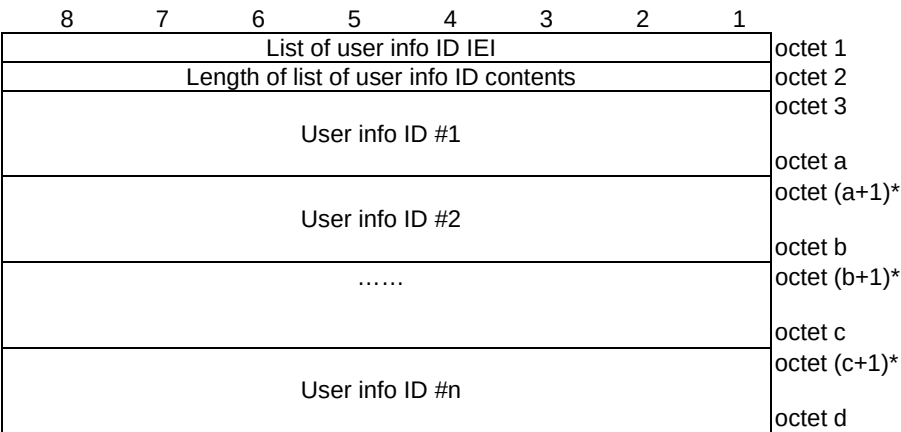


Figure 11.3.47.1: List of user info ID information element

Table 11.3.47.1: List of user info ID information element

Each user info ID field is coded as specified in figure 11.3.39.1 (octets 3 to 8) and in table 11.3.39.1.

11.3.48 List of user info IDs and layer-2 IDs

The list of user info IDs and layer-2 IDs information element contains the user info ID and the associated layer-2 ID of one or more UEs.

The list of user info IDs and layer-2 IDs information element is a type 4 information element with the minimum length of 12 octets and the maximum length of 257 length.

The list of user info IDs and layer-2 IDs information element is coded as shown in figure 11.3.48.1 and table 11.3.48.1.

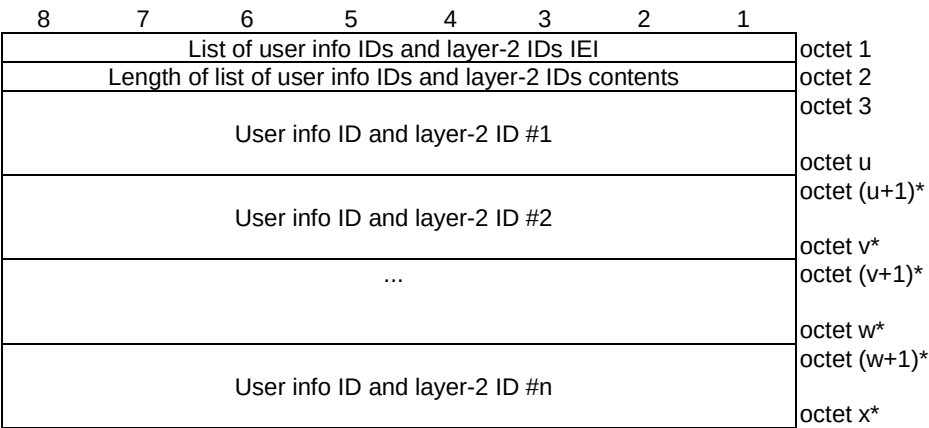


Figure 11.3.48.1: List of user info IDs and layer-2 IDs information element

Table 11.3.48.1: List of user info IDs and layer-2 IDs information element

User info ID and layer-2 ID (octet 3 to u)
The user info ID and layer-2 ID field contains the user info ID of the UE with its associated layer-2 ID and is coded as in figure 11.3.48.2 and in table 11.3.48.2.

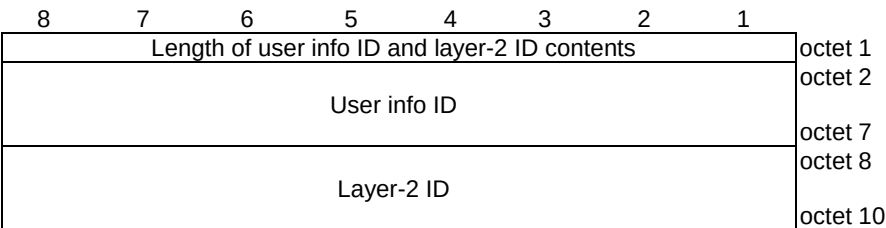


Figure 11.3.48.2: User info ID and layer-2 ID

Table 11.3.48.2: User info ID and layer-2 ID

User info ID (octet 2 to octet 7) The user info ID field contains the value of the user info ID of the UE and is coded as specified in figure 11.3.39.1 from the octet 3 and in table 11.3.39.1.
Layer-2 ID (octet 8 to 10) The layer-2 ID field contains the layer-2 ID of the UE and is coded as in figure 11.3.25.1 (octets 2 to 4) and in table 11.3.25.1.

11.3.49 UE IP address

The purpose of the UE IP address information element is to indicate the IP address of the UE.

The UE IP address is a type 4 information element with minimum length of 7 octets and a maximum length of 19 octets.

The UE IP address information element is coded as shown in figure 11.3.49.1 and table 11.3.49.1.

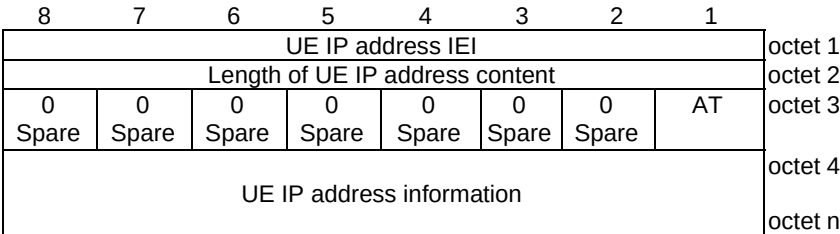


Figure 11.3.49.1: UE IP address

Table 11.3.49.1: UE IP address

Address type (AT) (octet 3 bit 1): The AT field indicates the IP address type. Bits 1 0 IPv4 1 IPv6
UE IP address information (octet 4 to n) If the AT value indicates IPv4, the UE IP address information in octet 4 to octet 7 contains an IPv4 address. If the AT value indicates IPv6, the UE IP address information in octet 4 to octet 11 contains a /64 IPv6 prefix. Octet 12 to 19 are set to all zero.

11.3.50 List of UE IP addresses

The purpose of the list of UE IP addresses information element is to indicate a list of IP addresses of the UEs.

The list of UE IP addresses is a type 4 information element with a minimum length of 7 octets and a maximum length of 257 octets.

The List of UE IP addresses information element is coded as shown in figure 11.3.50.1 and table 11.3.50.1.

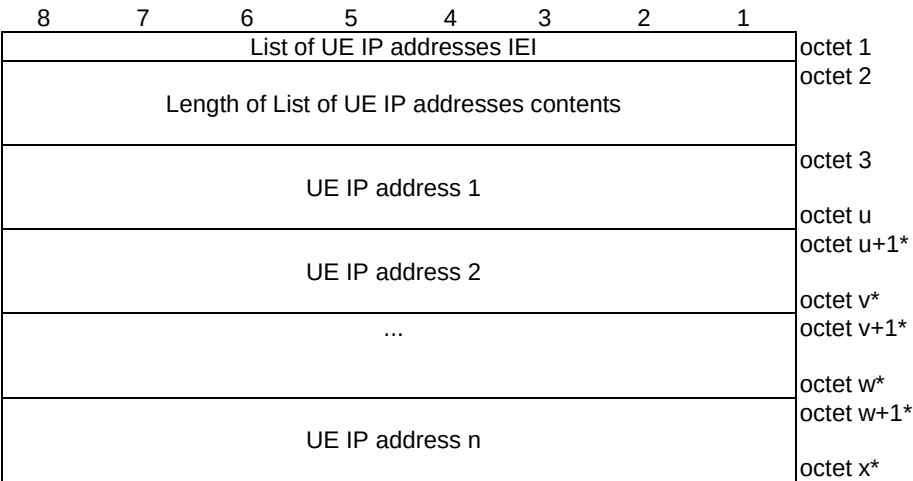


Figure 11.3.50.1: List of UE IP addresses information element

Table 11.3.50.1: List of UE IP addresses information element

UE IP address (octets 3 to u)
The UE IP addresses is encoded as defined in Figure 11.3.49.1 from octet 3 and Table 11.3.49.1.

11.3.50A5GS identity type

See clause 9.11.3.3 of 3GPP TS 24.501 [11].

11.3.51 Spare half octet

This element is used in the description of PC5 signalling messages when an odd number of half octet type 1 information elements are used. This element is filled with spare bits set to zero and is placed in bits 5 to 8 of the octet unless otherwise specified.

11.3.52 MSBs of K_{NRP} ID 2

The purpose of the MSBs of K_{NRP} ID 2 information element is to carry the 16 most significant bits of the K_{NRP} ID.

The MSBs of K_{NRP} ID 2 information element is a type 4 information element with a length of 4 octets.

The MSBs of K_{NRP} ID 2 information element is coded as shown in figure 11.3.52.1 and table 11.3.52.1.

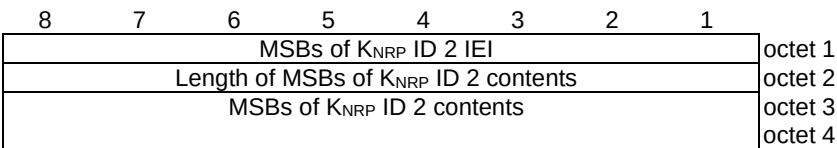


Figure 11.3.52.1: MSBs of K_{NRP} ID 2 information element

Table 11.3.52.1: MSBs of K_{NRP} ID 2 information element

MSBs of K_{NRP} ID 2 contents (octet 3 to 4)
This field contains the 16 most significant bits of K_{NRP} ID.

11.3.53 LSBs of K_{NRP} ID 2

The purpose of the LSBs of K_{NRP} ID 2 information element is to carry the 16 least significant bits of the K_{NRP} ID.

The LSBs of K_{NRP} ID 2 information element is a type 4 information element with a length of 4 octets.

The LSBs of K_{NRP} ID 2 information element is coded as shown in figure 11.3.53.1 and table 11.3.53.1.

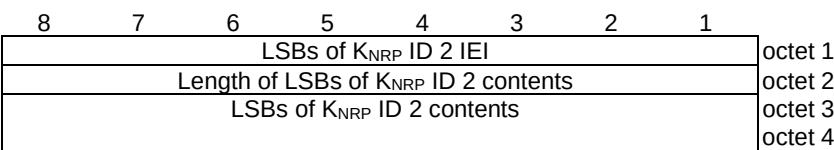


Figure 11.3.53.1: LSBs of K_{NRP} ID 2 information element

Table 11.3.53.1: LSBs of K_{NRP} ID 2 information element

LSBs of K_{NRP} ID 2 contents (octet 3 to 4)
This field contains the 16 least significant bits of K_{NRP} ID.

11.3.54 MSB of $K_{SLP-seSS}$ ID

The purpose of the MSB of $K_{SLP-seSS}$ ID information element is to carry the 8 most significant bits of the $K_{SLP-seSS}$ ID.

The MSB of $K_{SLP-seSS}$ ID information element is a type 4 information element with a length of 2 octets.

The MSB of $K_{SLP-seSS}$ ID information element is coded as shown in figure 11.3.54.1 and table 11.3.54.1.

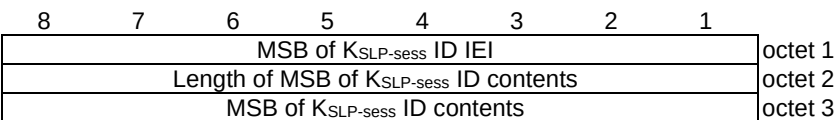


Figure 11.3.54.1: MSB of $K_{SLP-seSS}$ ID information element

Table 11.3.54.1: MSB of $K_{SLP-seSS}$ ID information element

MSB of $K_{SLP-seSS}$ ID contents (octet 3)
This field contains the 8 most significant bits of $K_{SLP-seSS}$ ID.

11.3.55 K_{SLP} ID

The purpose of the K_{SLP} ID information element is to carry the identity of the K_{SLP} held by a UE.

The K_{SLP} ID is a type 4 information element with a length of 5 octets.

The K_{SLP} ID information element is coded as shown in figure 11.3.55.1 and table 11.3.55.1.

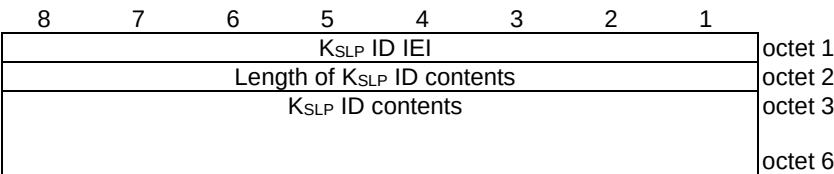


Figure 11.3.55.1: K_{SLP} ID information element

Table 11.3.55.1: K_{SLP} ID information element

K _{SLP} ID contents (octet 2 to 5)
This field contains the 32-bit identifier of a K _{SLP} .

11.3.56 Relay indication

The relay indication parameter is used to indicate whether the PROSE DIRECT LINK ESTABLISHMENT REQUEST message can be forwarded with required changes by a 5G ProSe UE-to-UE relay UE.

The relay indication is a type 1 information element with a length of 1 octet.

The relay indication IE is coded as shown in figure 11.3.56.1 and table 11.3.56.1.

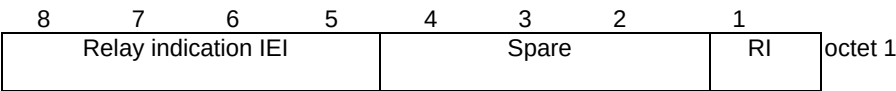


Figure 11.3.56.1: Relay indication information element

Table 11.3.56.1: Relay indication information element

Relay indication (RI) (octet 1, bit 1)	
The bit is used to indicate whether the PROSE DIRECT LINK ESTABLISHMENT REQUEST message can be forwarded with required changes by a 5G ProSe UE-to-UE relay UE.	
Bit	
1	
0	The PROSE DIRECT LINK ESTABLISHMENT REQUEST message cannot be forwarded by a 5G ProSe UE-to-UE relay UE
1	The PROSE DIRECT LINK ESTABLISHMENT REQUEST message can be forwarded by a 5G ProSe UE-to-UE relay UE
Bits 2 to 4 of octet 1 are spare and shall be coded as zero.	

11.3.57 List of application layer IDs

The purpose of the list of application layer IDs information element is to indicate a list of application layer IDs of the UEs.

The list of application layer IDs is a type 4 information element with a minimum length of 3 octets and a maximum length of 257 octets.

The List of application layer IDs information element is coded as shown in figure 11.3.57.1 and table 11.3.57.1.

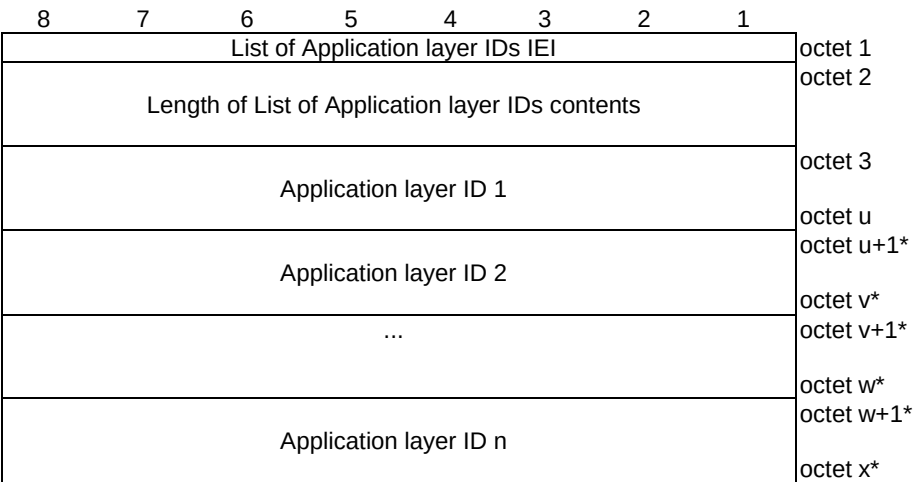


Figure 11.3.57.1: List of Application layer IDs information element

Table 11.3.57.1: List of Application layer IDs information element

Application layer ID (octets 3 to u)
The Application layer ID is encoded as defined in figure 11.3.4.1 from octet 2 and table 11.3.4.1.

11.3.58 List of multi-hop remote UE parameters

The list of multi-hop remote UE parameters is used to indicate the identity, address information, hop count, and the associated PC5 QoS flow for the 5G ProSe multi-hop remote UE(s).

The list of multi-hop remote UE parameters information element is a type 6 information element with the minimum length of 22 octets and the maximum length of 65538 octets.

The list of multi-hop remote UE parameters information element is coded as shown in figure 11.3.58.1, figure 11.3.58.2 and table 11.3.58.1.

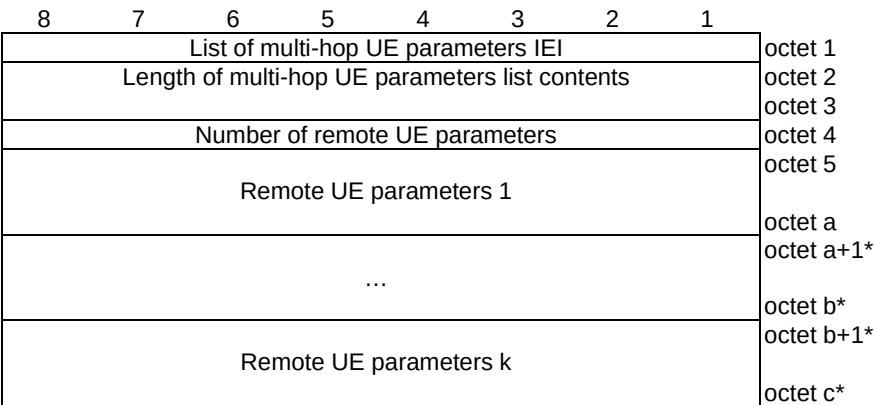


Figure 11.3.58.1: List of multi-hop remote UE parameters information element

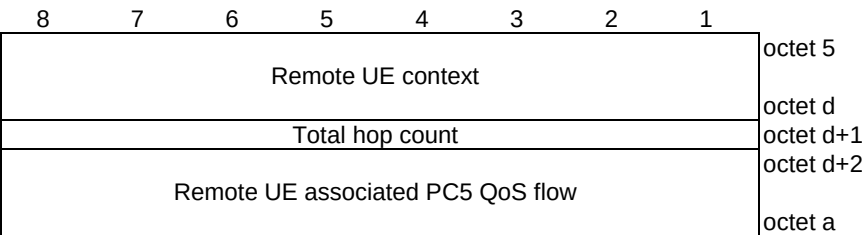


Figure 11.3.58.2: Remote UE parameters

Table 11.3.58.1: List of multi-hop remote UE parameters information element

Remote UE parameters (octet 5 to a) The contents of remote UE parameters field are applicable for one individual UE and contains the remote UE context, hop count and the remote UE associated PC5 QoS flow.
Remote UE context (octet 5 to d) The remote UE context field contains the identity and address information of the UE and is coded as the remote UE context field specified in figure 9.11.4.29.2 in 3GPP TS 24.501 [11], starting from octet 5 till octet j+k+3.
Total hop count (octet d+1) The total hop count field is coded as specified in figure 11.2.21.1 and table 11.2.21.1 and contains the total number of hops of the 5G ProSe multi-hop remote UE from the network.
Remote UE associated PC5 QoS flow (octet d+1 to a) The Remote UE associated PC5 QoS flow field contains the PC5 QoS flow associated with the 5G ProSe multi-hop remote UE and is coded as the PC5 QoS flow descriptions information element specified in Figure 11.3.5.1 starting from octet 2 till octet x.

11.3.59 Hop limit

The purpose of the Hop limit information element is to indicate the required number of hops for the 5G ProSe multi-hop UE-to-UE relay communication.

The value of Hop limit is an integer in the 1-15 range.

The Hop limit IE is a type 1 information element, with a length of 1 octet.

The Hop limit IE is coded as shown in figure 11.3.59.1 and table 11.3.59.1.

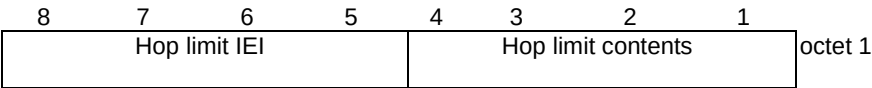


Figure 11.3.59.1: Hop limit information element

Table 11.3.59.1: Hop limit information element

Hop limit contents (octet 1) Hop limit contains an integer in the 1-15 range. The integer value "zero" shall not be used.

11.4 5G ProSe direct discovery message over PC3a formats

11.4.1 Data types format in XML schema

To exchange structured information over the transport protocol, XML text format/notation is introduced.

The corresponding XML data types for the data types used in ProSe messages are provided in table 11.4.1.1.

Table 11.4.1.1: Primitive or derived types for ProSe parameter type

ProSe parameter type	Type in XML schema
Integer	xs:integer
String	xs:string
Boolean	xs:boolean
Binary	xs:hexBinary
Bit string	xs:hexBinary
Time	xs:dateTime

For complex data types described in clause 11.4.2, an XML "complexType" can be used.

Message construction shall be compliant with W3C REC-xmlschema-2-20041028: "XML Schema Part 2: Datatypes" [29]

11.4.2 Parameters in 5G ProSe direct discovery messages over PC3a

11.4.2.1 Transaction ID

This parameter is used to uniquely identify a PC3a control protocol for ProSe direct discovery transaction when it is combined with other PC3a control protocol for ProSe direct discovery transactions in the same transport message. The UE shall set this parameter to a new number for each outgoing new discovery request. The transaction ID is an integer in the 0-255 range.

11.4.2.2 Command

This parameter is used to indicate the type of discovery request (announce, monitor, query, or response) contained in a DISCOVERY_REQUEST message. It is an integer in the 0-255 range encoded in table 11.4.2.2.1.

Table 11.4.2.2.1: Command

0	Reserved
1	Announce
2	Monitor
3	Query
4	Response
5	Metadata_update
6-255	Unused

11.4.2.3 Void

11.4.2.4 Prose application ID

This parameter is used to carry an identity used for open 5G ProSe direct discovery, identifying application related information for the ProSe-enabled UE. It is coded as specified in 3GPP TS 23.003 [12].

To support 5G ProSe in SNPN, the value of PLMN ID within the ProSe application ID shall be combined with a network identifier (NID) to identify an SNPN, as specified in clause 24.2 of 3GPP TS 23.003 [12].

11.4.2.5 Application identity

This parameter is used to identify the particular application that triggers the DISCOVERY_REQUEST message. The Application identity information element is coded as the ProSe identifier specified in clause 11.3.3.

11.4.2.6 ProSe application code

This parameter is used to contain a ProSe application code. The format of the ProSe application code is as follows:

- a) if the ProSe application code is included in a MATCH_REPORT message and application-controlled extension is used, the ProSe application code is encoded as a 184 bitstring composed of:
 - 1) the ProSe application code Prefix; and
 - 2) the ProSe application code Suffix; or
- b) in all other cases, the ProSe application is encoded as a 184 bitstring as defined in 3GPP TS 23.003 [12].

To support 5G ProSe in SNPN, the value of PLMN ID within the ProSe application code shall be combined with a network identifier (NID) to identify a SNPN.

11.4.2.7 Validity timer T5060

This parameter is used to carry the value of validity timer T5060 associated with a ProSe application code. It is an integer in the 1-525600 range representing the timer value in unit of minutes.

11.4.2.8 PC3a control protocol cause value

This parameter is used to indicate the particular reason why a DISCOVERY_REQUEST or MATCH_REPORT message from the UE has been rejected by the 5G DDNMF. It is an integer in the 0-255 range encoded in table 11.4.2.8.1.

Table 11.4.2.8.1: PC3a control protocol cause value

0	Reserved
1	Invalid Application
2	Unknown ProSe application ID
3	UE authorization failure
4	Unknown ProSe application code
5	Invalid MIC
6	Invalid UTC-based counter
7	Invalid message format
8	Scope violation in ProSe application ID
9	Unknown RPAUID
10	Unknown or invalid discovery entry ID
11	Invalid discovery target
12	UE unauthorised for discovery with application-controlled extension
13	UE unauthorised for on-demand announcing
14	Missing application level container
15	Invalid data in application level container
16	Invalid match event
17	No valid ProSe application code
18	Invalid UE Identity
19	Not compatible PC5 UE ciphering algorithm capability
20-255	Unused

11.4.2.9 Discovery filter

The elements in the discovery filter parameter are listed below.

- a) ProSe application code: The ProSe application code is used by a monitoring UE for full or partial matching of PROSE PC5 DISCOVERY messages received on the PC5 interface (see clause 10.2.1). Only one code is allowed in a discovery filter;
- b) ProSe application mask: a bitmask provided by the 5G DDNMF in order to allow the monitoring UE to perform a full matching or partial matching of PROSE PC5 DISCOVERY messages received on the PC5 interface. A ProSe application mask with all bits set to "1" is used for full matching. One or more ProSe application masks may be included in a discovery filter. The length of the ProSe application mask is as same as the length of ProSe application code; and
- c) TTL Timer T5064: time-to-live duration for which the associated discovery filter is valid, after which it shall not be used. It is an integer in the 1-525600 range representing the timer value in unit of minutes.

11.4.2.10 Monitored PLMN ID

This parameter is used to indicate the PLMN ID of the PLMN in which the PROSE PC5 DISCOVERY message containing a ProSe application code for which there was a match event was received. It is coded as specified in 3GPP TS 23.003 [12].

11.4.2.11 VPLMN ID

This parameter is used to indicate the PLMN ID of the PLMN in which the requesting UE is registered. It is coded as specified in 3GPP TS 23.003 [12].

11.4.2.12 UTC-based counter

This parameter is used to indicate the UTC time associated with the discovery transmission opportunity in which a PROSE PC5 DISCOVERY message is sent. This parameter is also used to indicate the UTC time associated with the security protected relay service code for 5G ProSe UE-to-network relay or 5G ProSe UE-to-UE relay when PROSE DIRECT LINK ESTABLISHMENT REQUEST message is sent. It is expressed in unit of seconds and coded in binary format as the 32 least significant bits of the coordinated universal time as defined in 3GPP TS 38.331 [13].

11.4.2.13 Validity timer T5072

This parameter is used to carry the value of validity timer T5072 associated with a ProSe application code for which there was a match event. It is an integer in the 1-525600 range representing the timer value in unit of minutes.

11.4.2.14 Metadata flag

This parameter is used to indicate whether the UE wishes to receive the latest metadata information associated with the ProSe application ID or RPAUID in the MATCH_REPORT_ACK from the 5G DDNMF. It is a Boolean value coded as follows:

- a) False: the UE does not wish to receive the latest metadata information associated with the ProSe application ID or RPAUID in the MATCH_REPORT_ACK from the 5G DDNMF; or
- b) True: the UE wishes to receive the latest metadata information associated with the ProSe application ID or RPAUID in the MATCH_REPORT_ACK message from the 5G DDNMF.

11.4.2.15 Metadata

This parameter is used to carry the metadata that is associated with the ProSe application ID contained in the MATCH_REPORT_ACK message. The purpose of the metadata is to carry additional application-layer information associated with a particular ProSe application ID. Examples of such information are postal address, phone number, URL etc. The length and contents of the metadata are out of scope of 3GPP. The format of the metadata is a UTF8-encoded string.

11.4.2.16 Current time

This parameter is used to carry the current UTC-based time at the 5G DDNMF. The format of this parameter follows the XML data type defined in table 11.4.1.1 for ProSe parameter type "Time".

11.4.2.17 Max offset

This parameter is used to indicate the maximum time difference between the time on the UE's ProSe clock and the UTC-based counter associated with the discovery slot in seconds, as specified in 3GPP TS 33.503 [34]. The Max offset is an integer in the 1-32 range.

11.4.2.18 Discovery type

This parameter is used to indicate the type of ProSe direct discovery contained in the DISCOVERY_REQUEST message or MATCH_REPORT message. It is an integer in the 0-3 range encoded as table 11.4.2.18.1.

Table 11.4.2.18.1: Discovery type

0	Reserved
1	Open discovery
2	Restricted discovery
3	Unused

11.4.2.19 Match report refresh timer T5074

This parameter is used to carry the value of match report refresh timer T5074 associated with a ProSe application code for which there was a match event. It is an integer in the 1-525600 range representing the timer value in unit of minutes.

11.4.2.20 Requested timer

During the announce request procedure for open 5G ProSe direct discovery or restricted 5G ProSe direct discovery model A, the requested timer element is used to carry the length of validity timer associated with the ProSe application code or the ProSe restricted code that the UE expects to receive from the 5G DDNMF. When the procedure is to inform the 5G DDNMF that the UE wants to stop announcing a ProSe application code or a ProSe restricted code before the associated valid timer expires, the requested timer shall be set to 0.

During the monitor request procedure for open 5G ProSe direct discovery or restricted 5G ProSe direct discovery model A, the requested timer element is only used to inform the 5G DDNMF that the UE wants to stop monitoring using discovery filter(s) or restricted discovery filter(s). The requested timer shall be set to 0.

It is an integer in the 0-525600 range representing the timer value in unit of minutes.

11.4.2.21 DDNMF transaction ID

This parameter is used to uniquely identify a PC3a control protocol for ProSe direct discovery transaction when it is combined with other PC3a control protocol for ProSe direct discovery transactions in the same transport message. The 5G DDNMF shall set this parameter to a new number for each outgoing new request. The DDNMF transaction ID is an integer in the 0-255 range.

11.4.2.22 Update info

This parameter is used to carry the following:

- a) the updated information for an announcing UE in restricted discovery with a new ProSe restricted code to replace the old one in the discovery entry and the corresponding validity timer. In this case the parameter shall contain the following:
 - 1) ProSe restricted code: See clause 11.4.2.27; and
 - 2) validity timer T5062: See clause 11.4.2.32.

- b) the updated information for a monitoring UE in restricted discovery with a new set of restricted discovery filters to be used for a given discovery entry. In this case the parameter shall contain one or more restricted discovery filters as defined in clause 11.4.2.30;
- c) the updated information for an announcing UE in open discovery with a new ProSe application code to replace the old one in the discovery entry and the corresponding validity timer. In this case the parameter shall contain:
 - 1) ProSe application code: See clause 11.4.2.6; and
 - 2) validity timer T5060: See clause 11.4.2.7; or
- d) the updated information for a monitoring UE in open discovery with a new set of discovery filters to be used for a given discovery entry. In this case the parameter shall contain one or more discovery filters defined in clause 11.4.2.9.

11.4.2.23 RPAUID

This parameter is used to carry the RPAUID, which is an identity used for restricted 5G ProSe direct discovery, identifying application related information for the 5G ProSe-enabled UE.

11.4.2.24 Announcing type

This parameter is used to indicate whether the UE requests on demand announcing in a DISCOVERY_REQUEST message. It is an integer in the 0-255 range encoded as table 11.4.2.24.1.

Table 11.4.2.24.1: Announcing type

0	Normal
1	On demand
2-225	Unused

11.4.2.25 Application level container

This parameter is used to carry the Application level container, which contains application-level data transparent to the 3GPP network transferred between the application client in the UE and the ProSe application server.

11.4.2.26 Discovery entry ID

This parameter is used to carry the discovery entry ID, which is an identity allocated by the 5G DDNMF to refer to a discovery entry in the UE's context as a result of a discovery request, either announcing or monitoring. It is an integer in the 0-65535 range.

11.4.2.27 ProSe restricted code

This parameter is used to contain a ProSe restricted code. The format of the ProSe restricted code is as follows:

- a) if the ProSe restricted code is included in a MATCH_REPORT message and application-controlled extension is not used, the ProSe restricted code is encoded as a 184 bitstring composed of:
 - 1) the ProSe restricted code in the 64 most significant bits; and
 - 2) the remaining 120 bits set to zero;
- b) if the ProSe restricted code is included in a MATCH_REPORT message and application-controlled extension is used, the ProSe restricted code is encoded as a 184 bitstring composed of
 - 1) the ProSe restricted code prefix in the 64 most significant bits;
 - 2) the ProSe restricted code suffix; and
 - 3) any remaining unused least significant bits set to zero; or

- c) in all other cases, the ProSe restricted code is encoded as a 64 bitstring as defined in 3GPP TS 23.003 [12].

11.4.2.28 ProSe restricted code suffix range

This parameter is used to carry a range of consecutive ProSe restricted code suffixes, each of which can be appended by the UE to a ProSe restricted code prefix (see clause 11.4.2.27) for restricted 5G ProSe direct discovery with application-controlled extension. A ProSe restricted code suffix range includes a beginning suffix code and optionally an ending suffix code, as described below:

- a) beginning suffix code: the bit-length of this bit string reflects the length of the suffix portion of the ProSe restricted code allocated by the ProSe application server for an RPAUID based on application configuration. The binary value of this code is the lowest value of the ProSe restricted code suffix range; and
- b) ending suffix code: the binary value of this code is the highest value of the ProSe restricted code suffix range. The length of the ending suffix code shall be the same as that of the beginning suffix code.

If the ProSe restricted code suffix range contains only a single ProSe restricted code suffix, then that suffix is represented by the beginning suffix code and the ending suffix code is omitted.

11.4.2.29 On demand announcing enabled indicator

This parameter is used to carry the on demand announcing enabled indicator, which is a Boolean value indicating whether on demand announcing is enabled or not in the 5G DDNMF.

11.4.2.30 Restricted discovery filter

This parameter is used to carry the discovery filter(s) used to monitor an individual target RPAUID in restricted 5G ProSe direct discovery model A. It contains one or more filters, TTL timer T5066, optionally an RPAUID parameter identifying the target RPAUID, optionally a metadata indicator and optionally the corresponding metadata. The elements in the restricted discovery filter parameter are defined as below:

- a) filter: a matching filter used for restricted 5G ProSe direct discovery Model A monitoring. It contains one code and one or more masks. The code is used by a monitoring UE for full or partial matching of PROSE PC5 DISCOVERY messages received on the PC5 interface with a ProSe restricted code (see clause 11.4.2.27). Only one code is allowed in a filter. The mask is a bitmask provided by the 5G DDNMF in order to allow the monitoring UE to perform a full matching or partial matching of PROSE PC5 DISCOVERY messages received on the PC5 interface. A mask with all bits set to "1" is used for full matching. One or more masks may be included in a filter. The length of the mask is the same as the length of the code;
- b) TTL Timer T5066: time-to-live duration for which the associated restricted discovery filter is valid, after which it shall not be used. It is an integer in the 1-525600 range representing the timer value in unit of minutes;
- c) RPAUID: identifier of the target RPAUID to be monitored;
- d) metadata indicator: it contains the information element defined in clause 11.4.2.44; and
- e) metadata: application-layer metadata associated with the monitoring target.

11.4.2.31 ACE enabled indicator

This parameter is used to indicate whether application-controlled extension for open 5G ProSe direct discovery or restricted 5G ProSe direct discovery is enabled. It is an integer value in the 0-255 range encoded as table 11.4.2.31.1.

Table 11.4.2.31.1: ACE enabled indicator

0	Reserved
1	Normal
2	Application-controlled extension enable
3-225	Unused

11.4.2.32 Validity timer T5062

This parameter is used to carry the value of validity timer T5062 associated with a ProSe restricted code or ProSe restricted code prefix. It is an integer in the 1-525600 range representing the timer value in unit of minutes.

11.4.2.33 Restricted code security material

This parameter is used as a container for the information necessary for security keys and algorithms protecting the sending or receiving of restricted 5G ProSe direct discovery messages over the PC5 interface. The elements in the restricted code security material parameter are listed below:

- a) DUSK: an optional key which is allocated by the 5G DDNMF and is used by the UE for scrambling or unscrambling the PROSE PC5 DISCOVERY message containing the ProSe restricted code in restricted 5G ProSe direct discovery. The calculation of the DUSK is defined in 3GPP TS 33.503 [34];
- b) DUIK: an optional key which is allocated by the 5G DDNMF and is used by the UE to compute the MIC that is included in the PROSE PC5 DISCOVERY message containing the ProSe restricted code in restricted 5G ProSe direct discovery. The calculation of the DUIK is defined in 3GPP TS 33.503 [34]; and
- c) DUCK and associated encrypted bitmask: DUCK is an optional key which is allocated by the 5G DDNMF and is used by the UE to encrypt a portion of the PROSE PC5 DISCOVERY message containing the ProSe restricted code in restricted 5G ProSe direct discovery. The calculation of the DUCK is defined in 3GPP TS 33.503 [34]. The encrypted bitmask is a bitmask which uses bit "1" to mark the positions of the bits for which the DUCK encryption is applied.
- d) MIC-check-indicator: an optional indication which is provided by the 5G DDNMF and indicates whether to use match reports for MIC checking, used by the UE to decide whether to perform the required MIC check via the match report procedure for restricted 5G ProSe direct discovery. If this indication is included, the DUIK shall not be included in the restricted code security material parameter but provided as a separate parameter as specified in 3GPP TS 33.503 [34]. This indication is not used for 5G ProSe UE-to-network relay discovery and group member discovery, nor for 5G ProSe UE-to-UE relay discovery.

11.4.2.34 Discovery model

This parameter is used to indicate the model of ProSe direct discovery contained in the DISCOVERY_REQUEST message. It is an integer in the 0-3 range encoded as table 11.4.2.34.1.

Table 11.4.2.34.1: Discovery model

0	Reserved
1	Model A
2	Model B
3	Unused

11.4.2.35 ProSe response code

This parameter is used to carry the ProSe response code. It is a bit string coded as specified in 3GPP TS 23.003 [12].

11.4.2.36 Discovery query filter

This parameter is used to carry the discovery query filter that is allocated by the 5G DDNMF in the HPLMN or the subscribed SNPN to the discoveree UE for restricted Model B discovery, for a particular RPAUID. The elements in the discovery query filter parameter are defined as below:

- a) Code: the code is used by a discoveree UE for full or partial matching of PROSE PC5 DISCOVERY messages received on the PC5 interface containing a ProSe query code. Only one code is allowed in a discovery query filter; and
- b) Mask: the mask is a bitmask provided by the 5G DDNMF in order to allow the discoveree UE to perform a full matching or partial matching of PROSE PC5 DISCOVERY messages received on the PC5 interface containing

the ProSe query code. A mask with all bits set to "1" is used for full matching. One or more masks may be included in a filter. The length of the mask is the same as the length of the code.

11.4.2.37 Validity timer T5068

This parameter is used to carry the value of validity timer T5068 associated with a ProSe response code and corresponding discovery query filter(s). It is an integer in the 1-525600 range representing the timer value in unit of minutes.

11.4.2.38 Subquery result

This parameter is used to contain the information allocated by the 5G DDNMF related to one particular query target RPAUID which the discoverer UE intends to query with restricted 5G ProSe direct discovery model B. It contains one ProSe query code, one or more discovery response filter(s), validity timer T5070, an RPAUID parameter identifying the target RPAUID, restricted security and optionally the corresponding metadata. The elements in the subquery result parameter are defined as below:

- a) ProSe query code: it is a ProSe restricted code allocated by the 5G DDNMF to a discoverer UE to solicit the response from a discoveree UE for a particular target RPAUID;
- b) discovery response filter: it contains one code and one or more masks to be used to matching ProSe response code. The code is used by a discoverer UE to represent a targeted ProSe response code (see clause 11.4.2.35). The mask is a bitmask provided by the 5G DDNMF in order to allow the discoverer UE to perform a full matching or partial matching of PROSE PC5 DISCOVERY messages received on the PC5 interface containing the ProSe response code. A mask with all bits set to "1" is used for full matching. The length of the mask is the same as the length of the code;
- c) validity timer T5070: it represents the validity time associated with a ProSe query code and corresponding discovery response filter(s). It is an integer in the 1-525600 range representing the timer value in unit of minutes;
- d) code-sending security parameter: it contains the information element defined in clause 11.4.2.33;
- e) code-receiving security parameter: it contains the information element defined in clause 11.4.2.33;
- f) RPAUID: identifier of the target RPAUID to be monitored; and
- g) metadata: application-layer metadata associated with the querying target.

11.4.2.39 Validity timer T5076

This parameter is used to carry the value of validity timer T5076 associated with a ProSe restricted code for which there was a match event. It is an integer in the 1-525600 range representing the timer value in unit of minutes.

11.4.2.40 Match report refresh timer T5077

This parameter is used to carry the value of match report refresh timer T5077 associated with a ProSe restricted Code for which there was a match event. It is an integer in the 1-525600 range representing the timer value in unit of minutes.

11.4.2.41 Metadata index mask

This parameter is a bitmask provided by the 5G DDNMF in order to indicate the portion used for the metadata index in the ProSe application code for the monitoring UE. The length of the metadata index mask is as same as the length of ProSe application code.

11.4.2.42 Network-initiated transaction method

This parameter is used to indicate the method enabling transport of PC3a messages for 5G DDNMF-initiated ProSe direct discovery procedures. It is an integer in the 0-255 range encoded as table 11.4.2.42.1.

Table 11.4.2.42.1: Network-initiated transaction method

0	Unused
1	HTTP long polling
2-255	Unused

11.4.2.43 Announcing PLMN ID

This parameter is used to indicate the PLMN ID of the PLMN operating the radio resources which the UE intends to use for transmitting a PROSE PC5 DISCOVERY message. It is coded as specified in 3GPP TS 23.003 [12].

11.4.2.44 Metadata Indicator

This parameter is used to indicate whether there is a metadata associated with the target RPAUID. It is an integer value in the 0-255 range encoded as table 11.4.2.44.1.

Table 11.4.2.44.1: Metadata indicator

0	No metadata associated
1	Metadata associated
2-255	Unused

11.4.2.45 ProSe application code prefix

This parameter is used to contain a ProSe application code prefix. Its length indicates the size in bits of the allocated prefix, which can take any value that is a multiple of 8 in the 32 to 176 range.

NOTE: The size of the prefix for a given application is determined by the ProSe application server and made known to the 5G DDNMF by means that are out of scope of 3GPP.

11.4.2.46 ProSe application code suffix

This parameter is used to contain a ProSe application code suffix. The ProSe application code suffix is used with a ProSe application code prefix to form a 184-bit ProSe application code for open 5G ProSe direct discovery with application-controlled extension.

11.4.2.47 ProSe application code ACE

This parameter is used to carry a set of ProSe application code(s) allocated for a corresponding ProSe application ID when application-controlled extension is used. It contains one ProSe application code Prefix and one or more ProSe application code suffix range(s). The elements in the ProSe application code ACE parameter are defined as below:

- a) ProSe application code prefix: as defined in clause 11.4.2.45; and
- b) ProSe application code suffix range: this parameter is used to carry a range of consecutive ProSe application code suffixes (see clause 11.4.2.46). A ProSe application code suffix range includes a beginning suffix code and optionally an ending suffix code, as described below:
 - 1) beginning suffix code: the bit-length of this bit string reflects the length of the suffix portion of the ProSe application code allocated by the ProSe application server for a ProSe application ID based on application configuration. The binary value of this code is the lowest value of the ProSe application code suffix range; and
 - 2) ending suffix code: the binary value of this code is the highest value of the ProSe application code suffix range. The length of the ending suffix code shall be the same as that of the beginning suffix code.

If the ProSe application code suffix range contains only a single ProSe application code suffix, then that suffix is represented by the beginning suffix code and the ending suffix code is omitted.

11.4.2.48 Discovery key

This parameter is used to carry a Discovery key allocated by the 5G DDNMF. This key is used by the UE to compute the MIC that is included in the PROSE PC5 DISCOVERY message. The format of Discovery key is defined in 3GPP TS 33.303 [36].

11.4.2.49 PC5 security policies

This parameter is used to indicate the PC5 security policies as integer values, where the PC5 signalling security policies are defined in table 11.3.12.1 and the PC5 user plane security policies are defined in table 11.3.23.1.

11.4.2.50 PC5 UE ciphering algorithm capability

This parameter is used to indicate the UE supported ciphering algorithms as integer values, where the UE supported ciphering algorithms field is defined as octet 3 of figure 11.3.11.1 and table 11.3.11.1.

11.4.2.51 Selected PC5 ciphering algorithm

This parameter is used to indicate the selected PC5 ciphering algorithm as integer values, where the selected PC5 ciphering algorithm field is defined as bit 5 to 7 of octet 2 in figure 11.3.22.1 and table 11.3.22.1.

11.4.2.52 ProSe PC5 discovery message

This parameter is used to include the entire PROSE PC5 DISCOVERY message where the match event occurred. For the restricted 5G ProSe direct discovery procedure, this parameter is included if it is required to check the MIC via the match report procedure as specified in clause 6.2.9.2 and clause 6.2.10.2.

11.4.2.53 PKMF address

This parameter is used to carry a 5G PKMF address to the UE by the 5G DDNMF in order to find a 5G PKMF for the authentication based on security procedure over user plane as specified in 3GPP TS 33.503 [34].

The PKMF address information element is coded as shown in figure 11.4.2.53.1, figure 11.4.2.53.2, figure 11.4.2.53.3, and table 11.4.2.53.1.

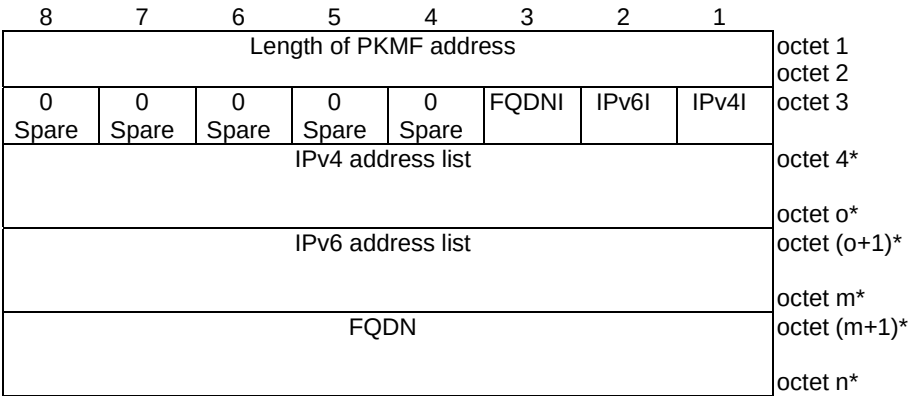


Figure 11.4.2.53.1: PKMF address

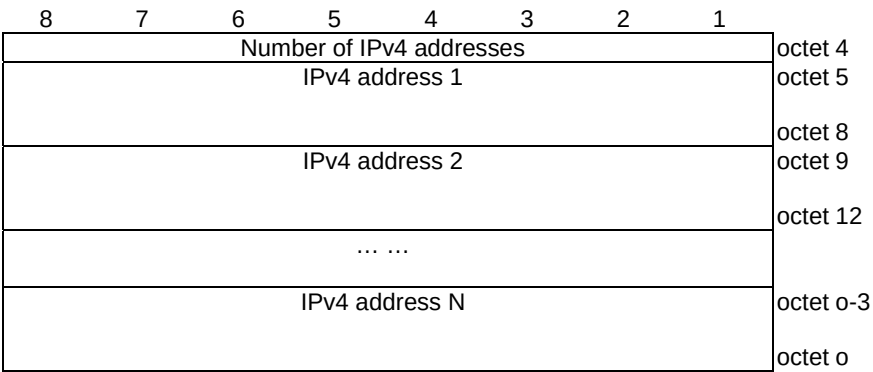


Figure 11.4.2.53.2: IPv4 address list

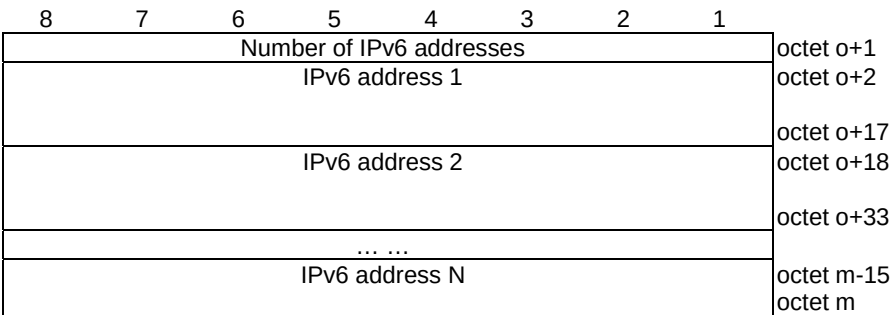


Figure 11.4.2.53.3: IPv6 address list

Table 11.4.2.53.1: PKMF address information element

IPv4 addresses indicator (IPv4I) (octet 3 bit 1): (NOTE 1)	
Bit	
1	
0	IPv4 address list is not present
1	IPv4 address list is present
IPv6 addresses indicator (IPv6I) (octet 3 bit 2): (NOTE 1)	
Bit	
2	
0	IPv6 address list is not present
1	IPv6 address list is present
FQDN indicator (FQDNI) (octet 3 bit 3): (NOTE 2)	
Bit	
3	
0	FQDN is not present
1	FQDN is present
IPv4 address list (octet 4 to octet o)	
IPv4 address list contains the IPv4 address(es) of the 5G PKMF and shall be encoded as defined in figure 11.4.2.53.2.	
IPv6 address list (octet o+1 to octet m)	
IPv6 address list contains the IPv6 address(es) of the 5G PKMF and shall be encoded as defined in figure 11.4.2.53.3.	
FQDN (octet m+1 to n)	
FQDN field contains a sequence of one octet FQDN length field and a FQDN value of variable size. The FQDN value field shall be encoded as defined in clause 28.3.2.1 of 3GPP TS 23.003 [12].	
NOTE 1: If multiple IPv4 addresses and/or IPv6 addresses are included, which one of these addresses is selected is implementation dependent.	
NOTE 2: If the 5G PKMF supports the 5G PKMF Services with "https" URI scheme (i.e., use of TLS is mandatory), then the FQDN shall be used to construct the target URI.	

11.5 Void

11.6 5G ProSe security message over PC8 formats

11.6.1 Data types format in XML schema

To exchange structured information over the transport protocol, XML text format/notation is introduced.

The corresponding XML data types for the data types used in ProSe messages are provided in table 11.6.1.1.

Table 11.6.1.1: Primitive or derived types for ProSe parameter type

ProSe parameter type	Type in XML schema
Integer	xs:integer
String	xs:string
Boolean	xs:boolean
Binary	xs:hexBinary
Bit string	xs:hexBinary
Time	xs:dateTime

For complex data types described in clause 11.6.2, an XML "complexType" can be used.

Message construction shall be compliant with W3C REC-xmlschema-2-20041028: "XML Schema Part 2: Datatypes" [29].

11.6.2 Parameters in 5G ProSe security messages over PC8

11.6.2.1 Transaction ID

This parameter is used to uniquely identify a PC8 control protocol for 5G ProSe security transaction when it is combined with other PC8 control protocol for 5G ProSe security transactions in the same transport message. The UE shall set this parameter to a new number for each outgoing new key request. The transaction ID is an integer in the 0-255 range.

11.6.2.2 UP-PRUK

This parameter is used to indicate the UP-PRUK allocated by the 5G PKMF. The calculation of the UP-PRUK is defined in 3GPP TS 33.503 [34].

11.6.2.3 UP-PRUK ID

This parameter is used to indicate the identifier of the UE stored UP-PRUK. The UP-PRUK ID value consists of two fields:

- a) UP-PRUK ID format field which is the 1st character of the UP-PRUK ID value: an ASCII character, as defined in IETF RFC 20 [40], coded in table 11.6.2.3.1; and

Table 11.6.2.3.1: UP-PRUK ID format

ASCII character "0"	Reserved
ASCII character "1"	NAI
ASCII character "2"	64-bit string
other ASCII characters	unused

- b) UP-PRUK ID field which is 2nd and later characters of the UP-PRUK ID value:

- 1) if the UP-PRUK ID format field indicates "NAI", the UP-PRUK ID field is a UP-PRUK ID in the NAI format as defined in clause 28.7.10 of 3GPP TS 23.003 [12], encoded as UTF-8 string; or
- 2) if the UP-PRUK ID format field indicates "64-bit string", the UP-PRUK ID field is a 64-bit string, encoded using 16 hexadecimal digits, each digit indicated by an ASCII character "0" - "9" or "A" - "F", as defined in IETF RFC 20 [40].

11.6.2.4 PC5 UE security capabilities

See clause 11.4.2.50.

11.6.2.5 MCC

This parameter is used to indicate the MCC as specified in Annex A of ITU-T Recommendation E.212 [27].

11.6.2.6 MNC

The coding of this parameter is responsibility of each administration. If MNC consists of 2 digits, MNC value is between 10 and 99.

11.6.2.7 Current time

See clause 11.4.2.16.

11.6.2.8 Max offset

See clause 11.4.2.17.

11.6.2.9 Expiration timer

This parameter is used to indicate the expiration timer of the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE, the expiration timer of the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE, the expiration timer of the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE or the expiration timer of the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE.

It is an integer in the 1-525600 (decimal) range representing the timer value in unit of minutes.

11.6.2.10 Relay service code

This parameter is used to indicate a connectivity service provided by the 5G ProSe UE-to-network relay or the 5G ProSe UE-to-UE relay.

It is an integer in the 0 to 16777215 (decimal) range.

11.6.2.11 Selected PC5 ciphering algorithm

See clause 11.4.2.51.

11.6.2.12 DUSK

This parameter is used to provide DUSK as specified in 3GPP TS 33.503 [34].

11.6.2.13 DUIK

This parameter is used to provide DUIK as specified in 3GPP TS 33.503 [34].

11.6.2.14 DUCK

This parameter is used to provide DUCK as specified in 3GPP TS 33.503 [34].

11.6.2.15 Encrypted bitmask

This parameter is used to provide encrypted_bits_mask associated with a DUCK as specified in 3GPP TS 33.503 [34].

11.6.2.16 GPI

This parameter is used to indicate the GPI encoded as specified in clause 5.3.5 in 3GPP TS 33.223 [44].

11.6.2.17 Signalling ciphering policy

This parameter is used to indicate the signalling ciphering policy. The parameter is encoded as the signalling ciphering policy field as specified in the table 11.3.12.1, with values in the 0 to 7 range.

11.6.2.18 User plane integrity protection policy

This parameter is used to indicate the user plane integrity protection policy. The parameter is encoded as the user plane integrity protection policy field as specified in the table 11.3.23.1, with values in the 0 to 7 range.

11.6.2.19 User plane ciphering policy

This parameter is used to indicate the user plane ciphering policy. The parameter is encoded as the user plane ciphering policy field as specified in the table 11.3.23.1, with values in the 0 to 7 range.

11.6.2.20 PC8 control protocol cause value

This parameter is used to indicate the particular reason why a PROSE_SECURITY_PARAM_REQUEST, PROSE_PRUK_REQUEST or PROSE_KEY_REQUEST message from the UE has been rejected by the 5G PKMF. It is an integer in the 0-255 range encoded in table 11.6.2.20.1.

Table 11.6.2.20.1: PC8 control protocol cause value

0	Reserved
3	UE authorization failure
1, 2, 4-255	Unused

11.6.2.21 SUCI

This parameter is used to indicate the SUCI of the 5G ProSe remote UE in NAI format as specified in 3GPP TS 23.003 [12].

11.6.2.22 K_{NR}P freshness parameter 1

This parameter is used to indicate 128-bit long K_{NR}P freshness parameter 1 as specified in 3GPP TS 33.503 [34].

11.6.2.23 AUTS

This parameter is used to provide 112-bit long information to begin a re-synchronisation as specified in 3GPP TS 33.503 [34].

11.6.2.24 RAND

This parameter is used to provide a 128-bit long non-predictable challenge as specified in 3GPP TS 33.503 [34].

11.6.2.25 K_{NR}P

This parameter is used to provide a 256-bit K_{NR}P as specified in 3GPP TS 33.503 [34].

11.6.2.26 K_{NR}P freshness parameter 2

This parameter is used to indicate 128-bit long K_{NR}P freshness parameter 2 as specified in 3GPP TS 33.503 [34].

11.6.2.27 PLMN ID

This parameter is used to provide the HPLMN ID of the 5G ProSe UE-to-network relay UE, the 5G ProSe multi-hop UE-to-network relay UE, the 5G ProSe multi-hop remote UE, the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe UE-to-UE relay UE for which the security parameters are associated. It is coded as specified in 3GPP TS 23.003 [12].

11.7 Formats for messages transmitted over the PC3ach interface

11.7.1 Data types format in XML schema

To exchange structured information over the transport protocol, XML text format/notation is introduced.

The corresponding XML data types for the data types used in 5G ProSe PC3ach messages are provided in table 11.7.1.

Table 11.7.1: Primitive or derived types for 5G ProSe PC3ach Parameter Type

5G ProSe Parameter Type	Type in XML Schema
Integer	xs:integer
String	xs:string
Boolean	xs:boolean
Binary	xs:hexBinary
Bit string	xs:hexBinary
Time	xs:dateTime

For complex data types described in clause 11.7.2, an XML "complexType" can be used.

Message construction shall be compliant with W3C REC-xmlschema-2-20041028 [29].

11.7.2 Parameters in messages transmitted over the PC3ach interface

11.7.2.1 Transaction ID

This parameter is used to uniquely identify a message transmitted over the PC3ach interface when it is combined with another message transmitted over the PC3ach interface in the same transport message. The UE shall set this parameter to a new number for each outgoing new message which includes this information element and is transmitted over the PC3ach interface. The transaction ID is an integer in the 0-255 range.

11.7.2.2 Sequence number

This parameter is used to indicate sequence number of the usage information report. The sequence number is an integer in the 0-4294967295 range. The sequence number is set to 0 on UE power up and is increased by 1 whenever a new usage information report is created.

11.7.2.3 In coverage

This parameter is used to indicate whether the UE was in NG-RAN coverage. It is a Boolean value coded as follows:

True the UE is in NG-RAN coverage.

False the UE is out of NG-RAN coverage.

11.7.2.4 NCGI

This parameter is used to indicate NG-RAN Cell Global Identification of the NG-RAN cell where the UE was camping on or which the UE used in the 5GMM-CONNECTED mode. The coding of NCGI is defined in 3GPP TS 23.003 [12].

11.7.2.5 5G ProSe direct communication radio parameters

This parameter is used to indicate the radio parameters used for 5G ProSe direct communication. Format of the value is according to the SL-PreconfigurationNR-r16 ASN.1 data type described in 3GPP TS 38.331 [13].

11.7.2.6 Cause value

This parameter is used to indicate the particular reason why the 5G DDNMF CTF (ADF) rejects PROSE_USAGE_INFORMATION_REPORT_LIST message. It is an integer in the 0-255 range encoded as follows:

- 0 Reserved
- 2 UE authorization failure
- 3 Invalid message format
- 10 Unable to process usage information report list
- 1, 4-9, 11-255 Unused

11.7.2.7 Timestamp

This parameter is used to indicate time and date. The format of this parameter follows the XML data type defined in table 11.7.1 for 5G ProSe PC3ach message parameter type "Time".

11.7.2.8 ProSe layer-2 group ID

This parameter is used to indicate a ProSe layer-2 group ID. The value of ProSe layer-2 group ID is a 24-bit bit-string.

11.7.2.9 5G ProSe group IP multicast address

This parameter is used to indicate a 5G ProSe Group IP multicast address. If the IP address is an IPv4 address, its value is coded as a string representing the dotted-decimal format of the IPv4 address as specified in IETF RFC 1166 [48]. If the IP address is an IPv6 address, its value is coded as a string representing the canonical text representation format of the IPv6 address as specified in IETF RFC 5952 [49].

11.7.2.10 UE IP address

This parameter is used to indicate an IP address used by the UE as a source address. If the IP address is an IPv4 address, its value is coded as a string representing the dotted-decimal format of the IPv4 address as specified in IETF RFC 1166 [48]. If the IP address is an IPv6 address, its value is coded as a string representing the canonical text representation format of the IPv6 address as specified in IETF RFC 5952 [49].

11.7.2.11 UE layer-2 ID

This parameter is used to indicate the layer-2 ID used by the UE. The value of UE layer-2 ID is a 24-bit bit-string.

11.7.2.12 Data amount

This parameter is used to indicate the amount of transmitted or received data in octets. The value of this parameter is coded as an integer.

11.7.2.13 Radio resources indicator

This parameter is used to indicate whether the operator-provided radio resources or the configured radio resources were used for 5G ProSe direct communication.

It is an integer in the 0-255 range encoded as follows:

- 0 Reserved
- 1 the operator-provided radio resources
- 2 the configured radio resources
- 3-255 Unused

11.7.2.14 Radio frequency

This parameter is used to indicate the radio frequency used for 5G ProSe direct communication.

Format of the value is according to the ARFCN-ValueNR ASN.1 data type described in 3GPP TS 38.331 [13].

11.7.2.15 PC5 QoS flow identifier

This parameter is used to indicate the PC5 QoS flow identifier used to identify the QoS flow for 5G ProSe direct communication. It is coded as specified in Table 11.3.5.1.

11.7.2.16 PQI

This parameter is used to indicate the PQI of PC5 QoS flow used for 5G ProSe direct communication. It is coded as specified in Table 11.3.5.1.

11.7.2.17 GFBR

This parameter is used to indicate the guaranteed flow bit rate (GFBR) of PC5 QoS flow used for 5G ProSe direct communication. It is coded as specified in Table 11.3.5.1.

11.7.2.18 MFBR

This parameter is used to indicate the maximum flow bit rate (MFBR) of PC5 QoS flow used for 5G ProSe direct communication. It is coded as specified in Table 11.3.5.1.

11.7.2.19 Averaging window

This parameter is used to indicate the averaging window of PC5 QoS flow used for 5G ProSe direct communication. It is coded as specified in Table 11.3.5.1.

11.7.2.20 Resource type

This parameter is used to indicate the resource type of PC5 QoS flow used for 5G ProSe direct communication. It is coded as specified in Table 11.3.5.1.

11.7.2.21 Default priority level

This parameter is used to indicate the default priority level of PC5 QoS flow used for 5G ProSe direct communication. It is coded as specified in Table 11.3.5.1.

11.7.2.22 Packet delay budget

This parameter is used to indicate the packet delay budget of PC5 QoS flow used for 5G ProSe direct communication. It is coded as specified in Table 11.3.5.1.

11.7.2.23 Packet error rate

This parameter is used to indicate the packet error rate of PC5 QoS flow used for 5G ProSe direct communication. It is coded as specified in Table 11.3.5.1.

11.7.2.24 Default maximum data burst volume

This parameter is used to indicate the default maximum data burst volume of PC5 QoS flow used for 5G ProSe direct communication. It is coded as specified in Table 11.3.5.1.

11.8 Parameter formats for 5G ProSe MANET messages

11.8.1 Multi-hop UE-to-UE discovery info

The purpose of the multi-hop UE-to-UE discovery info parameter is to carry the list of IP address and the associated user info (i.e., Application layer ID) of the 5G ProSe multi-hop layer-3 end UE(s) connected to the 5G ProSe multi-hop UE-to-UE relay UE.

The multi-hop UE-to-UE discovery info parameter follows the message TLV format defined in IETF RFC 5444 [59].

The multi-hop UE-to-UE discovery info parameter has a minimum length of 14 octets and a maximum length of 65539 octets.

The multi-hop UE-to-UE discovery info parameter is coded as shown in figure 11.8.1.1 and table 11.8.1.1.

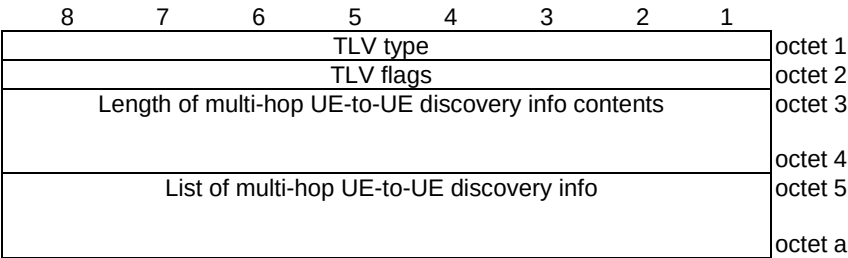


Figure 11.8.1.1: Multi-hop UE-to-UE discovery info parameter

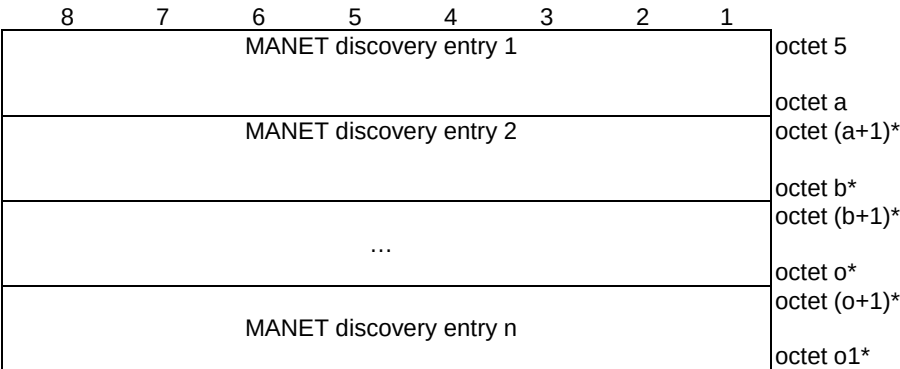


Figure 11.8.1.2: List of multi-hop UE-to-UE discovery info

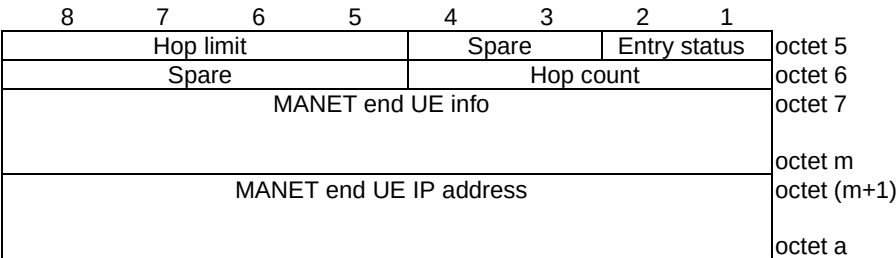


Figure 11.8.1.3: MANET discovery entry

Table 11.8.1.1: Multi-hop UE-to-UE discovery info parameter

TLV type (octet 1) The TLV type is set to the value 128 (decimal) for the multi-hop UE-to-UE discovery info parameter (i.e., "10000000" from bits 8 to 1).	
TLV flags (octet 2) The TLV flags is set to "00011000" (from bits 8 to 1) as per IETF RFC 5444 [59].	
Hop limit (Bits 8 to 5 of octet 5) Hop limit contains an integer in the 1-15 range as received from the 5G ProSe multi-hop layer-3 end UE.	
Entry status (Bits 2 to 1 of octet 5) This field indicates the status of MANET discovery entry whether to add, update, or remove the entry in the MANET routing table.	
Bits	
2	1
0	0
0	1
1	0
1	1
Hop count (Bits 4 to 1 of octet 6) Hop count contains an integer in the 1-15 range.	
MANET end UE info (octet 7 to m) The MANET end UE info field is the Application layer ID of the 5G ProSe multi-hop layer-3 end UE connected to the 5G ProSe multi-hop UE-to-UE relay UE. The MANET end UE info field is coded as the length and value part of Application layer ID information element as specified in clause 11.2.15 starting with the second octet.	
MANET end UE IP address (octet m+1 to a) The MANET end UE IP address is encoded as defined in Figure 11.3.49.1 from octet 2 and Table 11.3.49.1.	

NOTE: The value of 128 (decimal) for <tlv-type> is from the Message-Type-specific use range of the Message TLV Types registry defined in IETF RFC 5444 [59].

11.9 5G ProSe broadcasting message formats

11.9.1 ProSe broadcasting message type

This parameter is used to indicate the type of ProSe broadcasting message over PC5 interface.

This parameter is coded as shown in table 11.9.1.1.

The ProSe broadcasting message type is a type 3 information element, with the length of 1 octet.

Table 11.9.1.1: ProSe broadcasting message type

Bits							
8	7	6	5	4	3	2	1
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1
1	1	1	1	1	1	1	1
All other values are spare.							

12 List of system parameters

12.1 Overview

The description of timers in the following tables should be considered a brief summary. The precise details are found in clauses 4 to 8, which should be considered the definitive descriptions.

12.2 Timers for provisioning of parameters for 5G ProSe configuration procedures

Timers of provisioning of parameters for 5G ProSe configuration are shown in table 12.2.1.

NOTE: Timer T5040 is defined in 3GPP TS 24.587 [18].

Table 12.2.1: Timers for provisioning of parameters for 5G ProSe configuration – UE side

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5051	Validity timer value for UE policies for 5G ProSe direct discovery over PC5 (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.3.	Start using the new UE policies for 5G ProSe direct discovery received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe direct discovery	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5052	Validity timer value for UE policies for 5G ProSe direct communication over PC5 (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.4.	Start using the new UE policies for 5G ProSe direct communications received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe direct communications	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5053	Validity timer value for UE policies for 5G ProSe UE-to-network relay UE (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.5.	Start using the new UE policies for 5G ProSe UE-to-network relay UE received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe UE-to-network relay UE	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5054	Validity timer value for UE policies for 5G ProSe remote UE (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.6.	Start using the new UE policies for 5G ProSe Remote UE received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe Remote UE	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5055	Validity timer value for the security related parameters at the 5G ProSe UE-to-network relay UE, used for UE-to-network relay discovery when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.5.	Start using the security related parameters for discovery in the new UE policies for 5G ProSe UE-to-network relay UE received in MANAGE UE POLICY COMMAND message	Stop using the security related parameters for discovery in the old UE policies for 5G ProSe UE-to-network relay UE	Consider the existing configured security related parameters for discovery as invalid
T5056	Validity timer value for the security related parameters at the 5G ProSe remote UE, used for UE-to-network relay discovery when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.6.	Start using the security related parameters for discovery in the new UE policies for 5G ProSe remote UE received in MANAGE UE POLICY COMMAND message	Stop using the security related parameters for discovery in the old UE policies for 5G ProSe remote UE	Consider the existing configured security related parameters for discovery as invalid

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5057	Validity timer value for UE policies for 5G ProSe usage information reporting (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.7.	Start using the new UE policies for 5G ProSe usage information reporting received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe usage information reporting	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5058	Validity timer value for UE policies for 5G ProSe UE-to-UE relay UE (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.8.	Start using the new UE policies for 5G ProSe UE-to-UE relay UE received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe UE-to-UE relay UE	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5059	Validity timer value for UE policies for 5G ProSe end UE (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.9.	Start using the new UE policies for 5G ProSe end UE received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe end UE	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5101	Validity timer value for the security related parameters at the 5G ProSe UE-to-UE relay UE, used for UE-to-UE relay discovery when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.8.	Start using the security related parameters for discovery in the new UE policies for 5G ProSe UE-to-UE relay UE received in MANAGE UE POLICY COMMAND message	Stop using the security related parameters for discovery in the old UE policies for 5G ProSe UE-to-UE relay UE	Consider the existing configured security related parameters for discovery as invalid
T5102	Validity timer value for the security related parameters at the 5G ProSe end UE, used for UE-to-UE relay discovery when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.9.	Start using the security related parameters for discovery in the new UE policies for 5G ProSe end UE received in MANAGE UE POLICY COMMAND message	Stop using the security related parameters for discovery in the old UE policies for 5G ProSe end UE	Consider the existing configured security related parameters for discovery as invalid
T5120	Validity timer value for UE policies for 5G ProSe multi-hop UE-to-network relay UE (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.10.	Start using the new UE policies for 5G ProSe multi-hop UE-to-network relay UE received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe multi-hop UE-to-network relay UE	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5121	Validity timer value for UE policies for 5G ProSe multi-hop remote UE (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.12.	Start using the new UE policies for 5G ProSe multi-hop remote UE received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe multi-hop remote UE	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5122	Validity timer value for UE policies for 5G ProSe intermediate UE-to-network relay UE (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.11.	Start using the new UE policies for 5G ProSe intermediate UE-to-network relay UE received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe intermediate UE-to-network relay UE	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5123	Validity timer value for UE policies for 5G ProSe multi-hop UE-to-UE relay UE (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.13.	Start using the new UE policies for 5G ProSe multi-hop UE-to-UE relay UE received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe multi-hop UE-to-UE relay UE	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5124	Validity timer value for UE policies for 5G ProSe multi-hop end UE (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.14.	Start using the new UE policies for 5G ProSe multi-hop end UE received in MANAGE UE POLICY COMMAND message	Stop using the old UE policies for 5G ProSe multi-hop end UE	Initiate the UE-requested ProSeP provisioning procedure (NOTE 1)
T5127	Validity timer value for the security related parameters at the 5G ProSe multi-hop UE-to-network relay UE, used for multi-hop UE-to-network relay discovery when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.10.	Start using the security related parameters for discovery in the new UE policies for 5G ProSe multi-hop UE-to-network relay UE received in MANAGE UE POLICY COMMAND message	Stop using the security related parameters for discovery in the old UE policies for 5G ProSe multi-hop UE-to-network relay UE	Consider the existing configured security related parameters for discovery as invalid
T5128	Validity timer value for the security related parameters at the 5G ProSe multi-hop remote UE, used for multi-hop UE-to-network relay discovery when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.12.	Start using the security related parameters for discovery in the new UE policies for 5G ProSe multi-hop remote UE received in MANAGE UE POLICY COMMAND message	Stop using the security related parameters for discovery in the old UE policies for 5G ProSe multi-hop remote UE	Consider the existing configured security related parameters for discovery as invalid

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5129	Validity timer value for the security related parameters at the 5G ProSe intermediate UE-to-network relay UE, used for multi-hop UE-to-network relay discovery when the security procedure over control plane as specified in 3GPP TS 33.503 [34] is used (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.11.	Start using the security related parameters for discovery in the new UE policies for 5G ProSe intermediate UE-to-network relay UE received in MANAGE UE POLICY COMMAND message	Stop using the security related parameters for discovery in the old UE policies for 5G ProSe intermediate UE-to-network relay UE	Consider the existing configured security related parameters for discovery as invalid
T5130	Validity timer value for the security related parameters at the 5G ProSe multi-hop UE-to-UE relay UE, used for multi-hop UE-to-UE relay discovery, which is specified in 3GPP TS 24.555 [17] clause 5.13.	Start using the security related parameters for discovery in the new UE policies for 5G ProSe multi-hop UE-to-UE relay UE received in MANAGE UE POLICY COMMAND message	Stop using the security related parameters for discovery in the old UE policies for 5G ProSe multi-hop UE-to-UE relay UE	Consider the existing configured security related parameters for discovery as invalid
T5131	Validity timer value for the security related parameters at the 5G ProSe multi-hop end UE, used for multi-hop UE-to-UE relay discovery, which is specified in 3GPP TS 24.555 [17] clause 5.14.	Start using the security related parameters for discovery in the new UE policies for 5G ProSe multi-hop end UE received in MANAGE UE POLICY COMMAND message	Stop using the security related parameters for discovery in the old UE policies for 5G ProSe multi-hop end UE	Consider the existing configured security related parameters for discovery as invalid

NOTE 1: The timers expire only once.

12.3 Timers for 5G ProSe direct link management procedures

NOTE: Timer T3346 is defined in 3GPP TS 24.008 [31].

Table 12.3.1: Timers for 5G ProSe direct link management

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5080	16s at the source 5G ProSe end UE otherwise 8s NOTE 1 NOTE 3	Upon sending a PROSE DIRECT LINK ESTABLISHMENT REQUEST message	Upon receiving a PROSE DIRECT LINK ESTABLISHMENT ACCEPT or PROSE DIRECT LINK ESTABLISHMENT REJECT message from the target UE if the Target user info IE or the UE-to-UE relay UE user info IE is included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message as described in clause 7.2.2.4.	Retransmission of PROSE DIRECT LINK ESTABLISHMENT REQUEST message as described in clause 7.2.2.6.1
T5081	5s NOTE 3	Upon sending a PROSE DIRECT LINK MODIFICATION REQUEST message	Upon receiving a PROSE DIRECT LINK MODIFICATION ACCEPT or PROSE DIRECT LINK MODIFICATION REJECT or PROSE DIRECT LINK RELEASE REQUEST message from the target UE	Retransmission of PROSE DIRECT LINK MODIFICATION REQUEST message
T5082	2s	Upon sending a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message	Upon receiving a PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT or PROSE DIRECT LINK IDENTIFIER UPDATE REJECT or PROSE DIRECT LINK RELEASE REQUEST message from the target UE	Retransmission of the PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message
T5083	2s	Upon sending a PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message	Upon receiving a PROSE DIRECT LINK IDENTIFIER UPDATE ACK message or PROSE DIRECT LINK RELEASE REQUEST message from the initiating UE	Retransmission of the PROSE DIRECT LINK IDENTIFIER UPDATE ACCEPT message
T5084	5s	Upon receiving a PC5 signalling message or PC5 user plane data	Upon 5G ProSe direct link release or upon initiating the 5G ProSe direct link keep-alive procedure	Initiate the 5G ProSe direct link keep-alive procedure
T5085	5s	Upon sending a PROSE DIRECT LINK KEEPALIVE REQUEST message	Upon receiving a PC5 signalling message or PC5 user plane data	Retransmission of the PROSE DIRECT LINK KEEPALIVE REQUEST message

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5086	Default 10m NOTE 2	Upon receiving a Maximum inactivity period in a PROSE DIRECT LINK KEEPALIVE REQUEST message, receiving a PC5 signalling message or receiving PC5 user plane data	Upon receiving a PC5 signalling message or PC5 user plane data	Either initiate the 5G ProSe direct link keep-alive procedure or the 5G ProSe direct link release procedure
T5087	5s	Upon sending a PROSE DIRECT LINK RELEASE REQUEST message	Upon receiving a PROSE DIRECT LINK RELEASE ACCEPT message from the target UE	Retransmission of PROSE DIRECT LINK RELEASE REQUEST message
T5088	As described in clause 7.2.2.5 and clause 7.2.6.3	Upon receiving a PROSE DIRECT LINK ESTABLISHMENT REJECT message with PC5 signalling protocol cause value set to #13 "congestion situation" and a back-off timer value is provided in the message Upon receiving a PROSE DIRECT LINK RELEASE REQUEST message with PC5 signalling protocol cause value set to #13 "congestion situation" and a back-off timer value is provided in the message	Upon receiving PROSE PC5 DISCOVERY message from the same UE-to-network relay UE due to starting announcing UE procedure or discoverer UE procedure as described in clause 8.2.1.2.1.2 and clause 8.2.1.3.2.2 respectively	Take the peer UE onboard for UE-to-network relay UE discovery and selection
T5089	2s	Upon sending a PROSE DIRECT LINK SECURITY MODE COMMAND message	Upon receiving a PROSE DIRECT LINK SECURITY MODE COMPLETE or PROSE DIRECT LINK SECURITY MODE REJECT message from the target UE	Retransmission of PROSE DIRECT LINK SECURITY MODE COMMAND message
T5090	NOTE 2	Upon establishing a 5G ProSe direct link and satisfying the privacy requirement for 5G UE-to-network relay or at least one of ProSe identifiers for the 5G ProSe direct link satisfying the privacy requirements or upon completing the 5G ProSe direct link identifier update procedure	Upon completing a 5G ProSe direct link identifier update or upon accepting a PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message or upon a 5G ProSe direct link release	Transmission of PROSE DIRECT LINK IDENTIFIER UPDATE REQUEST message
T5091	8s	Upon sending a PROSE DIRECT LINK REKEYING REQUEST message	Upon receiving a PROSE DIRECT LINK REKEYING RESPONSE message or PROSE DIRECT LINK RELEASE REQUEST message from the target UE	Retransmission of PROSE DIRECT LINK REKEYING REQUEST message
T5092	2s	Upon sending a PROSE DIRECT LINK AUTHENTICATION REQUEST message	Upon receiving a PROSE DIRECT LINK AUTHENTICATION RESPONSE or DIRECT LINK AUTHENTICATION REJECT message from the target UE	Retransmission of PROSE DIRECT LINK AUTHENTICATION REQUEST message

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5093	2s	Upon sending a PROSE AA MESSAGE TRANSPORT REQUEST message	Upon receiving a PROSE AA MESSAGE TRANSPORT RESPONSE message from the target UE	Retransmission of PROSE AA MESSAGE TRANSPORT REQUEST message
T5096	2s	Upon sending a PROSE DIRECT LINK MODIFICATION ACCEPT message	Upon receiving a PROSE DIRECT LINK MODIFICATION ACK message from the initiating UE	Retransmission of the PROSE DIRECT LINK MODIFICATION ACCEPT message
T5097	2s	Upon sending a PROSE UE TO UE RELAY UPDATE REQUEST message	Upon receiving a PROSE DIRECT RELAY UPDATE ACCEPT message from the ProSe layer-3 UE to UE relay UE	Retransmission of PROSE UE TO UE RELAY UPDATE REQUEST message
T5098	8s	Upon sending a PROSE PATH SWITCHING REQUEST message	Upon receiving a PROSE PATH SWITCHING ACCEPT message from the target UE	On 1 st expiry and 2 nd expiry: Retransmission of PROSE PATH SWITCHING REQUEST message; On the 3 rd expiry, the procedure is aborted (see clause 7.7.3.6.1)
T5099	2s	Upon sending a PROSE DIRECT LINK IDENTITY REQUEST message	Upon receiving a PROSE DIRECT LINK IDENTITY RESPONSE message from the target UE	Retransmission of the PROSE DIRECT LINK IDENTITY REQUEST message
T5201	2s	Upon sending a PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message	Upon receiving a PROSE DIRECT LINK SECURITY ESTABLISHMENT ACCEPT or PROSE DIRECT LINK SECURITY ESTABLISHMENT REJECT message from the target UE	Retransmission of the PROSE DIRECT LINK SECURITY ESTABLISHMENT REQUEST message
T5202	2s	Upon sending a PROSE DIRECT DISCOVERY SET TRANSFER IND message	Upon receiving a PROSE DIRECT DISCOVERY SET TRANSFER ACK message from the target UE	Retransmission of the PROSE DIRECT DISCOVERY SET TRANSFER IND message

NOTE 1: If the Target user info IE or UE-to-UE relay UE user info IE is not included in the PROSE DIRECT LINK ESTABLISHMENT REQUEST message, then the initiating UE may keep the timer T5080 running upon receiving PROSE DIRECT LINK ESTABLISHMENT ACCEPT message as described in clause 7.2.2.4.

NOTE 2: The value of this timer is the privacy timer value which is one of the configuration parameters for 5G ProSe direct communication (see clause 5.2.4 and clause 5.2.5) and it is specified in 3GPP TS 24.555 [17] clause 5.4, clause 5.5 and clause 5.6.

NOTE 3: When the UE operates in a multi-hop environment, the UE, based on implementation, may select a higher value for this timer to accommodate for multi-hop.

12.4

Timers for 5G ProSe direct discovery procedures over PC3a

Table 12.4.1: Timers for 5G ProSe direct discovery procedures over PC3a – UE side

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5060	NOTE 1	Upon receiving a ProSe application code with an associated T5060 timer in a DISCOVERY_RESPONSE message whose transaction ID contained in the <response-announce> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "announce", as described in clause 6.2.2.4. Upon receiving a ProSe application code with an associated T5060 timer in the Update info in the <discovery-update-request> element in a DISCOVERY_UPDATE_REQUEST message and the discovery entry ID in the <discovery-update-request> element is known, as described in clause 6.2.11.3.	Upon receiving a new T5060 timer value for the same ProSe application code or receiving a new Timer associated with a new ProSe application code for the same ProSe application ID in a DISCOVERY_RESPONSE message. When the UE selects a new PLMN. Upon receiving a <discovery-update-request> element in a DISCOVERY_UPDATE_REQUEST message and the discovery entry ID in the <discovery-update-request> element is known, as described in clause 6.2.11.3.	Stop announcing the associated ProSe application code over the PC5 interface and re-initiate the announce request procedure if the request from upper layers to announce the ProSe application ID corresponding to the associated ProSe application code is still in place.

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5062	NOTE 2	Upon receiving a ProSe restricted code or ProSe restricted code prefix with an associated T5062 timer in a DISCOVERY_RESPONSE message whose transaction ID contained in the <restricted-announce-response> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "announce" and the discovery type set to "Restrict discovery", as described in clause 6.2.3.4. Upon receiving a ProSe restricted code with an associated T5062 timer in the Update info in the <discovery-update-request> element in a DISCOVERY_UPDATE_REQUEST message and the discovery entry ID in the <discovery-update-request> element is known, as described in clause 6.2.12.3.2.	Upon receiving a new T5062 timer value for the same ProSe restricted code or ProSe restricted code prefix, or upon receiving a new T5062 timer associated with a new ProSe restricted code or ProSe restricted code prefix for the same RPAUID in a DISCOVERY_RESPONSE message. When the UE selects a new PLMN. Upon receiving a ProSe restricted code with an associated T5062 timer in the Update info in the <discovery-update-request> element in a DISCOVERY_UPDATE_REQUEST message and the discovery entry ID in the <discovery-update-request> element is known, as described in clause 6.2.12.3.2.	Stop announcing the associated ProSe restricted code over the PC5 interface if the ProSe restricted code is already allocated; and re-initiate the announce request procedure if the request from upper layers to announce the RPAUID corresponding to the associated ProSe restricted code is still in place.
T5064	NOTE 3	Upon receiving a discovery filter with an associated T5064 timer in a DISCOVERY_RESPONSE message whose transaction ID contained in the <response-monitor> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "monitor", as described in clause 6.2.4.4. Upon receiving a discovery filter in the Update info in the <discovery-update-request> element in a DISCOVERY_UPDATE_REQUEST message and the discovery entry ID in the <discovery-update-request> element is known, as described in clause 6.2.11.3.	Upon receiving a new T5064 timer value for the same discovery filter in a DISCOVERY_RESPONSE message. Upon receiving a <discovery-update-request> element in a DISCOVERY_UPDATE_REQUEST message and the discovery entry ID in the <discovery-update-request> element is known, as described in clause 6.2.11.3.	Stop using the associated discovery filter for ProSe direct discovery monitoring over the PC5 interface and re-initiate the monitor request procedure, if the request from upper layers to monitor the ProSe application ID corresponding to the associated discovery filter is still in place.

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5066	NOTE 4	Upon receiving a Restricted discovery filter with an associated T5066 timer in a DISCOVERY_RESPONSE message whose transaction ID contained in the <restricted-monitor-response> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "monitor" and the discovery type set to "Restrict discovery", as described in clause 6.2.5.4. Upon receiving a Restricted discovery filter in the Update info in the <discovery-update-request> element in a DISCOVERY_UPDATE_REQUEST message and the discovery entry ID in the <discovery-update-request> element is known, as described in clause 6.2.12.3.2.	Upon receiving one or more new T5066 timer values for the same discovery entry in a DISCOVERY_RESPONSE message. Upon receiving a Restricted discovery filter in the Update info in the <discovery-update-request> element in a DISCOVERY_UPDATE_REQUEST message and the discovery entry ID in the <discovery-update-request> element is known, as described in clause 6.2.12.3.2.	Stop using the associated Restricted discovery filter for restricted 5G ProSe direct discovery monitoring over the PC5 interface and re-initiate the monitor request procedure, if the request from upper layers to monitor the corresponding discovery target is still in place.
T5068	NOTE 5	Upon receiving a ProSe response code and discovery query filters with an associated T5068 timer in a DISCOVERY_RESPONSE message whose transaction ID contained in the <restricted-discoveree-response> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "response" and the discovery type set to "Restrict discovery", as described in clause 6.2.6.4.	Upon receiving a new T5068 timer value for the same discovery entry in a DISCOVERY_RESPONSE message. When the UE selects a new PLMN.	Stop announcing the associated ProSe response code or monitoring with the associated discovery query filter(s) over the PC5 interface and re-initiate the discoveree request procedure if the request from upper layers to announce the RPAUID in Model B is still in place.
T5070	NOTE 6	Upon receiving a ProSe query code and discovery response filters with an associated T5070 timer in a DISCOVERY_RESPONSE message whose transaction ID contained in the <restricted-discoverer-response> element matches the value sent by the UE in a DISCOVERY_REQUEST message with the command set to "query" and the discovery type set to "Restrict discovery", as described in clause 6.2.7.4.	Upon receiving a new T5070 timer value for the same discovery entry in a DISCOVERY_RESPONSE message.	Stop announcing the associated ProSe query code or monitoring with the associated discovery response filter(s) over the PC5 interface and re-initiate the discoverer request procedure if the request from upper layers to query for the same targets in Model B is still in place.

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5072	NOTE 7	Upon receiving a T5072 timer in a MATCH_REPORT_ACK message whose transaction ID contained in the <match-ack> element matches the value sent by the UE in a MATCH_REPORT message, as described in clause 6.2.8.4.	Upon receiving a new T5072 timer value for the same ProSe application code in a MATCH_REPORT_ACK message. Upon receiving a MATCH_REPORT_ACK message with a <match-reject> element containing PC3a control protocol cause value is #5.	The UE may inform the upper layers that the corresponding ProSe application ID is no longer matched.
T5074	NOTE 7	Upon receiving a T5074 timer in a MATCH_REPORT_ACK message whose transaction ID contained in the <match-ack> element matches the value sent by the UE in a MATCH_REPORT message, as described in clause 6.2.8.4.	Upon receiving a new T5074 timer value for the same ProSe application code in a MATCH_REPORT_ACK message. When the corresponding T5074 timer for the ProSe application code is stopped or expires.	The UE needs to send a Match Report on next instance it detects the corresponding ProSe application code.
T5076	NOTE 8	Upon receiving a T5076 timer in a MATCH_REPORT_ACK message whose transaction ID contained in the <restricted-match-ack> element matches the value sent by the UE in a MATCH_REPORT message, as described in clause 6.2.9.4 or 6.2.10.4.	Upon receiving a new T5076 timer value for the same ProSe restricted code or ProSe response code in a MATCH_REPORT_ACK message. Upon receiving a MATCH_REPORT_ACK message with a <match-reject> element containing PC3a control protocol cause value #5.	The UE may inform the upper layers that the corresponding RPAUID is no longer matched.
T5077	NOTE 8	Upon receiving a T5077 timer in a MATCH_REPORT_ACK message whose transaction ID contained in the <restricted-match-ack> element matches the value sent by the UE in a MATCH_REPORT message, as described in clause 6.2.9.4.	Upon receiving a new T5077 timer value for the same ProSe restricted code or ProSe response code in a MATCH_REPORT_ACK message. When the corresponding T5076 timer for the ProSe restricted code or ProSe response code is stopped or expires.	The UE needs to send a Match Report on next instance it detects the corresponding ProSe restricted code or ProSe response code.

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
NOTE 1:	The value of this timer is provided by the 5G DDNMF during the announce request and discovery update procedure for open 5G ProSe direct discovery.			
NOTE 2:	The value of this timer is provided by the 5G DDNMF during the announce request and discovery update procedure for restricted 5G ProSe direct discovery model A.			
NOTE 3:	The value of this timer is provided by the 5G DDNMF during the monitor request and discovery update procedure for open 5G ProSe direct discovery.			
NOTE 4:	The value of this timer is provided by the 5G DDNMF during the monitor request and discovery update procedure for restricted 5G ProSe direct discovery model A.			
NOTE 5:	The value of this timer is assigned by the 5G DDNMF during the discoveree request procedure for restricted 5G ProSe direct discovery model B.			
NOTE 6:	The value of this timer is assigned by the 5G DDNMF during the discoverer request procedure for restricted 5G ProSe direct discovery model B.			
NOTE 7:	The value of this timer is provided by the 5G DDNMF during the match report procedure for open 5G ProSe direct discovery.			
NOTE 8:	The value of this timer is provided by the 5G DDNMF during the match report procedure for restricted 5G ProSe direct discovery model A or match report procedure for restricted 5G ProSe direct discovery model B.			

Table 12.4.2: Timers for 5G ProSe direct discovery procedures over PC3a – 5G DDNMF side

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5061	NOTE 1	Upon assigning a ProSe application code with an associated T5060 value to the UE, as described in clause 6.2.2.3 and clause 6.2.11.2.	Upon receiving a new DISCOVERY_REQ UEST message from the UE with the command set to "announce" for the same ProSe application ID.	Delete the association between the UE, the requested ProSe application ID and the corresponding ProSe application code allocated by the 5G DDNMF.
T5063	NOTE 3	Upon assigning a ProSe restricted code or ProSe restricted code prefix with an associated T5062 value to the UE, as described in clause 6.2.3.3 and clause 6.2.12.3.1.	Upon receiving a new DISCOVERY_REQ UEST message from the UE with the command set to "announce" for the same RPAUID or discovery entry ID. Set to be the same as the discovery entry in which this timer is running.	Delete the association between the UE, the RPAUID and the corresponding ProSe restricted code or ProSe restricted code prefix allocated by the 5G DDNMF.
T5065	NOTE 2	Upon assigning a discovery filter with an associated T5064 value to the UE, as described in clause 6.2.4.3 and clause 6.2.11.2.	Upon receiving a new DISCOVERY_REQ UEST message from the UE with the command set to "monitor" for the same ProSe application ID	Delete the association between the UE, the requested ProSe application ID and the corresponding discovery filter allocated by the 5G DDNMF.
T5067	NOTE 4	Upon assigning a Restricted discovery filter with an associated T5066 value to the UE, as described in clause 6.2.5.3 and clause 6.2.12.3.1.	Upon receiving a new DISCOVERY_REQ UEST message from the UE with the command set to "monitor" and discovery entry ID set to be the same as the discovery entry in which this timer is running.	Delete the association between the UE, the RPAUID and the corresponding Restricted discovery filter allocated by the 5G DDNMF.
T5069	NOTE 5	Upon assigning a ProSe query code, ProSe response code and discovery query filter(s) with an associated T5068 value to the UE, as described in clause 6.2.6.3.	Upon receiving a new DISCOVERY_REQ UEST message from the UE with the command set to "response" for the same RPAUID or discovery entry ID. Set to be the same as the discovery entry in which this timer is running.	Delete the discovery entry in discoveree UE context which contains association between the UE, the RPAUID and the corresponding ProSe query code, ProSe response code, discovery query filter(s) allocated by the 5G DDNMF.

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5071	NOTE 6	Upon retrieving the ProSe query code, ProSe response code from discoveree UE context and assigning Discovery Response Filter(s) with an associated T5070 value to the UE, as described in clause 6.2.7.3.	Upon receiving a new DISCOVERY_REQ UEST message from the UE with the command set to "query" and discovery entry ID set to be the same as the discovery entry in which this timer is running.	Delete the discovery entry in discoverer UE context which contains the association between the UE, the RPAUID and the corresponding Discovery Response Filter(s) allocated by the 5G DDNMF.
NOTE 1: The value of this timer is assigned by the 5G DDNMF during the announce request and discovery update procedure for open 5G ProSe direct discovery. NOTE 2: The value of this timer is assigned by the 5G DDNMF during the monitor request and discovery update procedure for open 5G ProSe direct discovery. NOTE 3: The value of this timer is assigned by the 5G DDNMF during the announce request and discovery update procedure for restricted 5G ProSe direct discovery model A. NOTE 4: The value of this timer is assigned by the 5G DDNMF during the monitor request and discovery update procedure for restricted 5G ProSe direct discovery model A. NOTE 5: The value of this timer is assigned by the 5G DDNMF during the discoveree request procedure for restricted 5G ProSe direct discovery model B. NOTE 6: The value of this timer is assigned by the 5G DDNMF during the discoverer request procedure for restricted 5G ProSe direct discovery model B.				

NOTE: Multiple instances of the timers T5061, T5063, T5065, T5067, T5069 and T5071 can run simultaneously in the 5G DDNMF.

12.5 Timers for broadcast mode 5G ProSe communication over PC5 interface

Table 12.5.1: Timers for broadcast mode 5G ProSe communication over PC5

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5100	Privacy timer value for source layer-2 ID of UE for 5G ProSe communication over PC5 (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.4.	Upon initiating transmission of broadcast mode 5G ProSe communication over PC5, as described in clause 7.3.2.4. Upon receiving an indication from upper layers that the application layer identifier has been changed while performing transmission of broadcast mode 5G ProSe communication over PC5, as described in clause 7.3.2.4. Upon T5100 expiration while performing transmission of broadcast mode 5G ProSe communication over PC5, as described in clause 7.3.2.4.	Upon stopping transmission of broadcast mode V2X communication over PC5, as described in clause 7.3.2.4.	Change the value of the source layer-2 ID self-assigned by the UE for broadcast mode ProSe communication over PC5. If the data unit(s) of a ProSe application contains IP data, change the value of the source IP address self-assigned by the UE for broadcast mode 5G ProSe communication over PC5.

12.6 Timers for groupcast mode 5G ProSe communication over PC5 interface

Table 12.6.1: Timers for groupcast mode 5G ProSe direct communication over PC5

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5200	Privacy timer value for source layer-2 ID of UE for 5G ProSe communication over PC5 (see clause 5.2), which is specified in 3GPP TS 24.555 [17] clause 5.4.	Upon initiating transmission of groupcast mode 5G ProSe communication over PC5, as described in clause 7.4.2.4. Upon receiving an indication from upper layers that the application layer identifier has been changed while performing transmission of groupcast mode 5G ProSe communication over PC5, as described in clause 7.4.2.4. Upon T5200 expiration while performing transmission of groupcast mode 5G ProSe communication over PC5, as described in clause 7.4.2.4.	Upon stopping transmission of groupcast mode 5G ProSe communication over PC5, as described in clause 7.4.2.4.	Change the value of the source Layer-2 ID self-assigned by the UE for groupcast mode ProSe communication over PC5. If the data unit(s) of a ProSe application contains IP data, change the value of the source IP address self-assigned by the UE for groupcast mode 5G ProSe communication over PC5.

12.7 Timers for 5G ProSe additional parameters announcement procedure

Table 12.7: Timers for 5G ProSe additional parameters announcement

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5106	NOTE 1	Upon receiving a T5106 value in a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE message as described in clause 10.3.25.	Upon receiving one or more new T5106 timer values in a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE message.	Re-initiate the additional parameters announcement request procedure, if the upper layer application still needs to obtain NCGI or TAI of the cell serving the 5G ProSe layer-3 UE-to-network relay UE or the 5G ProSe multi-hop layer-3 UE-to-network relay UE.
T5107	NOTE 2	Upon sending a PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE message as described in clause 10.3.25.	Upon sending a new PROSE ADDITIONAL PARAMETERS ANNOUNCEMENT RESPONSE message.	Stop the cell ID or TAI announcement by the 5G ProSe layer-3 UE-to-network relay UE or the 5G ProSe multi-hop layer-3 UE-to-network relay UE in the PROSE PC5 DISCOVERY message for relay discovery additional information.
NOTE 1: The value of this timer is provided by the 5G ProSe layer-3 UE-to-network relay UE or the 5G ProSe multi-hop layer-3 UE-to-network relay UE during the 5G ProSe additional parameters announcement procedure.				
NOTE 2: The value of this timer is assigned by the 5G ProSe layer-3 UE-to-network relay UE or the 5G ProSe multi-hop layer-3 UE-to-network relay UE during the 5G ProSe additional parameters announcement procedure.				

12.8 Timers for PC8 interface

Table 12.8.1: Timers for PC8 interface - UE side

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5094	Expiration time of the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE (see clause 8.2.9.2.2).	Reception of the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE.	Stop using the old 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE.	Initiation of 5G ProSe UE-to-network relay discovery security parameters request procedure, requesting the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe remote UE.
T5095	Expiration time of the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE (see clause 8.2.9.2.2).	Reception of the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE.	Stop using the old 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE.	Initiation of 5G ProSe UE-to-network relay discovery security parameters request procedure, requesting the 5G ProSe UE-to-network relay discovery security parameters for 5G ProSe UE-to-network relay UE.
T5105	Expiration time of the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE (see clause 8a.2.12.2.2).	Reception of the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE.	Stop using the old 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE.	Initiation of 5G ProSe UE-to-UE relay discovery security parameters request procedure, requesting the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe end UE.
T5016	Expiration time of the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE (see clause 8a.2.12.2.2).	Reception of the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE.	Stop using the old 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE.	Initiation of 5G ProSe UE-to-UE relay discovery security parameters request procedure, requesting the 5G ProSe UE-to-UE relay discovery security parameters for 5G ProSe UE-to-UE relay UE.

12.9 Timers for 5G ProSe UE-to-network relay with model B

Table 12.9.1: Timers for 5G ProSe UE-to-network relay with Model B

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5108	2s	Upon sending the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe UE-to-network relay UE with which the UE has a link established	Upon receiving the PROSE PC5 DISCOVERY message for UE-to-network relay discovery response from the 5G ProSe UE-to-network relay UE with which the UE has a link established	Retransmission the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation
T5109	NOTE	Upon receiving the PROSE PC5 DISCOVERY message for UE-to-network relay discovery response used for the PROSE PC5 DISCOVERY message signal strength measurement from the 5G ProSe UE-to-network relay UE with which the UE has a link established	Upon releasing the 5G ProSe direct link with a 5G ProSe UE-to-network relay UE	Sending the PROSE PC5 DISCOVERY message for UE-to-network relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe UE-to-network relay UE with which the UE has a link established
T5125	NOTE	Upon sending the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established	Upon receiving the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response from the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established	Retransmission the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation
T5126	NOTE	Upon receiving the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery response used for the PROSE PC5 DISCOVERY message signal strength measurement from the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established	Upon releasing the 5G ProSe direct link with the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE	Sending the PROSE PC5 DISCOVERY message for multi-hop UE-to-network relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe intermediate UE-to-network relay UE or the 5G ProSe multi-hop UE-to-network relay UE with which the UE has a link established
NOTE: The value of this timer is left to implementation.				

12.10 Timers for 5G ProSe UE-to-network relay discovery security material request procedure over PC3a interface

Table 12.10.1: Timers for 5G ProSe UE-to-network relay discovery over PC3a - UE side

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5078	Expiration time of the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE (see clause 8.2.12.2.2).	Reception of the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE.	Stop using the old 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE.	Initiation of 5G ProSe UE-to-network relay discovery security material request procedure, requesting the 5G ProSe UE-to-network relay discovery security material for 5G ProSe remote UE.
T5079	Expiration time of the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE (see clause 8.2.12.2.2).	Reception of the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE.	Stop using the old 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE.	Initiation of 5G ProSe UE-to-network relay discovery security material request procedure, requesting the 5G ProSe UE-to-network relay discovery security material for 5G ProSe UE-to-network relay UE.

12.11 Timers for 5G ProSe UE-to-UE relay discovery with model B

Table 12.11.1: Timers for 5G ProSe UE-to-UE relay discovery with model B

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5110	2s	Upon sending the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe UE-to-UE relay UE with which the UE has a link established	Upon receiving the PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery response from the 5G ProSe UE-to-UE relay UE with which the UE has a link established	Retransmission the PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery solicitation
T5111	NOTE	Upon receiving the PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery response used for the PROSE PC5 DISCOVERY message signal strength measurement from the 5G ProSe UE-to-UE relay UE with which the UE has a link established	Upon releasing the 5G ProSe direct link with a 5G ProSe UE-to-UE relay UE	Sending the PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe UE-to-UE relay UE with which the UE has a link established
T5112	2s	Upon sending the PROSE PC5 DISCOVERY message for UE-to-UE relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the 5G ProSe UE-to-UE relay UE and the discoveree end UE with which the 5G ProSe UE-to-UE relay UE has a link established	Upon receiving the PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery response from the discoveree end UE with which the 5G ProSe UE-to-UE relay UE has a link established	Retransmission the PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery solicitation
T5113	NOTE	Upon receiving the PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery response used for the PROSE PC5 DISCOVERY message signal strength measurement from the discoveree end UE with which the 5G ProSe UE-to-UE relay UE has a link established	Upon releasing the 5G ProSe direct link with a 5G ProSe UE-to-UE relay UE	Sending the PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the 5G ProSe UE-to-UE relay UE and the discoveree end UE with which the 5G ProSe UE-to-UE relay UE has a link established
NOTE: The value of this timer is left to implementation.				

12.12 Timers for 5G ProSe UE-to-UE relay discovery security material request procedure over PC3a interface

Table 12.12.1: Timers for 5G ProSe UE-to-UE relay discovery over PC3a - UE side

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5103	Expiration time of the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE (see clause 8a.2.11.2.2).	Reception of the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE.	Stop using the old 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE.	Initiation of 5G ProSe UE-to-UE relay discovery security material request procedure, requesting the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe end UE.
T5104	Expiration time of the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE (see clause 8a.2.11.2.2).	Reception of the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE.	Stop using the old 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE.	Initiation of 5G ProSe UE-to-UE relay discovery security material request procedure, requesting the 5G ProSe UE-to-UE relay discovery security material for 5G ProSe UE-to-UE relay UE.

12.13 Timers for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery with model B

Table 12.13.1: Timers for 5G ProSe multi-hop layer-3 UE-to-UE relay discovery with model B

TIMER NUM.	TIMER VALUE	CAUSE OF START	NORMAL STOP	ON EXPIRY
T5211	NOTE	Upon sending the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe multi-hop UE-to-UE relay UE or the discoverer end UE with which the UE has a link established	Upon receiving the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response from the 5G ProSe multi-hop UE-to-UE relay UE or the discoverer end UE with which the UE has a link established	Retransmission the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery solicitation
T5212	NOTE	Upon receiving the PROSE PC5 DISCOVERY message for multi-hop UE-to-UE relay discovery response used for the PROSE PC5 DISCOVERY message signal strength measurement from the 5G ProSe multi-hop UE-to-UE relay UE or the discoverer end UE with which the UE has a link established	Upon releasing the 5G ProSe direct link with the 5G ProSe multi-hop UE-to-UE relay UE or the discoverer end UE	Sending the PROSE PC5 DISCOVERY message for 5G ProSe UE-to-UE relay discovery solicitation used to trigger the PROSE PC5 DISCOVERY message signal strength measurement between the UE and the 5G ProSe multi-hop UE-to-UE relay UE or the discoverer end UE with which the UE has a link established

NOTE: The value of this timer is left to implementation.

Annex A (informative): IANA registrations

A.1 IANA registrations for MIME types

A.1.1 General

IETF RFC 4288 [41], clause 9, states the process that applies in case of changes to the registry of media types. Any changes to the format after the registration with IANA would invoke this procedure.

A.1.2 application/vnd.3gpp-prose-pc3a+xml

Your Name:

<MCC name>

Your Email Address:

<MCC email address>

Media Type Name:

Application

Subtype name:

Vendor Tree – vnd.3gpp-prose-pc3a+xml

Required parameters:

None.

Optional parameters:

"charset" the parameter has identical semantics to the charset parameter of the "application/xml" media type as specified in clause 9.1 of IETF RFC 7303 [42].

Encoding considerations:

binary.

Security considerations:

Same as general security considerations for application/xml media type as specified in clause 9.1 of IETF RFC 7303 [42]. The information transported in this media type does not include active or executable content. Mechanisms for privacy and integrity protection of protocol parameters exist. Those mechanisms as well as authentication and further security mechanisms are described in 3GPP TS 33.503 [34].

This media type does not include provisions for directives that institute actions on a recipient's files or other resources.

This media type does not include provisions for directives that institute actions that, while not directly harmful to the recipient, may result in disclosure of information that either facilitates a subsequent attack or else violates a recipient's privacy in any way.

This media type does not employ compression.

Interoperability considerations:

The media type allows for interoperability of messages transmitted for 5G ProSe over the PC3a interface. The messages are sent between user equipment and mobile network.

Published specification:

3GPP TS 24.554 (<http://www.3gpp.org/ftp/Specs/html-info/24554.htm>)

Applications which use this media type:

n/a.

Fragment identifier considerations:

The handling in clause 5 of IETF RFC 7303 [42] applies.

Restrictions on usage:

None.

Provisional registration? (standards tree only):

n/a.

Additional information:

1. Deprecated alias names for this type: n/a
2. Magic number(s): n/a
3. File extension(s): n/a
4. Macintosh File Type Code(s): n/a
5. Object Identifier(s) or OID(s): n/a

Intended usage:

Common.

Other information/general comment:

The media type is intended to be used in 5G proximity service procedures.

Person to contact for further information:

- Name: <MCC name>
- Email: <MCC email address>
- Author/Change controller:
 - i) Author: 3GPP CT1 Working Group/3GPP_TSG_CT_WG1@LIST.ETSI.ORG
 - ii) Change controller: <MCC name>/<MCC email address>

A.1.2A application/vnd.3gpp-prose-pc8+xml

Your Name:

<MCC name>

Your Email Address:

<MCC email address>

Media Type Name:

Application

Subtype name:

Vendor Tree - vnd.3gpp-prose-pc8+xml

Required parameters:

None

Optional parameters:

"charset" the parameter has identical semantics to the charset parameter of the "application/xml" media type as specified in clause 9.1 of IETF RFC 7303 [42].

Encoding considerations:

binary.

Security considerations:

Same as general security considerations for application/xml media type as specified in clause 9.1 of IETF RFC 7303 [42]. The information transported in this media type does not include active or executable content. Mechanisms for privacy and integrity protection of protocol parameters exist. Those mechanisms as well as authentication and further security mechanisms are described in 3GPP TS 33.503 [34].

This media type does not include provisions for directives that institute actions on a recipient's files or other resources.

This media type does not include provisions for directives that institute actions that, while not directly harmful to the recipient, may result in disclosure of information that either facilitates a subsequent attack or else violates a recipient's privacy in any way.

This media type does not employ compression.

Interoperability considerations:

The media type allows for interoperability of messages transmitted over the PC8 interface. The messages are sent between user equipment and mobile network.

Published specification:

3GPP TS 24.554 (<http://www.3gpp.org/ftp/Specs/html-info/24554.htm>)

Applications which use this media type:

n/a.

Fragment identifier considerations:

The handling in clause 5 of IETF RFC 7303 [42] applies.

Restrictions on usage:

None.

Provisional registration? (standards tree only):

n/a.

Additional information:

1. Deprecated alias names for this type: n/a.
2. Magic number(s): n/a.
3. File extension(s): n/a.

4. Macintosh File Type Code(s): n/a.

5. Object Identifier(s) or OID(s): n/a.

Intended usage:

Common.

Other information/general comment:

The media type is intended to be used in 5G proximity service procedures.

Person to contact for further information:

- Name: <MCC name>
- Email: <MCC email address>
- Author/Change controller:
 - i) Author: 3GPP CT1 Working Group/3GPP_TSG_CT_WG1@LIST.ETSI.ORG
 - ii) Change controller: <MCC name>/<MCC email address>

A.1.3 application/vnd.3gpp-prose-pc3ach+xml

Your Name:

<MCC name>

Your Email Address:

<MCC email address>

Media Type Name:

Application

Subtype name:

Vendor Tree – vnd.3gpp-prose-pc3ach+xml

Required parameters:

None

Optional parameters:

"charset" the parameter has identical semantics to the charset parameter of the "application/xml" media type as specified in clause 9.1 of IETF RFC 7303 [42].

Encoding considerations:

binary.

Security considerations:

Same as general security considerations for application/xml media type as specified in clause 9.1 of IETF RFC 7303 [42]. The information transported in this media type does not include active or executable content. Mechanisms for privacy and integrity protection of protocol parameters exist. Those mechanisms as well as authentication and further security mechanisms are described in 3GPP TS 33.503 [34].

This media type does not include provisions for directives that institute actions on a recipient's files or other resources.

This media type does not include provisions for directives that institute actions that, while not directly harmful to the recipient, may result in disclosure of information that either facilitates a subsequent attack or else violates a recipient's privacy in any way.

This media type does not employ compression.

Interoperability considerations:

The media type allows for interoperability of messages transmitted over the PC3ach interface, including those related to transport of the usage information request of proximity services. The messages are sent between user equipment and mobile network.

Published specification:

3GPP TS 24.554 (<http://www.3gpp.org/ftp/Specs/html-info/24554.htm>)

Applications which use this media type:

n/a

Fragment identifier considerations:

The handling in clause 5 of IETF RFC 7303 [42] applies.

Restrictions on usage:

None

Provisional registration? (standards tree only):

n/a

Additional information:

1. Deprecated alias names for this type: n/a
2. Magic number(s): n/a
3. File extension(s): n/a
4. Macintosh File Type Code(s): n/a
5. Object Identifier(s) or OID(s): n/a

Intended usage:

Common.

Other information/general comment:

The media type is intended to be used in proximity service procedures.

Person to contact for further information:

- Name: <MCC name>
- Email: <MCC email address>
- Author/Change controller:
 - i) Author: 3GPP CT1 Working Group/3GPP_TSG_CT_WG1@LIST.ETSI.ORG
 - ii) Change controller: <MCC name>/<MCC email address>

Annex B (informative): Change history

Change history							
Date	Meeting	TDoc	CR	R ev	C at	Subject/Comment	New version
2021-02	CT1#128 e	C1-211183				Draft skeleton provided by the rapporteur.	0.0.0
2021-02	CT1#128 e	C1-211184				Implementing the following p-CR agreed by CT1: C1-211184 Editorial change from the rapporteur.	0.1.0
2021-04	CT1#129 e					Implementing the following p-CR agreed by CT1: C1-212046, C1-212274, C1-212275, C1-212276, C1-212383, C1-212384, C1-212385, C1-212468, C1-212469, C1-212470, C1-212472, C1-212474, C1-212475, C1-212477, C1-212488, C1-212495, C1-212498, C1-212505, C1-212507, C1-212531, C1-212572, C1-212574, C1-212579, C1-212586, C1-212587, C1-212588, C1-212589, C1-212590, C1-212591, C1-212592, C1-212594 Editorial change from the rapporteur. Correction from the rapporteur.	0.2.0
2021-05	CT1#130 e					Implementing the following p-CR agreed by CT1: C1-213020, C1-213755, C1-213043, C1-213044, C1-213045, C1-213046, C1-213202, C1-213674, C1-213203, C1-213205, C1-213568, C1-213569, C1-213570, C1-213571, C1-213572, C1-213843, C1-213802, C1-213770, C1-213768, C1-213767, C1-213667, C1-213668, C1-213670, C1-213671, C1-213756 Editorial change from the rapporteur. Correction from the rapporteur.	0.3.0
2021-08	CT1#131 e					Implementing the following p-CR agreed by CT1: C1-215037, C1-215038, C1-215119, C1-215036, C1-215039, C1-214813, C1-214794, C1-215127, C1-215060, C1-215113, C1-215140, C1-215058, C1-215110, C1-215107, C1-215141, C1-215072, C1-214597, C1-214951, C1-215069, C1-215066, C1-215067, C1-214334, C1-214469, C1-214313, C1-214595, C1-214312 Editorial change from the rapporteur. Correction from the rapporteur.	0.4.0
2021-10	CT1#132 e					Implementing the following p-CR agreed by CT1: C1-216106 C1-216038, C1-216034, C1-216182, C1-216190, C1-216159, C1-215616, C1-216155, C1-216107, C1-215844, C1-215620, C1-216191, C1-216175, C1-216189, C1-216160, C1-216158, C1-216156, C1-216186, C1-216037, C1-216041, C1-216183, C1-215615, C1-216147, C1-216184, C1-216035, C1-216095, C1-216036, C1-216188, C1-215829 Editorial change from the rapporteur. Correction from the rapporteur.	0.5.0
2021-12	CT#94-e					Implementing the following p-CR agreed by CT1: C1-216701 C1-216704, C1-216776, C1-216896, C1-216990, C1-216991, C1-216992, C1-217005, C1-217119, C1-217145, C1-217148, C1-217149, C1-217164, C1-217193, C1-217194, C1-217270, C1-217362, C1-217363, C1-217364, C1-217391, C1-217394, C1-217398, C1-217403, C1-217408 Editorial change from the rapporteur. Correction from the rapporteur.	1.0.0
2022-01	CT1#133 bis-e					Implementing the following p-CR agreed by CT1: C1-220489, C1-220494, C1-220497, C1-220498, C1-220499, C1-220500, C1-220601, C1-220633, C1-220634, C1-220635, C1-220636, C1-220637, C1-220638, C1-220639, C1-220686, C1-220688, C1-220745, C1-220746, C1-220752, C1-220775, C1-220777, C1-220779, C1-220781, C1-220782, C1-220789, C1-220791, C1-220794, C1-220803, C1-220805, C1-220807 Editorial change from the rapporteur. Correction from the rapporteur.	1.1.0
2022-02	CT1#134 e					Implementing the following p-CR agreed by CT1: C1-221149, C1-221154, C1-221158, C1-221163, C1-221312, C1-221492, C1-221494, C1-221495, C1-221496, C1-221499, C1-221501, C1-221506, C1-221508, C1-221509, C1-221570, C1-221571, C1-221572, C1-221574, C1-221782, C1-221783, C1-221837, C1-221863, C1-221864, C1-221873, C1-221875, C1-221877, C1-221879, C1-221880, C1-221949 Editorial change from the rapporteur. Correction from the rapporteur.	1.2.0
2022-03	CT#95e					TS 24.554 v2.0.0 presented to TSG for approval	2.0.0
2022-03	CT#95e					TS 24.554 v17.0.0 created by MCC after CT#95e	17.0.0
2022-06	CT#96	CP-221241	0001	1	B	DRX configuration parameters and Tx profiles	17.1.0
2022-06	CT#96	CP-221241	0003	1	F	Privacy timer for U2N relay	17.1.0
2022-06	CT#96	CP-221241	0004	1	F	Ciphering algorithm exchange between UE and DDNMF	17.1.0
2022-06	CT#96	CP-221209	0005	2	F	RRC container in L2 relay discovery message	17.1.0
2022-06	CT#96	CP-221241	0006	1	F	L2 relay not using authentication over PC5	17.1.0

2022-06	CT#96	CP-221209	0007	2	B	ProSe remote user key procedure	17.1.0
2022-06	CT#96	CP-221209	0008	3	B	PC5-S for forwarding EAP message	17.1.0
2022-06	CT#96	CP-221241	0010	-	F	IANA registration for MIMIE types for 5G ProSe	17.1.0
2022-06	CT#96	CP-221210	0011	2	B	General parts for procedures for PC8 interface	17.1.0
2022-06	CT#96	CP-221242	0012	1	B	5G ProSe UE-to-network relay discovery security parameters request procedure for PC8 interface	17.1.0
2022-06	CT#96	CP-221210	0014	3	B	Key request procedure for PC8 interface	17.1.0
2022-06	CT#96	CP-221242	0015	1	B	Handling of unknown, unforeseen and erroneous protocol data for PC8 interface	17.1.0
2022-06	CT#96	CP-221242	0016	1	B	Timers for PC8 interface	17.1.0
2022-06	CT#96	CP-221241	0017	-	F	Clarifications on 5G ProSe direct discovery procedure over PC5 interface	17.1.0
2022-06	CT#96	CP-221241	0018	-	F	Resolving Editor's Notes in match report procedures	17.1.0
2022-06	CT#96	CP-221241	0019	-	F	Corrections for UTC-based counter LSB parameter	17.1.0
2022-06	CT#96	CP-221241	0020	1	F	Resolving Editor's Notes in 5G ProSe UE-to-network relay discovery over PC5 procedures	17.1.0
2022-06	CT#96	CP-221241	0021	1	F	Update to configuration parameters	17.1.0
2022-06	CT#96	CP-221241	0022	1	F	Update to direct link establishment for 5G ProSe layer 3 relay	17.1.0
2022-06	CT#96	CP-221241	0023	1	F	Update to Mobility Restrictions for 5G ProSe UE-to-Network Relaying	17.1.0
2022-06	CT#96	CP-221241	0024	1	F	Update to QoS handling for layer-3 relay with N3IWF	17.1.0
2022-06	CT#96	CP-221242	0025	1	F	New cause for direct link release	17.1.0
2022-06	CT#96	CP-221242	0026	1	F	Update to QoS flow handling for L3 U2N relay	17.1.0
2022-06	CT#96	CP-221209	0027	2	F	Clarification on different source L2 IDs for discovery and communication	17.1.0
2022-06	CT#96	CP-221242	0028	1	B	Add target user ID in relay discovery solicitation message	17.1.0
2022-06	CT#96	CP-221209	0029	2	F	Correction on 5G ProSe direct discovery over PC5 when UE not in coverage	17.1.0
2022-06	CT#96	CP-221242	0030	1	F	Handling of destination layer-2 ID collision for direct discovery and direct communication in the UE	17.1.0
2022-06	CT#96	CP-221242	0031	1	F	Clarification on the initiating UE stopping passing the same PROSE PC5 DISCOVERY message to lower layers	17.1.0
2022-06	CT#96	CP-221209	0039	4	F	Changes to Match report message for MIC check	17.1.0
2022-06	CT#96	CP-221241	0040	-	F	PC5 discovery message encoding changes for security protection	17.1.0
2022-06	CT#96	CP-221241	0041	1	B	ProSe application traffic descriptor introduction	17.1.0
2022-06	CT#96	CP-221209	0042	2	B	Relay Service Code Privacy Protection	17.1.0
2022-06	CT#96	CP-221241	0044	1	F	Rejection of 5G ProSe direct link due to unsuccessful PDU session establishment by L3 relay UE	17.1.0
2022-06	CT#96	CP-221241	0045	1	F	Rejection of PC5 link modification due to lack of packet filters for the PDU session	17.1.0
2022-06	CT#96	CP-221241	0046	-	F	Release of PC5 link by an L2 remote UE due to mobility management back-off timer	17.1.0
2022-06	CT#96	CP-221209	0047	2	B	Pending indication for PDU session with secondary authentication for remote UE	17.1.0
2022-06	CT#96	CP-221241	0048	1	F	Clarification on 5G PKMF	17.1.0
2022-06	CT#96	CP-221242	0050	1	F	Harmonizing the terminologies LSBs of KNRP ID and MSBs of KNRP ID	17.1.0
2022-06	CT#96	CP-221242	0051	1	F	Unifying the terminologies of 5G ProSe UE-to-network relay UE and 5G ProSe remote UE	17.1.0
2022-06	CT#96	CP-221241	0052	-	F	Correction for the privacy timer of 5G ProSe transmission over PC5	17.1.0
2022-06	CT#96	CP-221242	0053	1	F	Security protection of the restricted 5G ProSe Direct Discovery messages over PC5	17.1.0
2022-06	CT#96	CP-221241	0055	-	F	Replacing configured PC5 security policies with the PC5 security policies received during restricted 5G ProSe direct discovery procedures	17.1.0
2022-06	CT#96	CP-221241	0057	-	B	Signalling integrity protection policy for layer-2 UE-to-network relay	17.1.0
2022-06	CT#96	CP-221241	0058	-	B	Configuring PC5 security policies for layer-2 UE-to-network relay	17.1.0
2022-06	CT#96	CP-221242	0059	1	F	UE-to-network relay unicast direct communication procedures over PC5 interface	17.1.0
2022-06	CT#96	CP-221242	0061	1	F	Applicability of 5G ProSe direct link authentication procedure to UE-to-network relay	17.1.0
2022-06	CT#96	CP-221242	0062	1	F	Resolving the ENs related to possible changes to the 5G ProSe direct link establishment procedure due to the security requirements of UE-to-network relay	17.1.0
2022-06	CT#96	CP-221242	0063	1	B	Resolving the EN related to possible changes to the 5G ProSe direct link re-keying procedure due to the security requirements of UE-to-network relay	17.1.0
2022-06	CT#96	CP-221241	0064	-	F	Resolving the EN related to possible changes to the 5G ProSe direct link release procedure due to the security requirements of UE-to-network relay	17.1.0
2022-06	CT#96	CP-221210	0065	3	B	Resolving the EN related to possible changes to the 5G ProSe direct link security mode control procedure due to the security requirements of UE-to-network relay	17.1.0

2022-06	CT#96	CP-221242	0066	1	B	Introducing KNRP freshness parameter 1 and KNRP freshness parameter 2	17.1.0
2022-06	CT#96	CP-221242	0067	1	B	Introducing the GBA Push Info (GPI) in the 5G ProSe direct link security mode control procedure	17.1.0
2022-06	CT#96	CP-221210	0068	3	B	Handling of synchronization failure for 5G ProSe UE-to-network relay security	17.1.0
2022-06	CT#96	CP-221242	0069	1	B	Triggering 5G ProSe direct link release procedure due to secondary authentication failure	17.1.0
2022-06	CT#96	CP-221209	0071	2	F	Authorization to use Model A and Model B for 5G ProSe UE-to-network relay discovery	17.1.0
2022-06	CT#96	CP-221209	0072	-	B	References, definitions and abbreviations for 5G ProSe charging	17.1.0
2022-06	CT#96	CP-221210	0074	2	B	Transport protocol for PC3ch Control Protocol for 5G ProSe direct communication	17.1.0
2022-06	CT#96	CP-221209	0078	1	B	Charging information collection for 5G ProSe Direct Discovery	17.1.0
2022-06	CT#96	CP-221209	0079	-	B	IANA registrations for MIME types for 3gpp-5g-prose-pc3ch+xml	17.1.0
2022-06	CT#96	CP-221210	0080	3	F	Update to configuration by application server	17.1.0
2022-06	CT#96	CP-221210	0081	1	F	UE not providing SUPI in PC3a messages	17.1.0
2022-06	CT#96	CP-221210	0082	1	B	PC8 messages XML elements, semantic and parameters	17.1.0
2022-06	CT#96	CP-221210	0085	1	B	Precedence between the 5G PKMF address provided in the ProSeP by the PCF and by the 5G DDNMF	17.1.0
2022-06	CT#96	CP-221209	0086	-	F	Provisioning of ProSe NR frequencies associated with the ProSe identifier for unicast communication mode to lower layers	17.1.0
2022-06	CT#96	CP-221209	0089	-	F	Correction on indication in L2 relay UE to send SR	17.1.0
2022-06	CT#96	CP-221209	0091	1	D	Editorial changes	17.1.0
2022-06	CT#96	CP-221210	0093	2	F	Rejection of 5G ProSe direct link due to congestion at the 5GSM layer in the layer-3 UE to network relay	17.1.0
2022-06	CT#96	CP-221210	0094	1	B	The impact of NR Tx profile on the transmission and reception of Broadcast and Groupcast modes of 5G ProSe communication	17.1.0
2022-06	CT#96	CP-221210	0095	1	B	Introducing the validity timer of the security related parameters for discovery	17.1.0
2022-06	CT#96	CP-221210	0096	1	F	Applicability of Key establishment information container IE to the security of the UE-to-network relay	17.1.0
2022-06	CT#96	CP-221210	0097	1	F	Some miscellaneous corrections for 5G ProSe	17.1.0
2022-06	CT#96	CP-221209	0098	-	F	Correcting missing implementation related to security preservation for 5G ProSe	17.1.0
2022-06	CT#96	CP-221209	0099	-	F	Correction for the cases of deleting the old security context for 5G ProSe	17.1.0
2022-06	CT#96	CP-221210	0100	1	B	Rejecting PC5 connection establishment request upon security failure	17.1.0
2022-06	CT#96	CP-221210	0101	1	B	UE-to-network relay reselection upon security failure	17.1.0
2022-06	CT#96	CP-221210	0102	1	F	Adding 5G PKMF address request procedure in general clause	17.1.0
2022-06	CT#96	CP-221210	0103	1	F	Clarification on performing 5G ProSe direct discovery over PC5	17.1.0
2022-06	CT#96	CP-221210	0104	1	B	PKMF address request procedure over PC3a interface	17.1.0
2022-06	CT#96	CP-221210	0105	1	F	Clarification regarding the application identity used in the 5G ProSe direct discovery procedures - ALT. B	17.1.0
2022-06	CT#96	CP-221209	0106	-	F	Remove the default destination layer-2 ID in direct communication when provisioning	17.1.0
2022-06	CT#96	CP-221209	0107	-	F	Some editorial corrections	17.1.0
2022-06	CT#96	CP-221210	0108	-	F	Adding DRX handling for unicast communication procedures	17.1.0
2022-06	CT#96	CP-221072	0073	2	B	Usage information reporting configuration in the UE	17.1.0
2022-06	CT#96	CP-221073	0075	2	B	Procedures for PC3ch Control Protocol for 5G ProSe direct communication	17.1.0
2022-06	CT#96	CP-221074	0076	2	B	Messages transmitted over the PC3ch interface	17.1.0
2022-06	CT#96	CP-221075	0077	2	B	Formats for messages transmitted over the PC3ch interface	17.1.0
2022-09	CT#97e	CP-222144	0113	-	F	PC8 messages XML elements, semantic and parameters	17.2.0
2022-09	CT#97e	CP-222144	0117	-	F	Corrections for PC8 interface to remove PC5 security policies from key accept	17.2.0
2022-09	CT#97e	CP-222144	0120	1	F	Correction on L2 relay UE selection	17.2.0
2022-09	CT#97e	CP-222144	0121	1	F	Update match report procedures based on 33.503	17.2.0
2022-09	CT#97e	CP-222144	0123	1	F	Add the timer for AA message reliable transport procedure	17.2.0
2022-09	CT#97e	CP-222144	0125	1	F	Privacy timer for relay	17.2.0
2022-09	CT#97e	CP-222144	0127	-	F	PC5 QoS flows handling initiated by the 5G ProSe layer-3 remote UE	17.2.0
2022-09	CT#97e	CP-222144	0137	-	F	Correction on the name of the interface for usage information collection	17.2.0
2022-09	CT#97e	CP-222144	0138	-	F	Correction on message names	17.2.0
2022-09	CT#97e	CP-222144	0147	-	B	Providing the EAP message in the SMC procedure for the EAP success case	17.2.0
2022-09	CT#97e	CP-222144	0148	-	B	Providing the EAP message in the DCR procedure for the EAP failure case	17.2.0
2022-09	CT#97e	CP-222144	0152	-	F	Harmonizing the terminologies of 5G ProSe remote UE and 5G ProSe UE-to-network relay UE across the specification	17.2.0
2022-09	CT#97e	CP-222144	0154	-	B	Providing the discovery security material for UE-to-network relay from 5G DDNMF	17.2.0
2022-09	CT#97e	CP-222144	0155	-	F	Correction to timer numbers that are used for UE-to-network relay discovery security parameters request over PC8 interface	17.2.0

2022-09	CT#97e	CP-222144	0156	-	F	The use of UE-to-network relay discovery security parameters request procedure over PC8 interface	17.2.0
2022-09	CT#97e	CP-222144	0157	-	F	Correcting the cause code UE authorisation failure and other corrections.	17.2.0
2022-09	CT#97e	CP-222144	0158	-	F	Null algorithm is not security deactivation for 5G ProSe	17.2.0
2022-09	CT#97e	CP-222145	0112	1	F	Corrections for PC8 interface to indicate PRUK ID in key accept	17.2.0
2022-09	CT#97e	CP-222145	0114	1	F	Correcting timing of initiation of 5G ProSe remote user key request procedure	17.2.0
2022-09	CT#97e	CP-222145	0115	1	F	Correction for inclusion of HPLMN ID	17.2.0
2022-09	CT#97e	CP-222145	0119	1	C	Remove secondary authentication for U2N relay related context	17.2.0
2022-09	CT#97e	CP-222145	0124	2	F	Security protection on establishment request message for relay	17.2.0
2022-09	CT#97e	CP-222145	0126	1	F	New pre-condition for direct link establishment procedure initiation	17.2.0
2022-09	CT#97e	CP-222145	0128	1	F	Clarification on 5G ProSe direct link release procedure	17.2.0
2022-09	CT#97e	CP-222145	0129	1	F	Protocol data unit type used over user plane for NR PC5	17.2.0
2022-09	CT#97e	CP-222145	0130	1	F	Non-IP PDU transport procedure	17.2.0
2022-09	CT#97e	CP-222145	0133	1	F	Clarification on 5G DDNMF discovery	17.2.0
2022-09	CT#97e	CP-222145	0136	1	F	Addition of abnormal cases	17.2.0
2022-09	CT#97e	CP-222145	0141	1	B	The determination of using the control plane security solution for the 5G ProSe UE-to-network relay	17.2.0
2022-09	CT#97e	CP-222145	0159	1	F	Defining the abnormal cases and the timer used for 5G ProSe AA message reliable transport procedure	17.2.0
2022-09	CT#97e	CP-222145	0160	1	F	Resolving EN on mapping with the traffic descriptor in the ProSeP	17.2.0
2022-09	CT#97e	CP-222146	0111	2	F	PLMN ID IE definition	17.2.0
2022-09	CT#97e	CP-222146	0116	1	F	Correction of PRUK ID coding	17.2.0
2022-09	CT#97e	CP-222146	0118	1	F	Requesting UE policies for 5G ProSe usage information reporting	17.2.0
2022-09	CT#97e	CP-222146	0143	1	F	Clarification on the condition of including HPLMN ID in the DCR message	17.2.0
2022-09	CT#97e	CP-222146	0144	1	F	Clarifications for the Privacy Protection of Relay Service Code	17.2.0
2022-09	CT#97e	CP-222146	0145	1	B	Introducing the 5GPRUK ID in the DCR procedure	17.2.0
2022-09	CT#97e	CP-222146	0146	1	B	Introducing the 5GPRUK ID in the 5G ProSe direct link re-keying procedure	17.2.0
2022-09	CT#97e	CP-222146	0149	1	F	Clarification on the security procedure for Layer-3 UE-to-Network Relay with N3IWF support	17.2.0
2022-09	CT#97e	CP-222146	0150	1	B	Integrity protection of the DCR message for UE-to-network relay	17.2.0
2022-09	CT#97e	CP-222146	0151	1	F	Corrections related to 5G ProSe layer-3 UE-to-network relay with N3IWF support	17.2.0
2022-09	CT#97e	CP-222146	0153	1	F	The criteria for selecting 5G ProSe layer-3 UE-to-network relay with N3IWF support	17.2.0
2022-09	CT#97e					Corrections suggested by the rapporteur done by MCC	17.2.1
2022-12	CT#98e	CP-223149	0174	1	F	Single PC5 link between remote UE and the relay	17.3.0
2022-12	CT#98e	CP-223149	0175	1	F	Correction on some bullet logic and editorial changes	17.3.0
2022-12	CT#98e	CP-223148	0177	3	F	Alignment of Remote UE behaviours on PC5 unicast link establishment	17.3.0
2022-12	CT#98e	CP-223148	0179	1	F	Apply PC5 DRX to Layer-2 relay	17.3.0
2022-12	CT#98e	CP-223149	0181	1	F	Some clarifications related to the security mode control procedure	17.3.0
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