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Contents

Foreword

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

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1 Scope.

The present document is part of a series of documents that specify charging functionality and charging management in 3GPP networks. The 3GPP core network charging architecture and principles are specified in TS 32.240 [1], which provides an umbrella for other charging management TSs that specify:

- the content of the CDRs per domain / subsystem / service (offline charging);
- the content of real-time charging messages per domain / subsystem / service (online charging);
- the functionality of online and offline charging for those domains / subsystems / services;
- the interfaces that are used in the charging framework to transfer the charging information (i.e. CDRs or charging events).

The complete document structure for these TSs is defined in TS 32.240 [1].

The present document specifies the converged offline and online charging description for the 5G Data Connectivity domain based on the functional stage 2 description in TS 23.501 [200], TS 23.502 [201] and TS 23.503 [202].

This charging description includes the converged offline and online charging architecture and scenarios specific to the 5G Data Connectivity domain, as well as the mapping of the common 3GPP charging architecture specified in TS 32.240 [1] onto the 5G Data Connectivity domain.

It further specifies the structure and content of the CDRs for offline charging, and the charging events for converged online and offline charging. The present document is related to other 3GPP charging TSs as follows:

- The common 3GPP charging architecture is specified in TS 32.240 [1].
- The parameters, abstract syntax and encoding rules for the CDRs are specified in TS 32.298 [51].
- A transaction based mechanism for the transfer of CDRs within the network is specified in TS 32.295 [54].
- The file based mechanism used to transfer the CDRs from the network to the operator's billing domain (e.g. the billing system or a mediation device) is specified in TS 32.297 [52].
- The services, operations and procedures of charging, using Service Based Interface are specified in TS 32.290 [57].
- The charging service of 5G system is specified in TS 32.291 [58].

All references, abbreviations, definitions, descriptions, principles and requirements, used in the present document, that are common across 3GPP TSs, are defined in TR 21.905 [100]. Those that are common across charging management in 3GPP networks/domains, services or subsystems are provided in the umbrella TS 32.240 [1] and are copied into clause 3 of the present document for ease of reading. Finally, those items that are specific to the present document are defined exclusively in the present document.

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 TS 32.240: "Telecommunication management; Charging management; Charging architecture and principles".

[2] - [50] Void.

[51] 3GPP TS 32.298: "Telecommunication management; Charging management; Charging Data Record (CDR) parameter description".

[52] 3GPP TS 32.297: "Telecommunication management; Charging management; Charging Data Record (CDR) file format and transfer".

[53] Void.

[54] 3GPP TS 32.295: "Telecommunication management; Charging management; Charging Data Record (CDR) transfer".

[55-56] Void.

[57] 3GPP TS 32.290: "Telecommunication management; Charging management; 5G system; Services, operations and procedures of charging using Service Based Interface (SBI)".

[58] 3GPP TS 32.291: "5G system; Charging service, stage 3".

[59] - [99] Void.

[100] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[101] 3GPP TS 22.115: "Service aspects; Charging and billing".

[102] 3GPP TS 22.261: "Service requirements for next generation new services and markets".

[103] - [199] Void

[200] 3GPP TS 23.501:"System Architecture for the 5G System".

[201] 3GPP TS 23.502:"Procedures for the 5G System".

[202] 3GPP TS 23.503:"Policy and Charging Control Framework for the 5G System; Stage 2".

[203] - [299] Void

[300] - [399] Void.

[400] - [499] Void.

[500] - [599] Void.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [100] 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 [100].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Bd Reference point for the CDR file transfer from the 5G Data connectivity CGF to the BD.
Ga Reference point for CDR transfer between a CDF and the CGF.
Nchf Service based interface exhibited by CHF.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [100] 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 [100].

5GC	5G Core Network
5GS	5G System
ABMF	Account Balance Management Function
AF	Application Function
AMF	Access and Mobility Management Function
AUSF	Authentication Server Function
BD	Billing Domain
CCS	Converged Charging System
CDF	Charging Data Function
CGF	Charging Gateway Function
CHF	Charging Function
CP	Control Plane
CTF	Charging Trigger Function
DNN	Data Network Name
FBC	Flow Based Charging
GPSI	Generic Public Subscription Identifier
GUAMI	Globally Unique AMF Identifier
N3IWF	Non-3GPP InterWorking Function
NE	Network Element
NEF	Network Exposure Function
NF	Network Function
NRF	Network Repository Function
NSSF	Network Slice Selection Function
OCF	Online Charging Function
OCS	Online Charging System
PCC	Policy and Charging Control
PCF	Policy Control Function
PEI	Permanent Equipment Identifier
QBC	Qos flow Based Charging
QFI	QoS Flow Identifier
SMF	Session Management Function
SSC	Session and Service Continuity
SUPI	Subscription Permanent Identifier
UDM	Unified Data Management
UDR	Unified Data Repository
UPF	User Plane Function

4 Architecture considerations

4.1 High-level 5G System architecture

4.1.1 Non-roaming reference architecture

Figure 4.1.1.1 shows the 5G System high level architecture as defined in TS 23.501 [200] for 5G data connectivity, in the service-based representation for Control Plane (CP) Network Functions.

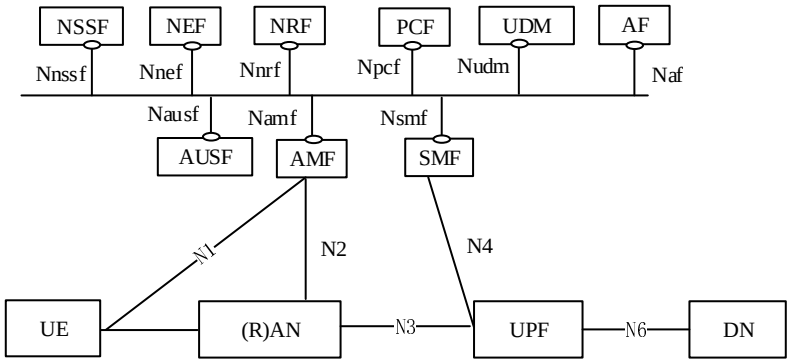

Figure 4.1.1.1: 5G System architecture

4.1.2 Roaming Home Routed reference architecture

Figure 4.1.2.1 shows the 5G System high level Roaming Home Routed architecture as defined in TS 23.501 [200] for 5G data connectivity, in the service-based representation for Control Plane (CP) Network Functions.

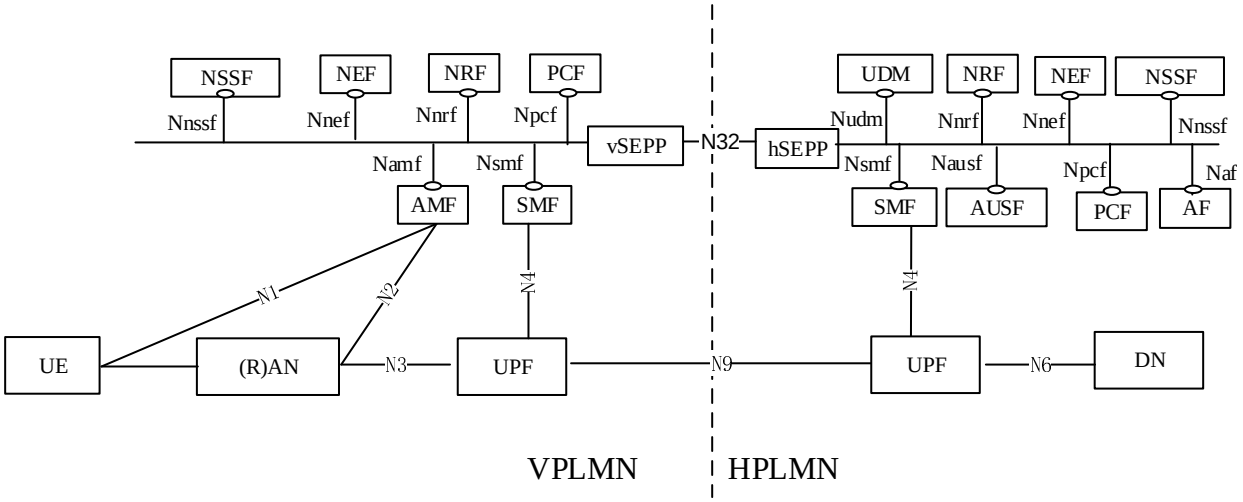

Figure 4.1.2.1: Roaming 5G System architecture - home routed scenario in service-based interface representation

4.1.3 Interworking with EPC architecture

Figure 4.1.3.1 shows the non-roaming architecture for interworking between 5GS and EPC/E-UTRAN as defined in TS 23.501 [200] for 5G data connectivity.

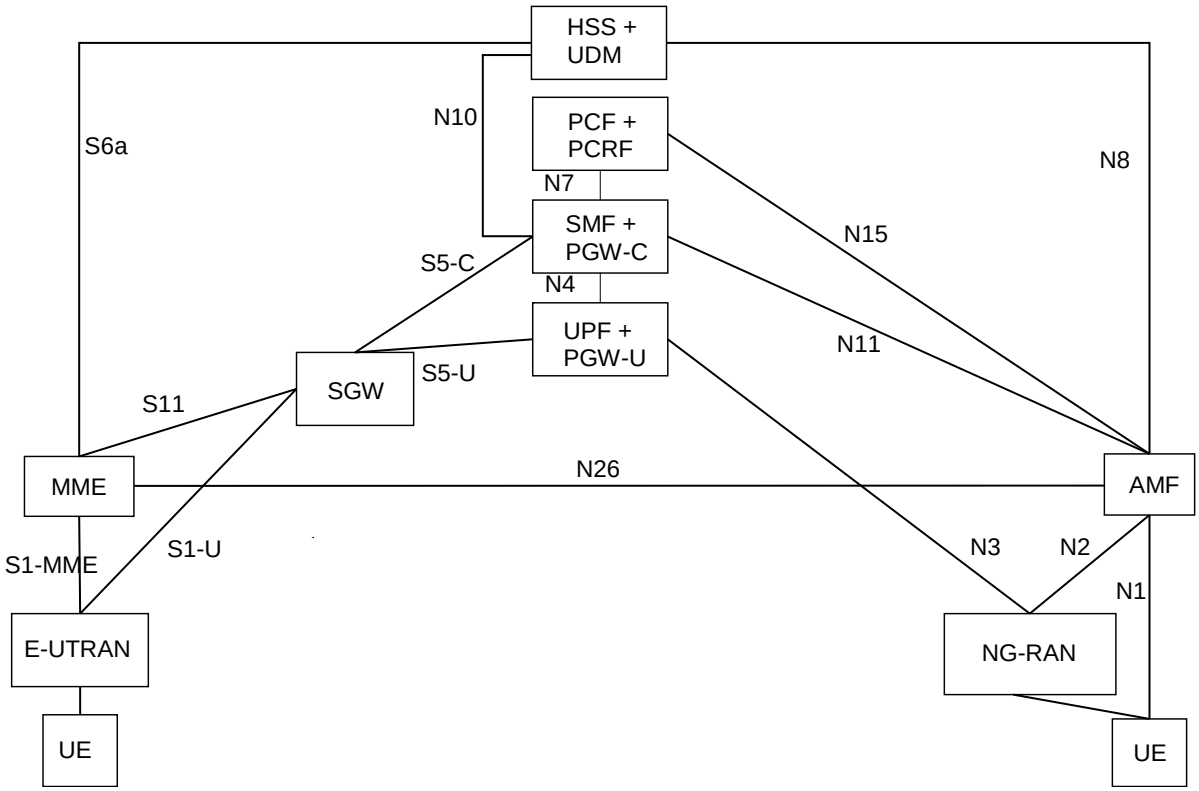

Figure 4.1.3.1: Non-roaming architecture for interworking between 5GS and EPC/E-UTRAN

4.1.4 Architecture reference for Non-3GPP Accesses

Figure 4.1.4.1 shows the non-roaming architecture for Non-3GPP Accesses as defined in TS 23.501 [200] for 5G data connectivity.

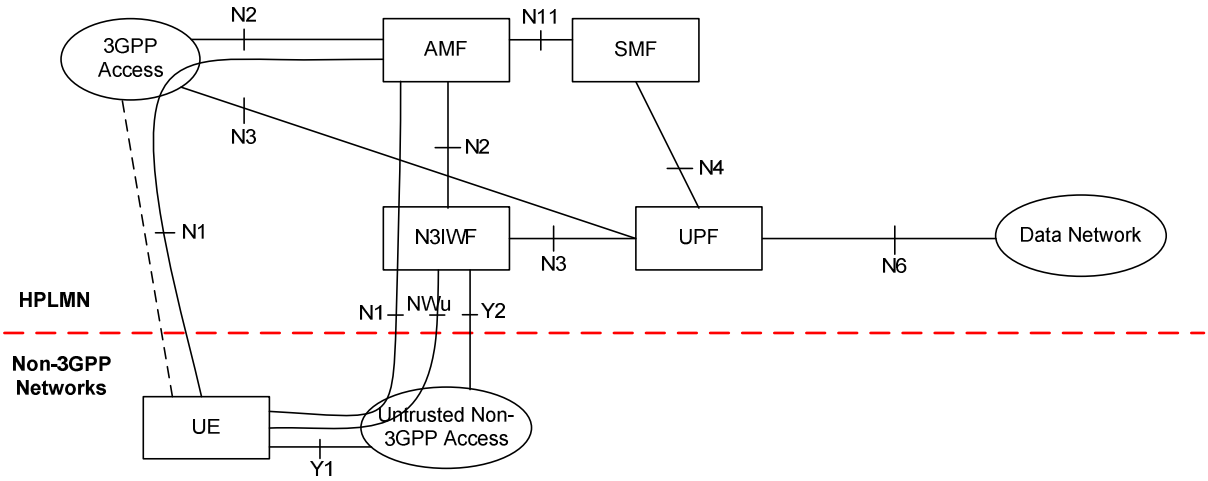

Figure 4.1.4.1: Non-roaming architecture for Non-3GPP Accesses

This reference architecture supports service based interfaces for AMF, SMF and other NFs not represented in the figure.

4.2 5G data connectivity domain converged charging architecture

The SMF embedding the CTF, generates charging events towards the CHF for PDU connectivity converged online and offline charging.

As described in TS 32.240 [1], the CTF generates charging events towards to the CHF for converged online and offline charging processing. The CDRs generation is performed by the CHF acting as a CDF, which transfers them to the CGF. Finally, the CGF creates CDR files and forwards them to the BD.

If the CGF is external, the CHF acting as a CDF, forwards the CDRs to the CGF across the Ga interface.
If the CGF is integrated, there is only one internal interface between the CHF and the CGF. In this case, the relationship between CHF and CGF is 1:1. An integrated CGF may support the Ga interface from other CDFs.

When an external CGF is used, this CGF may also be used by other, i.e. non-5GCS, network elements, according to network design and operator decision. It should be noted that the CGF may also be an integrated component of the BD – in this case, the Bd interface does not exist and is replaced by a proprietary solution internal to the BD.

Figure 4.2.1 depicts the architectural options for converged charging.

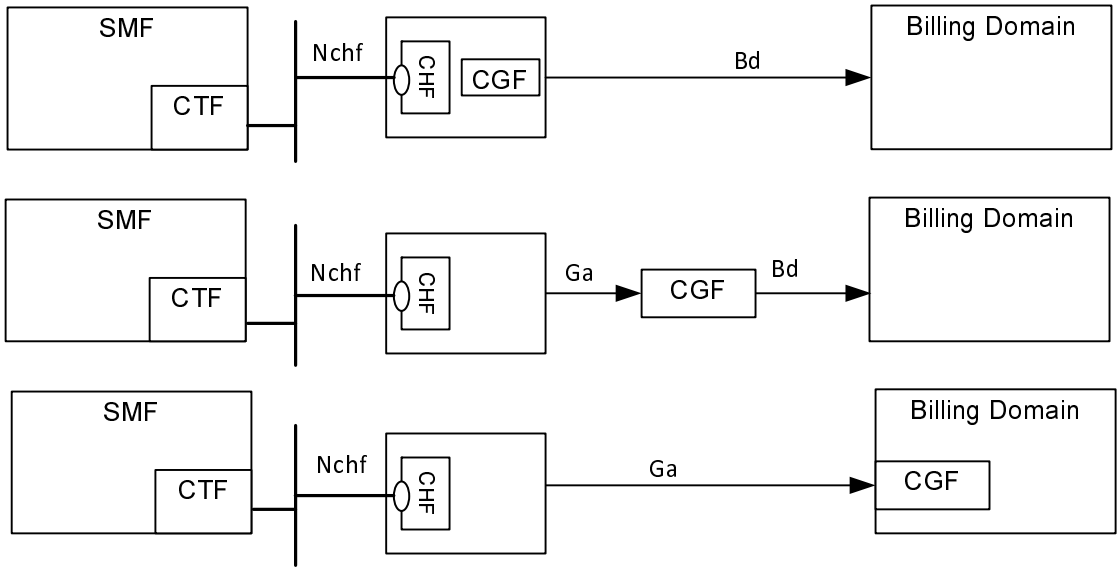

Figure 4.2.1: 5G data connectivity converged charging architecture

Nchf is described in clauses 5.2.1 and 5.2.2, Ga in clause 5.2.4 and Bd in clause 5.2.5.

5 5G data connectivity charging principles and scenarios

5.1 5G data connectivity charging principles

5.1.1 General

The charging functions specified for the 5G data connectivity charging:

- PDU session in SMF, refer to TS 23.501 [200];

- service data flows, within PDU session, refer to TS 23.503 [202].
- QoS flows within PDU session refer to TS 23.501 [200] and TS 23.503 [202].

5.1.2 Requirements

The following are high-level charging requirements specific to the packet domain, derived from the requirements in TS 22.115 [101], TS 22.261 [102], TS 23.501 [200], TS 23.502 [201] and TS 23.503 [202].

- The SMF shall support converged online and offline charging.
- The SMF shall support PDU session charging using service based interface.
- The SMF shall support network slice instance charging.
- The SMF shall collect charging information per PDU session for UEs served under 3GPP access and non-3GPP access.
- Every PDU session shall be assigned a unique identity number for billing purposes per PLMN. (i.e. the Charging Id).
- Data volumes on both the uplink and downlink directions shall be counted separately. The data volumes shall reflect the data as delivered to and forwarded from the user.
- The charging mechanisms shall provide the date and time information when the PDU session starts.
- The SMF shall be capable of handling the Charging Characteristics. Charging Characteristics can be specific to a subscription or subscribed DNN.
- The SMF may be capable of identifying data volumes, elapsed time or events for individual service data flows (flow based charging). One PCC rule identifies one service data flow.
- SMF shall allow reporting of the service or the detected application usage per rating group or per combination of the rating group and service id. This reporting level can be activated per PCC rule.
- The quota management shall be per rating group per PDU session.
- If there are multiple UPFs for one PDU session, the quota management may be one for all UPFs or separate per UPF and the usage and charging information reporting per UPF.
- The SMF shall support charging for PDU Session types of IP, Ethernet and Unstructured.
- In Home Routed scenario, the SMF shall collect charging information per PDU session and, based on Home Operator policy and agreement between Home and Visit Operators, shall be able to collect charging information per Qos Flow for in-bound and out-bound roamers in Home Routed scenario.
- For interworking between 5GS and EPC, the dedicated PGW-C + SMF shall collect charging information using the same mechanisms as the SMF.

5.1.3 Charging information

Charging information in the 5GC domain network is collected for each UE by the SMFs. PDU session charging allows the SMF to collect and categorize per UE per UPF per PDU session, charging information related to data volumes.

The SMF shall collect the following charging information for converged online and offline charging:

- usage of the access and core network resources: the charging information shall describe the amount of data delivered to and forwarded from the UE;
- usage duration: duration of PDU session is counted as the time interval from PDU session establishment to PDU session release;
- user: the charging information shall provide the actual UE addresses used by the user for the PDU session;

- data network: the charging information shall describe the data network addresses with a level of accuracy as determined by the DNN;
- usage of the external data networks: the charging information shall describe the amount of data sent and received to and from the external data network. External networks can be identified by the DNN;
- start time: identifying the time when the PDU session was started;
- user location: HPLMN, VPLMN, inside/outside presence reporting area, plus optional higher-accuracy location information.

The service data flows categorization is achieved by rating group or combination of the rating group and service id: i.e. based on the level of reporting defined per PCC rule, counting per rating group or combination of the rating group and service id. According to TS 23.503 [202], flow based charging shall support different charging models per PCC rule. These charging models may be based on volume, time and/or on number of events matching a specific service data flow template in PCC rule.

For service data flows defined for FBC, the SMF shall collect the following charging information:

- the information described above for PDU session;
- the amount of data transmitted in uplink and downlink directions categorized by rating group or combination of the rating group and service id when volume based charging applies;
- the duration of service data flows is counted and categorized by rating group or combination of the rating group and service id when time based charging applies;
- the number of events and corresponding time stamps categorized by rating group or combination of the rating group and service id when event based charging applies.

Within the PDU session the SMF shall collect the charging information for service data flows per UPF, categorized with rating group or combination of the rating group and service id.

The user can be identified by a Generic Public Subscription Identifier (GPSI) and/or a 5G Subscription Permanent Identifier (SUPI).

5.1.4 Charging Identifier

Charging identifier is created to allow correlation of charging information.

For the SMF the charging identifier is assigned per PDU session. At each PDU session establishment a new, i.e. assignment of a new PDU session id, PDU session specific SMF Charging Identifier is generated at the first SMF that processes the PDU session initiating request. This SMF Charging Identifier is globally unique (at least within the PLMN) and is then used in all subsequent messages for that PDU session.

5.1.5 PCC rules and charging

5.1.5.1 PCC rules and chargeable events

PCC rules can be activated, deactivated and modified at any time during the PDU session lifetime. The following attribute can be modified by the PCF in a dynamic PCC rule active in the SMF: Charging key, Service identifier, Sponsor Identifier, Application Service Provider Identifier, Measurement method and reporting level. The QoS Flow binding mechanism employed by the SMF upon operations on PCC rules, result in QoS Flows establishment, modification, or release. This is specified in TS 23.503 [202].

Activities on PCC rules and QoS Flows are not chargeable events. However, change of charging rule in PCC rules will lead to chargeable events "start of service data flow" and when this is the last service data flow for the original PCC rule, "termination of service data flow".

The charging key (i.e. Rating group) is a piece of information used to request online charging quotas as defined in TS 23.503 [202].

5.1.5.2 Specific PCC rules scenarios

Extended packet inspection can be supported in the SMF with pre-defined PCC rules. The SMF also has the possibility to output service specific charging information related to the packet inspection.

The capability of SMF to support Application Based Charging is achieved with appropriate PCC rules activation in the SMF. Such PCC Rule shall be defined with service data flow template including an Application Identifier for the application which needs to be detected, enforced and charged.

5.1.6 Session and Service Continuity modes

For any scenario of SSC modes specified in TS 23.501 [200], one charging Id shall correspond to a single PDU session ID.

As a result from such SSC mode, a new charging Id is generated by the SMF for the new PDU session Id, and the charging session associated to the old PDU session Id is released.

This behaviour applies to the following scenario:

- PDU session anchor UPF relocation, in SSC mode 2;
- PDU session anchor UPF relocation in SSC mode 3 with multiple PDU Sessions.

5.1.7 UE Presence in Presence Reporting Area (PRA)

At PDU session establishment, the CHF may provide the "Presence Reporting Area identifier" to be activated for Core Network pre-configured Presence Reporting Area(s) and additionally all of PRA Identifier(s) and list(s) of its elements for UE-dedicated Presence Reporting Area(s) to be reported when it subscribes to "Change of UE presence in Presence Reporting Area".

The CHF may change (activate/modify/remove) the Presence Reporting Area(s) to be reported by providing the updated PRA Identifier(s) to SMF.

The CHF may subscribe/unsubscribe to "Change of UE presence in Presence Reporting Area" re-authorization event trigger during the lifetime of the PDU session.

5.1.8 CHF selection

At the PDU session establishment, the pre-provisioned charging characteristics is used by the SMF to retrieve the CHF addresses.

In case UE subscribed charging characteristics are received from the UDM which include CHF addresses, they take precedence over the CHF addresses of the pre-provisioned charging characteristics.

The NRF may be used by the SMF to discover CHF instance(s), in case no CHF addresses could be identified in the charging characteristics. This is specified in TS 32.290 [57] clause 6.1.

CHF addresses supplied by the PCF during PCC interaction for the PDU session take precedence over CHF addresse(s) supplied by any other means.

5.1.9 Roaming

5.1.9.1 General

Based on roaming agreements between the V-PLMN and the H-PLMN, in Home Routed scenario, for each UE roaming in VPLMN:

- The SMF in VPLMN (V-SMF) shall be able to collect charging information per Qos Flow within a PDU session when UE is determined as an in-bound roamer, for CDR generation in VPLMN.
- The SMF in HPLMN (H-SMF) shall be able to collect charging information per Qos Flow within a PDU session when UE is determined as an out-bound roamer, for CDR generation in HPLMN.

This charging information collection mechanism is achieved under Roaming QoS flow Based Charging (QBC) performed by each PLMN, based on a set of charging parameters exchanged between the V-SMF and the H-SMF on a per PDU session basis during the PDU session establishment.

The two main parameters exchanged are:

- The Charging Id which also includes the VPLMN PLMN ID, assigned by the V-SMF and transferred to the H-SMF in the HPLMN at PDU session establishment.
- The "Roaming Charging Profile" negociated between the VPLMN and the HPLMN at PDU session establishment.

5.1.9.2 CHF selection

In roaming Home routed scenario, the CHF selection mechanism specified in clause 5.1.x applies to:

- the V-SMF for CHF selection in VPLMN;
- the H-SMF for CHF selection in HPLMN.

In the V-SMF, when the NRF is used, the V-CHF can be discovered, based on UE identified as in-bound roamer, and the PLMN Id of the H-PLMN.

5.2 5G data connectivity converged online and offline charging scenarios

5.2.1 Basic principles

5.2.1.1 General

Converged charging may be performed by the SMF interacting with CHF using Nchf specified in TS 32.290 [57] and TS 32.291 [58]. In order to provide the data required for the management activities outlined in TS 32.240 [1] (Credit-Control, accounting, billing, statistics etc.), the SMF shall be able to perform converged charging for each of the following:

- Charging data related to PDU session;
- Charging data related to service data flows within the PDU session.

Converged charging includes quota management and usage reporting.

The SMF shall be able to report charging events to CDF for CDR generation.

The SMF shall be able to perform convergent charging by interacting with CHF, for charging data related to PDU sessions. The Charging Data Request and Charging Data Response are exchanged between the SMF and the CHF, based on SCUR scenarios specified in TS 32.290 [57]. The Charging Data Request is issued by the SMF towards the CHF when certain conditions (chargeable events) are met.

The quota management is always per rating group, reporting level can be either per rating group or per combination of the rating group and service id, which is defined per PCC rule.

Converged charging uses centralized or decentralized unit determination and centralized rating scenarios for session based convergent charging specified in TS 32.290 [57].

The charging information collected per PDU session includes the network slice instance the PDU session belongs to.

The contents and purpose of each charging event that triggers interaction with CHF, as well as the chargeable events that trigger them, are described in the following sub-clauses.

The SMF initiates a charging session with Charging Date Request/Response [Initial], updates the charging session with Charging Date Request/Response [Update], and terminates the charging session with Charging Date Request/Response [Termination].

A detailed formal description of the converged charging parameters defined in the present document is to be found in TS 32.291 [58].

A detailed formal description of the CDR parameters defined in the present document is to be found in TS 32.298 [51].

5.2.1.2 Applicable Triggers in the SMF

5.2.1.2.1 General

When a charging event is issued towards the CHF, it includes details such as Subscriber identifier (e.g. SUPI), Charging-id, etc. and also containers identifying the volume count (separated for uplink and downlink traffic), with charging condition change information.

Each trigger condition (i.e. chargeable event) defined for the 5G data connectivity converged charging functionality, is specified with the associated behaviour when they are met.

Two categories of chargeable events are identified:

- immediate report: chargeable events for which, when occurring, the current counts are closed and sent together with the charging data generated by the SMF towards the CHF in a Charging Data Request. New counts are started by the SMF.

- deferred report: chargeable events for which, when occurring, the current counts are closed and stored together with the charging data generated by the SMF. The stored counts will be sent to the CHF in next a Charging Data Request. New counts are started by the SMF

When a PDU session starts, and the converged charging is activated, the SMF invokes a Charging Data Request [Initial] towards the CHF to get authorization to start. The SMF is optionally provided in the Charging Data Response [Initial], with a set of chargeable event triggers to be enabled, and the associated category (i.e. immediate or deferred report).

When provided, these triggers override the default triggers in the SMF, they remain active until they are updated or disabled by subsequent Charging Data Response [Update] from the CHF or the PDU session is terminated.

A set of chargeable events are based on trigger thresholds and default ones can be configured in Charging Characteristics which are described in Annex A.
The SMF is optionally provided in the Charging Data Response [Initial], with trigger thresholds which override the default ones configured in the Charging Characteristics selected by the SMF for the PDU session. They remain active until they are updated by subsequent Charging Data Response [Update] from the CHF or the PDU session is terminated.

5.2.1.2.2 Flow Based Charging (FBC) triggers

The set of chargeable events and associated category, which shall be supported by the SMF as the default, is specified in the sub-clause 5.2.1.4 for Flow Based Charging.

Two level of triggers can be supplied by the CHF:

- Triggers associated to the PDU session.

- Triggers associated to a rating group within the PDU session.

The set of triggers along with their category (i.e. immediate or deferred report) and level (i.e. per PDU session or per rating group), which can be supplied by the CHF to the SMF for 5G data connectivity converged charging are detailed in the sub-clause 5.2.1.4 for Flow Based Charging.

5.2.1.2.2 QoS flow Based Charging (QBC) triggers

The set of chargeable events and associated category, which shall be supported by the SMF as the default for QoS flow Based Charging, when applicable, is specified in the sub-clause 5.2.1.6.

Two level of triggers can be supplied by the CHF:

- Triggers associated to the PDU session.

- Triggers associated to a QoS Flow within the PDU session.

The set of triggers along with their category (i.e. immediate or deferred report) and level (i.e. per PDU session or per QoS Flow), which can be supplied by the CHF to the SMF for 5G data connectivity converged charging are detailed in the sub-clause 5.2.1.6 for QBC.

When QBC is used in the context of roaming, the set of triggers, their associated category, and trigger thresholds, compose the "Roaming Charging Profile", which governs the SMF charging data generation, synchronously between the V-SMF and the H-SMF when shared.

5.2.1.3 PDU session charging

Converged charging allows the SMF to collect charging information related to data volumes sent to and received by the UE/MS per user per PDU session. The user can be identified by SUPI.

If PDU session specific converged charging is supported, this is achieved by FBC charging, with specific rating group/service identifier, see clause 5.2.1.4.

5.2.1.4 Flow Based Charging (FBC)

For FBC charging, the SMF categorizes the service data flows within PDU session data traffic by rating group and / or combination of the rating group and service id. The level of the reporting and charging method is defined per PCC rule. Details of this functionality are specified in TS 23.503 [202] and TS 32.240 [1].

NOTE: The SMF can only include one QoS Information occurrence per combination of rating group/service id. This implies if an operator wishes to be able to separate usage according to 5QI and ARP for the same charging method, they will need to ensure that service data flows having different 5QI and ARP do not have the same:

- rating group in cases where rating reporting is used;
- rating group/service id where rating group/service id reporting is used.

When a service data flow is governed by a PCC Rule indicated with "Online" charging method, quota management is required before service delivery for controlling this service data flow to be able to start or continue.

When a service data flow is governed by a PCC Rule indicated with "Offline" charging method, quota management is not required for this service data flow. Usage reporting is required for this service data flow without affecting the delivery.

When a service data flow is governed by a PCC Rule indicated with "Online non-blocking" charging method, quota management is required for controlling this service data flow to be able to continue, service may be started before quota management.

According to TS 23.503 [202], FBC shall support different charging models per PCC rule. These charging models may be based on volume and/or time and on number of events matching a specific service data flow template in PCC rule. When a chargeable event occurs for which quota needs to be requested by the SMF to the CHF, the type of requested quota may depend on measurement method configured for the PCC rule.

In general, the charging of a service data flow shall be linked to the PDU session under which the service data flow has been activated.

The amount of data counted shall be the user plane payload at the UPF separated between UL and DL.

For PDU session specific charging, time metering shall start when PDU session is activated.

Table 5.2.1.4.1 summarizes the set of default trigger conditions and their category which shall be supported by the SMF. For "immediate report" category, the table also provides the corresponding Charging Data Request [Initial, Update, Termination] message sent from SMF towards the CHF.

Table 5.2.1.4.1: Default Trigger conditions in SMF

Trigger Conditions	Trigger level	Default category	CHF allowed to change category	CHF allowed to enable and disable	Message when "immediate reporting" category
Start of PDU Session.	PDU session	Immediate	Not Applicable	Not Applicable	Charging Data Request [Initial]
Start of the Service data flow and no charging session exists.	RG	Immediate	No	No	
Change of Charging conditions					Charging Data Request [Update]
QoS change	PDU session/ RG	Deferred	Yes	Yes	
User Location change	PDU session/ RG	Deferred	Yes	Yes	
Serving Node change	PDU session/ RG	Deferred	Yes	Yes	
Change of UE presence in Presence Reporting Area(s)	PDU session/ RG	Deferred	Yes	Yes	
Change of 3GPP PS Data off Status	PDU session/ RG	Deferred	Yes	Yes	
Tariff time change	PDU session/ RG	Deferred	No	No	
UE time zone change	PDU session/ RG	Immediate	Yes	Yes	
PLMN change	PDU session/ RG	Immediate	Yes	Yes	
RAT type change	PDU session/ RG	Immediate	Yes	Yes	
Session-AMBR change	PDU session	Immediate	Yes	Yes	
Addition of UPF	PDU Session	Immediate	Yes	Yes	
Removal of UPF	PDU session	Immediate	Yes	Yes	
Limit per PDU session					
Expiry of data time limit per PDU session	PDU session	Immediate	No	Yes	
Expiry of data volume limit per PDU session	PDU session	Immediate	No	Yes	
Expiry of data event limit per PDU session	PDU session	Immediate	No	Yes	
Expiry of limit of number of charging condition changes	PDU session	Immediate	No	Yes	
Limit per Rating group					
Expiry of data time limit per rating group	RG	Deferred	Yes	Yes	
Expiry of data volume limit per rating group	RG	Deferred	Yes	Yes	
Expiry of data event limit per rating group	RG	Deferred	Yes	Yes	
Quota management					
Time threshold reached	RG	Immediate	No	Yes	
Volume threshold reached	RG	Immediate	No	Yes	
Unit threshold reached	RG	Immediate	No	Yes	
Time quota exhausted	RG	Immediate	No	Yes	

Volume quota exhausted	RG	Immediate	No	Yes	
Unit quota exhausted	RG	Immediate	No	Yes	
Expiry of quota validity time	RG	Immediate	No	Yes	
Expiry of quota holding time	RG	Immediate	No	Yes	
Re-authorization request by CHF	RG	Immediate	No	No	
Start of service data flow, in case no valid quota for this rating group	RG	Immediate	No	No	
Others					
Termination of service data flow - last service data flow under a given Rating Group.	RG	Immediate	No	No	
Management intervention	PDU session	Immediate	No	No	
Expiry of Unused Quota Timer	PDU session	Immediate	No	Yes	Charging Data Request [Termination]
End of PDU session	PDU session	Immediate	No	No	
CHF response with session termination (e.g. Credit Limit Reached, Credit Control Not Applicable)	PDU session	Immediate	No	No	
Abort request is received from the CHF	PDU session	Immediate	No	No	

The default "Limit" trigger conditions, are trigger thresholds configured in the Charging Characteristics applied to the PDU session. It shall be possible for the CHF to override these default triggers when providing Charging Data Response [Initial], either to disable the triggers, or to enable triggers new thresholds value.

For converged charging, the following details of chargeable events and corresponding actions in the SMF are defined in Table 5.2.1.4.2:

Table 5.2.1.4.2: Chargeable events and their related actions in SMF

Chargeable event	Conditions	SMF action
Start of PDU session		Charging Data Request [Initial] with a possible request quota for later use
Start of service data flow	If quota management is required, and valid quota for this rating group does not exist	Charging Data Request [Update] with a request quota with a possible amount of quota.
	If service identifier level reporting is required by the PCC rule	Start new counts with time stamps for the combination of the rating group and service id
	If rating group level reporting is required by the PCC rule	Start new counts with time stamps for the rating group
	If sponsored connectivity level reporting is required by the PCC rule	Start new counts with time stamps for the combination of the rating group, sponsor identity and application service provider identity
	If charging resource, i.e. charging session, for the PDU session does not exist	Charging Data Request [Initial] with a possible request quota
Termination of service data flow	If service identifier level reporting is required by the PCC rule and this is the last service data flow for this combination of the rating group and service id	Close the counts with time stamps
	If rating group level reporting is required by the PCC rule and this is the last service data flow utilizing that specific rating group	Close the counts with time stamps
	If sponsored connectivity level reporting is required by the PCC rule and this was the last active service data flow for this combination of rating group, sponsor identity and application service provider identity	Close the counts with time stamps
Expiry of the Unused Quota Timer for the PDU session		Charging Data Request[Termination], indicating that charging session is terminated, and the PDU session is still active May include the configured unused quota timer value
End of PDU session in the SMF		Charging Data Request [Termination] Close the counts with time stamps
Quota specific chargeable events (e.g. threshold reached, QHT expires, quota exhaustion, validity time reached, forced re-authorization, expiry of quota holding time)		Charging Data Request [Update] with a possible request quota Close the counts and start new counts with time stamps
Change of charging condition in the SMF (e.g. QoS change, Session-AMBR change, user location change, Radio access type change, PLMN change, Serving Node change, UE Timezone change, change of UE presence in Presence Reporting Area(s), change of 3GPP PS Data Off status)	If the corresponding trigger is enabled	Close the counts and start new counts with time stamps for all active service data flows
	If the corresponding trigger is enabled and the category is set to "immediate reporting"	Charging Data Request [Update]
Addition of UPF	If the corresponding trigger is enabled and the category is set to "immediate reporting"	Charging Data Request [Update] with a request quota with a possible amount of quota.
Tariff time change		Close the counts and start new counts with time stamps
CHF response with session termination (e.g. Credit Limit Reached, Credit Control Not Applicable) , abort request		Charging Data Request [Termination] Close the counts with time stamps
Removal of a UPF	If quota management is being performed and quota is granted per each UPF	Charging Data Request[Update] Close the counts with time stamps for the removed UPF
	If quota management is being performed and quota is shared between UPFs	Close the counts with time stamps for the removed UPF

Chargeable event	Conditions	SMF action
	If there is no quota management performed	Close the counts with time stamps for the removed UPF
Expiry of time limit per rating group		Close the counts with time stamps
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If any matching service data flow is still active	Start new counts with time stamps
Expiry of data volume limit per rating group		Close the counts with time stamps
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If any matching service data flow is still active	Open a new service data container
Expiry of data event limit per rating group		Close the counts with time stamps
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If any matching service data flow is still active	Open a new service data container
Expiry of data event limit per PDU session		Charging Data Request [Update] Close the counts with time stamps
	If the PDU session is still active	Start new counts with time stamps
Expiry of time limit per PDU session		Charging Data Request [Update] Close the counts with time stamps
	If the PDU session is still active	Start new counts with time stamps
Expiry of data volume limit per PDU session		Charging Data Request [Update] Close the counts with time stamps
	If the PDU session is still active	Start new counts with time stamps
Expiry of a limit of number of charging condition changes per PDU session		Charging Data Request [Update] Close the counts with time stamps
	If the PDU session is still active	Start new counts with time stamps
Management intervention		Charging Data Request [Update] Close the counts with time stamps
	If the PDU session is still active	Start new counts with time stamps

When event based charging applies, the first occurrence of an event matching a service data flow template in PCC rule shall be considered as the start of a service.

How the termination of service data flows is detected, is specified in TS 23.503 [202]. Termination of the service data flow itself does not trigger Charging Data Request[Update].

The CDR generation mechanism processed by the CHF upon receiving Charging Data Request [Initial, Update, Termination] issued by the SMF for these chargeable events, is specified in clause 5.2.3.

5.2.1.5 SSC Mode and Triggers

In case of SSC Mode1, the chargeable events are Change of charging condition in the SMF.

In case of SSC Mode2 and SSC Mode3 PDU session Anchor with multiple PDU session, the chargeable events are Start of PDU session and End of PDU session.

There are two cases related to quota management when multiple UPFs are involved, and per Operator's policy the traffic is counted in more than one UPF:

- Quota shared by UPFs means that SMF manages the shared quota consumption per RG for multiple UPFs and reports the total quota consumed to CHF;

- Quota granted for each UPF means that the CHF manages the quota granted for each UPF and SMF manages and reports the quota consumption per UPF.

For configurations involving multiple UPFs and Operator's policy is to count the traffic in a single UPF (e.g. BP), the quota is granted to the SMF for this single UPF per RG for the whole traffic.

The following scenarios describe configurations in which the traffic is counted in more than one UPF:

In case of SSC mode 3 PDU Session Anchor with IPv6 Multi-homed PDU Session,

- The addition of UPF2 and BP (Change the part of traffic from UPF1 to UPF2):

- if quota granted for each UPF, SMF triggers the chargeable event of Start of SDF for UPF2 to request the quota;

- if quota shared by UPFs, SMF requests UPF1 report usage of quota, caches the usage from UPF1 and re-allocates the remaining quota to UPF2 and UPF1(if needed). When the granted quota from CHF is used up, the SMF reports total usage of quota to CHF.

- The removal of UPF1and BP:

  - In case the quota management and quota granted for each UPF, UPF1 reports final counts to SMF, SMF triggers the chargeable event of Remove the UPF to report final counts from UPF1;

  - In case the quota management and quota shared by UPFs, UPF1 report final counts to SMF, SMF caches the final count from UPF1. SMF sends counts from UPF1 and UPF2 to the CHF together in next Charging Data Request.

  - In case without the quota management, UPF1 report final count to SMF, SMF caches the final count from UPF1 and sends counts from UPF1 and UPF2 to the CHF together in next a Charging Data Request.

In case of Addition of additional PDU Session Anchor and Branching Point or UL CL:

- The addition of UPF2 and BP (Change the part of traffic from UPF1 to UPF2):

  - if quota granted for each UPF, SMF triggers the chargeable event of Start of SDF for UPF2 to request the quota for Rating group;

  - if quota shared by UPFs, SMF indicates UPF1 report usage of quota, caches the usage from UPF1 and re-allocates the remain quota to UPF2 and UPF1(if needed). When the granted quota from CHF is used up, the SMF reports total usage of quota to CHF.

In case of Removal of additional PDU Session Anchor and Branching Point or UL CL:

- The removal of UPF1 and BP (Change traffic from UPF1 to UPF2):

  - In case the quota management and quota granted for each UPF, UPF1 report final counts to SMF, SMF triggers chargeable event of Remove the UPF to report final counts from UPF1;

  - In case the quota management and quota shared by UPFs, UPF1 report final counts to SMF, SMF caches the final count from UPF1 and re-allocates the remain quota to UPF2. SMF sends counts from UPF1 and UPF2 to the CHF together in next a Charging Data Request.

  - In case without the quota management, UPF1 report final count to SMF, SMF caches the final count from UPF1 and sends counts from UPF1 and UPF2 to the CHF together in next a Charging Data Request.

In case of Change of additional PDU Session Anchor for IPv6 multi-homing or UL CL and Simultaneous change of Branching Point or UL CL and additional PSA for a PDU Session.

- The additional of UPF2 (Change the part of traffic from UPF1 to UPF2):

  - if quota granted for each UPF, SMF triggers the chargeable event of Start of SDF for UPF2 to request the quota for Rating group;

  - if quota shared by UPFs, SMF indicates UPF1 report usage of quota, caches the usage from UPF1 and re-allocates the remain quota to UPF2 and UPF1(if needed). When the granted quota from CHF is used up, the SMF reports total usage of quota to CHF.

- The removal of UPF1:

  - In case the quota management and quota granted for each UPF, UPF1 report final counts to SMF, SMF triggers chargeable event of Remove the UPF to report final counts from UPF1.

  - In case the quota management and quota shared by UPFs, UPF1 report final counts to SMF, SMF caches the final count from UPF1 and re-allocates the remain quota to UPF2. SMF sends counts from UPF1 and UPF2 to the CHF together in next Charging Data Request.

- In case without the quota management, UPF1 report final count to SMF, SMF caches the final count from UPF1 and sends counts from UPF1 and UPF2 to the CHF together in next a Charging Data Request.

5.2.1.6 QoS flow Based Charging

QoS flow Based Charging allows the SMF to collect charging information related to data volumes per PDU session, categorized per QoS Flow.

The user can be identified by SUPI.

For a given PDU session, QBC shall be performed by the SMF withinthe same charging session used for Flow Based Charging.

The SMF categorizes the volume within PDU session by QoS Flow identified by QoS Flow Identifier (QFI).

The amount of data counted for the QoS Flow shall be the user plane payload at the UPF.

Table 5.2.1.6.1 summarizes the set of default trigger conditions and their category which shall be supported by the SMF in QBC. For "immediate report" category, the table also provides the corresponding Charging Data Request [Initial, Update, Termination] message sent from SMF towards the CHF.

Table 5.2.1.6.1: Default Chargeable events in SMF for QBC

Chargeable event	Trigger level	Default category	CHF allowed to change category	CHF allowed to enable and disable	Message when "immediate reporting" category
Start of PDU session	PDU session	Immediate	Not Applicable	Not Applicable	Charging Data Request [Initial]
Start of a new QoS Flow	QoS Flow	Deferred	Not Applicable	Not Applicable	Charging Data Request [Update]
Change of Charging conditions					
QoS change	QoS Flow	Deferred	Yes	Yes	
User Location change	PDU session	Deferred	Yes	Yes	
AMF change	PDU session	Deferred	Yes	Yes	
Change of UE presence in Presence Reporting Area(s)	PDU session	Deferred	Yes	Yes	
Change of 3GPP PS Data off Status	PDU session	Deferred	Yes	Yes	
Tariff time change	PDU session	Deferred	No	No	
UE time zone change	PDU session	Immediate	Yes	Yes	
PLMN change	PDU session	Immediate	Yes	Yes	
RAT type change	PDU session	Immediate	Yes	Yes	
Session-AMBR change	PDU session	Immediate	Yes	Yes	
Addition of UPF	PDU session	Immediate	Yes	Yes	
Removal of UPF	PDU session	Immediate	Yes	Yes	
Limit per PDU session					
Expiry of data time limit per PDU session	PDU session	Immediate	Yes	Yes	
Expiry of data volume limit per PDU session	PDU session	Immediate	Yes	Yes	
Expiry of data event limit per PDU session	PDU session	Immediate	Yes	Yes	
Expiry of limit of number of charging condition changes	PDU session	Immediate	Yes	Yes	
Limit per QoS Flow					
Expiry of data time limit per QoS Flow	QoS Flow	Deferred	Yes	Yes	
Expiry of data volume limit per QoS Flow	QoS Flow	Deferred	Yes	Yes	
Others					
End of QoS Flow	QoS Flow	Deferred	Yes	Yes	
Management intervention	PDU session	Immediate	No	No	
End of PDU session	PDU session	Immediate	No	No	Charging Data Request [Termination]
Abort request is received from the CHF	PDU session	Immediate	No	No	

The default "Limit" trigger conditions, are trigger thresholds configured in the Charging Characteristics applied to the PDU session for QBC. It shall be possible for the CHF to override these default triggers when providing Charging Data Response[Initial], either to disable the triggers, or to enable triggers new thresholds value.

For QBC the following details of chargeable events and corresponding actions in the SMF are defined in Table 5.2.1.6.2:

Table 5.2.1.6.2: Chargeable events and their related actions in SMF for QBC

Chargeable event	Conditions	SMF action
Start of PDU session		Charging Data Request [Initial]
Start of a QoS Flow	Start of the QoS Flow associated with the default QoS rule	Charging Data Request [Update].
	Start of a new QoS Flow	Start new counts with time stamps.
End of PDU session		Charging Data Request [Termination] Close the counts with time stamps
Change of charging condition in the SMF (e.g. QoS change, Session-AMBR change, user location change, Radio access type change, PLMN change, AMF change, UE Timezone change, change of UE presence in Presence Reporting Area(s), change of 3GPP PS Data Off status)	If the corresponding trigger is enabled	Close the counts and start new counts with time stamps for all active QoS flows.
	If the corresponding trigger is enabled and the category is set to "immediate reporting"	Charging Data Request [Update]
Addition of UPF		Charging Data Request [Update].
Removal of UPF		Close the counts with time stamps for the removed UPF
Expiry of time limit per QoS Flow	If the corresponding trigger is enabled	Close the counts with time stamps.
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If the QoS Flow is still active	Start new counts with time stamps
Expiry of data volume limit per QoS Flow	If the corresponding trigger is enabled	Close the counts with time stamps
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If the QoS Flow is still active	Start new counts with time stamps
Expiry of time limit per PDU session	If the corresponding trigger is enabled	Close the counts with time stamps for all QoS flows.
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If the PDU session is still active	Start new counts with time stamps for all active QoS flows
Expiry of data volume limit per PDU session	If the corresponding trigger is enabled	Close the counts with time stamps for all QoS flows.
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If the PDU session is still active	Start new counts with time stamps for all active QoS flows
Expiry of a limit of number of charging condition changes per PDU session	If the corresponding trigger is enabled	Close the counts with time stamps for all QoS flows.
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If the PDU session is still active	Start new counts with time stamps for all active QoS flows
Management intervention		Charging Data Request [Update] Close the counts with time stamps for all QoS Flows
	If the PDU session is still active	Start new counts with time stamps
Abort		Charging Data Request [Termination] Close the counts with time stamps

The CDR generation mechanism processed by the CHF upon receiving Charging Data Request[Initial, Update, Termination] issued by the SMF for these chargeable events in QBC, is specified in clause 5.2.3.

5.2.1.7 Roaming QoS flow Based charging (QBC)

When QoS flow Based Charging specified in 5.2.1.6 is used in a context of roaming, a "Roaming Charging Profile" is defined to allow, when shared, QBC synchronized between both PLMNs and includes:- The set of chargeable events as per Table 5.2.1.6.1 and associated category.

- The set of thresholds for chargeable events based on trigger thresholds.

- An indication on whether the "Default partial record" or the "Individual partial record" mechanism per clause 5.2.3, is used by CHF.

A default "Roaming Charging Profile" is specified for the SMF and comprises:

- The set of chargeable events and associated category specified as the default per Table 5.2.1.6.1.
- The default set of thresholds configured in the Charging Characteristics for QBC.
- The "Default partial record" mechanism indicated as the one used by CHF.

In the VPLMN, at PDU session establishement the default "Roaming Charging Profile" in the V-SMF may optionally be overridden by a new "Roaming Charging Profile" supplied by the CHF in the Charging Data Response [Initial] with:

- updated set of chargeable events and associated category.
- updated thresholds for chargeable events based on trigger thresholds.
- the selected partial record mechanism ("Default partial record" or "Individual partial record").

This updated "Roaming Charging Profile" is transferred from the V-SMF to the H-SMF and may be acknowledged or replaced by the HPLMN selected "Roaming Charging Profile" to be used by the V-SMF.

In the HPLMN, at PDU session establishement, the "Roaming Charging Profile", when received by the H-SMF from the V-SMF, may be updated by the CHF in the HPLMN in the Charging Data Response [Initial] to H-SMF. This HPLMN CHF selected "Roaming Charging Profile" is used by the H-SMF and transferred towards the VPLMN.

The "Roaming Charging Profile" resulting from the exchange between the VPLMN and HPLMN at PDU session establishment shall remain unchanged during the PDU session lifetime.

The capability specified in clause 5.2.1.2.1 for the CHF to be able to update the triggers after the PDU session is established shall not be applicable for Roaming QBC.

5.2.2 Message flows

5.2.2.1 General

The flows in the present document specify the interaction between the SMF and the CHF for 5G data connectivity converged charging functionality, in different scenarios, based on TS 23.501 [200] and TS 23.502 [201] procedures and flows.

This interaction is based on Charging Data Request /Response specified in TS 32.290 [57], exchanged between the SMF embedding the CTF and the CHF.

As a general principle, the steps in the figures for the message flows below correspond to the steps of figures in TS 23.502 [202] with their detailed description.

These steps are summarized to highlight the main ones which are relevant for this scenario, and extended with the charging description.

5.2.2.2 PDU session charging from SMF

5.2.2.2.1 General

The subclause below describes PDU session charging in non-roaming scenarios.

5.2.2.2.2 PDU session establishment

The following figure 5.2.2.2.1 describes a PDU session establishment charging, based on clause 4.3.2.2.1 TS 23.502 [202] description:

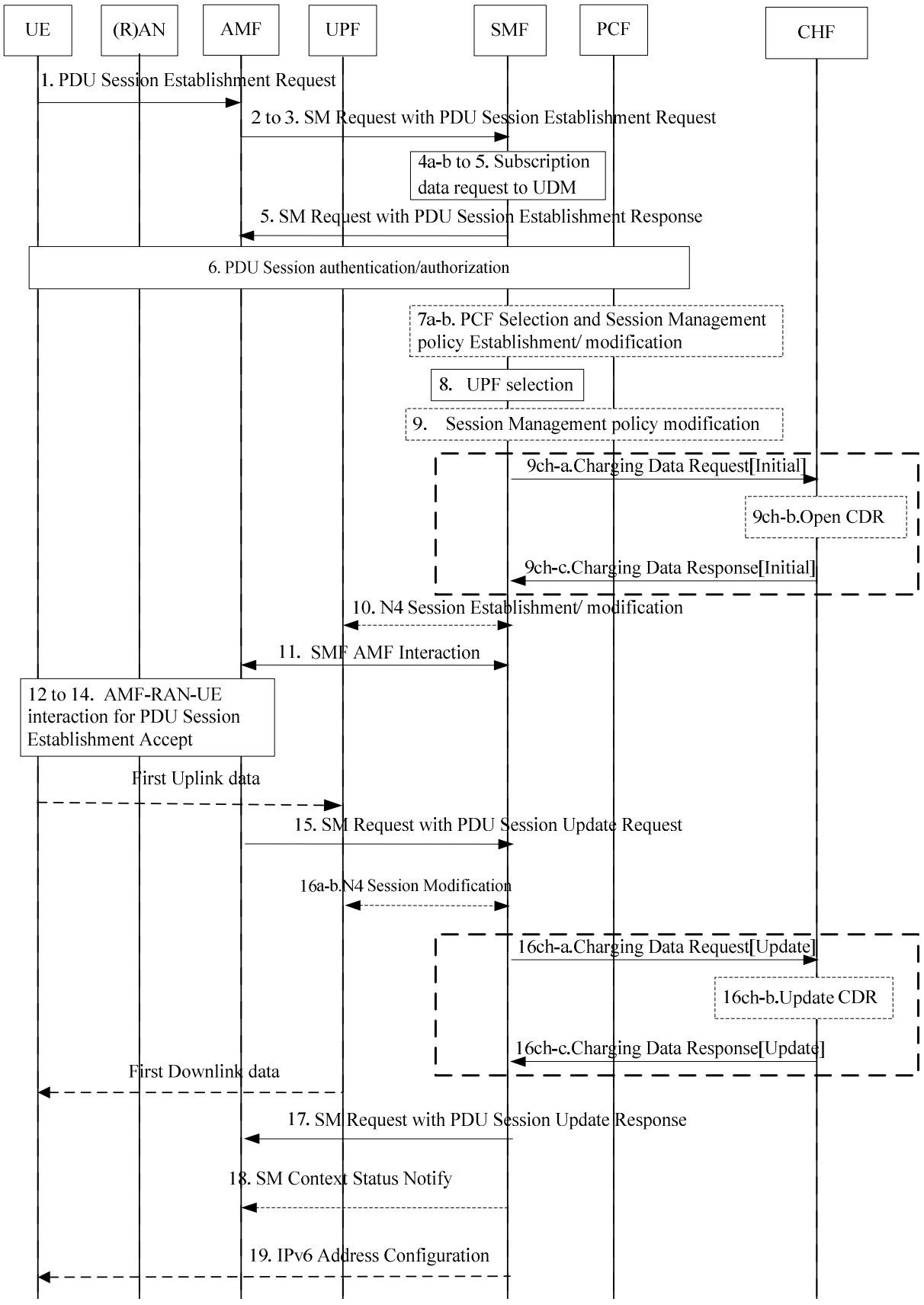

Figure 5.2.2.2.2.1: PDU session establishment

1. The UE initiates a PDU Session establishment procedure (PDU Session ID, PDU Type, SSC mode, User location information and Access Technology Type Information).

[2 to 3]. SMF selection by AMF, and sending of SM Request (PDU Session Establishment Request).

[4a-b] to 5. Subscription Data Request to UDM, based on (Subscriber Permanent ID, DNN): Default QoS profile.

6. PDU session authentication/authorization.

[7a-b]. If dynamic PCC is deployed, the SMF performs PCF selection, and requests for PCC Rules, and SMF selection of UPF.

8. The SMF selects an SSC mode for the PDU Session and also selects one or more UPFs.

9. The SMF may perform a Session Management Policy Modification procedure to report some event to the PCF that has previously subscribed.

9ch-a.The SMF creates a Charging Id for the PDU session, and sends Charging Data Request[initial] to CHF for authorization for the subscriber to start the PDU session which is triggered by start of PDU session charging event.

9ch-b. The CHF opens CDR for this PDU session.

9ch-c. The CHF acknowledges by sending Charging Data Response[Initial] to the SMF.

10. the SMF initiates an N4 Session Establishment procedure with the selected UPF, otherwise it initiates an N4 Session Modification procedure with the selected UPF.

11. SMF-AMF interaction.

[12 to 14].AMF-(R)AN-UE interaction.

15. AMF to SMF: SM Request (N2 SM information).

[16a-b]. N4 session Modification: the SMF provides AN Tunnel Info to the UPF. From this step, the UPF delivers any down-link packets to the UE that may have been buffered for this PDU Session.

16ch-a. This step may occur in case "start of service data flow" needs quota from CHF, for the SMF to request quota.

16ch-b. The CHF updates CDR for this PDU session.

16ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

17. SM Request with PDU session Update Response to AMF.

18. SMF sends SM Context Status Notify to AMF.

19. In case of PDU Type IPv6, IPv6 Address Configuration.

5.2.2.3 PDU session charging SSC Mode 1 from SMF

5.2.2.3.1 General

The subclause below describes PDU session SSC mode 1 charging in non-roaming scenarios.

5.2.2.3.2 PDU session charging SSC Mode 1

The following figure 5.2.2.3.2.1 describes a PDU session SSC mode 1 charging, based on clause 5.6.9.2.1 TS 23.501 [201] description:

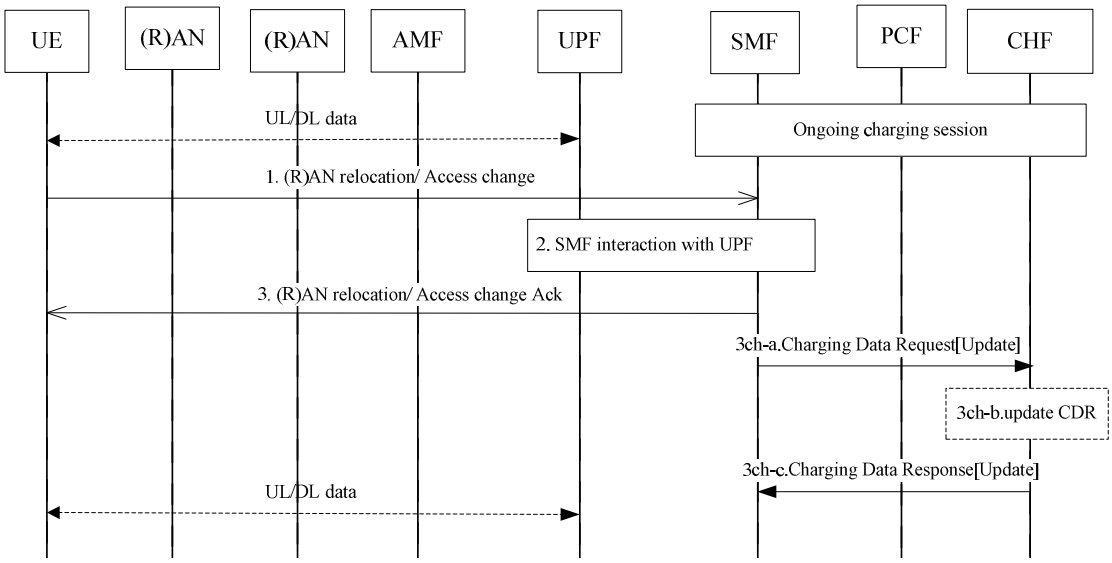

Figure 5.2.2.3.2.1: PDU session anchor relocation in SSC mode 1

Ongoing charging interaction associated with the established PDU session (UPF).

1. A (R)AN relocation is performed.

2. The SMF determines that the serving UPF needs to be maintained and interacts with the UPF for the path switch to the new (R)AN access.

3. the SMF acknowledges the path switch to the new (R)AN.

3ch-a. The SMF sends Charging Data Request[Update] to the CHF for reporting the charging information User location information/ Access Technology Type Information.

3ch-b. The CHF updates the CDR.

3ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

5.2.2.4 PDU session Charging SSC Mode 2 from SMF

5.2.2.4.1 General

The subclause below describes PDU session charging for change the PDU Session Anchor serving a PDU Session of SSC mode 2

5.2.2.4.2 PDU session Charging SSC Mode 2

The following figure 5.2.2.4.2.1 describes a PDU session anchor relocation in SSC mode 2 charging, based on clause 4.3.5.1 TS 23.502 [202] description:

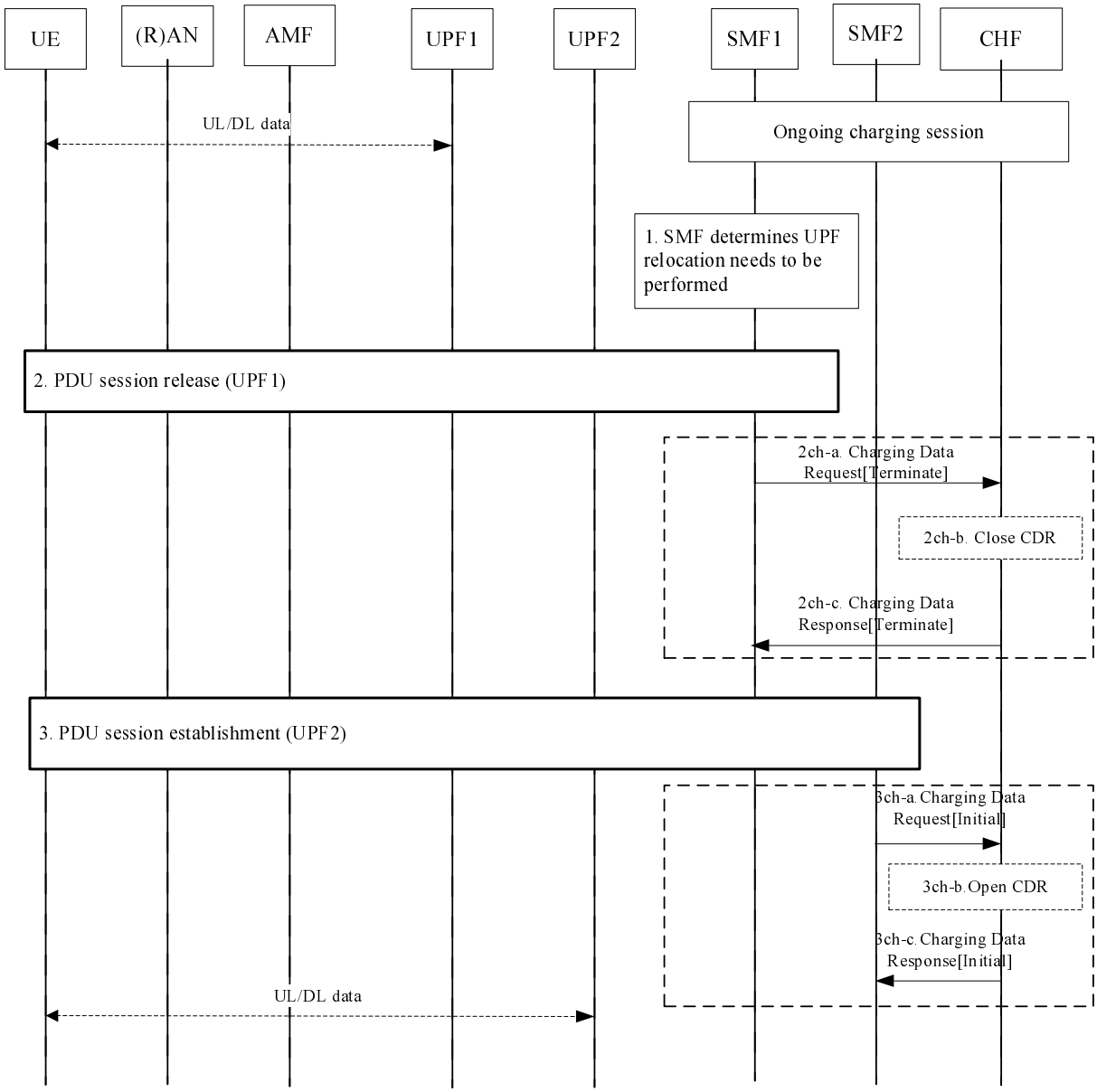

Figure 5.2.2.4.2.1: PDU session anchor relocation in SSC mode 2 with single PDU session anchor

Ongoing charging session associated with the established PDU session (UPF1)

1. The SMF1 determines that the serving UPF needs to be relocated due to events that may benefit from UPF relocation.

2. PDU session release procedure. The SMF sends a NAS message to the UE via the AMF (contains the PDU Session ID that needs to be relocated and Cause indicating that a PDU Session re-establishment to the same DN is required).

2ch-a. The SMF1 sends Charging Data Request[Termination] to the CHF for terminating the charging associated with old PDU session in UPF1.

2ch-b. The CHF closes the CDR for old PDU session in UPF1.

2ch-c. The CHF acknowledges by sending Charging Data Response[Termination] to the SMF1.

3. PDU session establishment procedure (UPF2) with a new PDU Session ID generated by the UE, resulting in new IP @ allocation.

3ch-a. The SMF2 creates a Charging Id for new PDU session in UPF2, and sends Charging Data Request[initial] to CHF for authorization for the subscriber to start the new PDU session which is triggered by start of PDU session charging event.

3ch-b. The CHF opens CDR for new PDU session in UPF2.

3ch-c. The CHF acknowledges by sending Charging Data Response[initial] to the SMF2.

NOTE: If the same SMF1 is re-selected is step 3, the same steps 3ch-a to b apply to SMF1

5.2.2.5 PDU session Charging SSC Mode 3 from SMF

5.2.2.5.1 General

The subclause below describes PDU session charging for change the PDU Session Anchor serving a PDU Session of SSC mode 3.

5.2.2.5.2 PDU session Charging SSC Mode 3

The following figure 5.2.2.5.2.1 describes a PDU session anchor relocation in SSC with mode 3 multiple PDU sessions and SMF reallocation, based on clause 4.3.5.2 TS 23.501 [201] description:

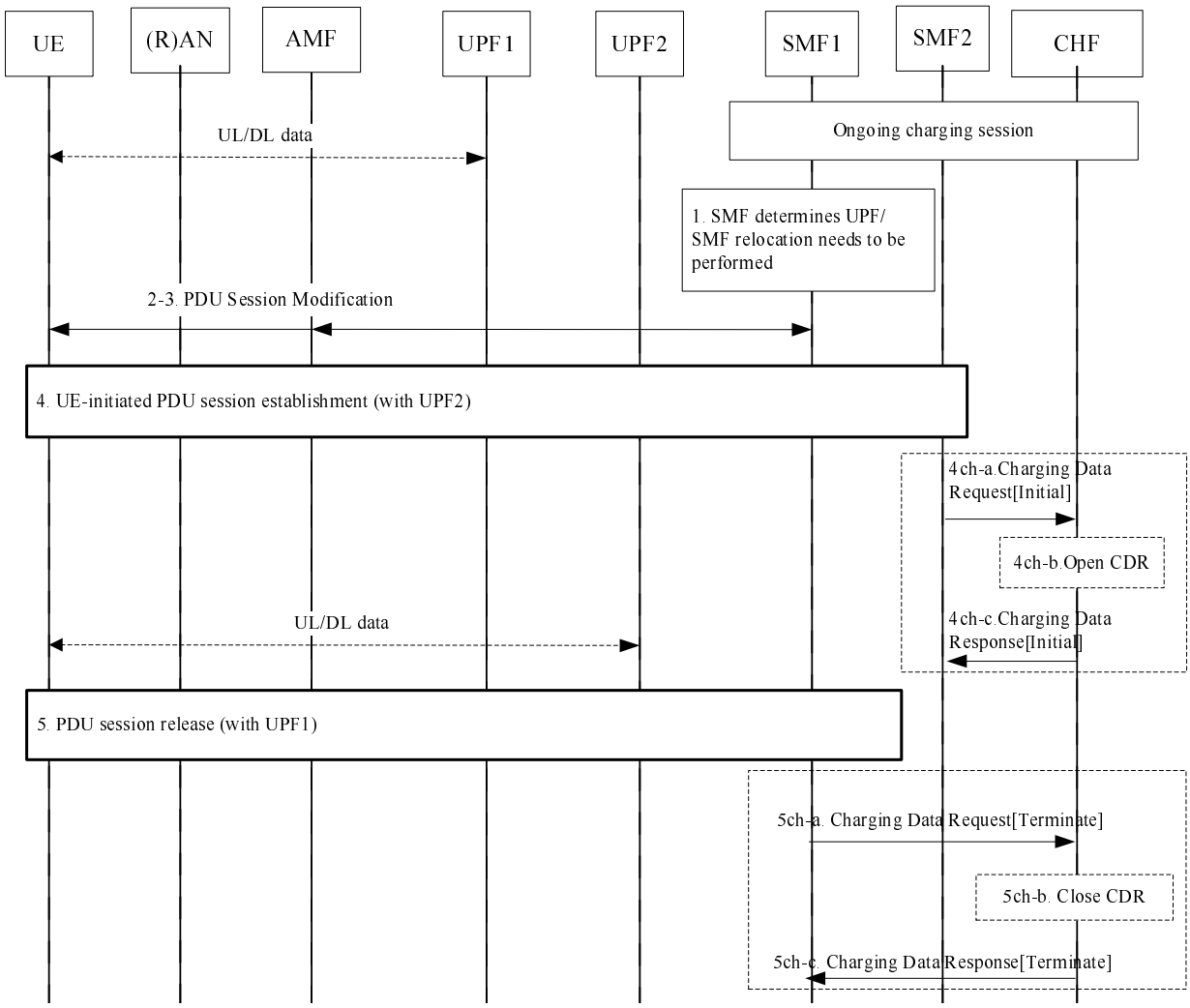

Figure 5.2.2.5.2.1: PDU session anchor relocation in SSC mode 3 with multiple PDU sessions – SMF reallocation

Ongoing charging interaction associated with the established PDU session (with UPF1).

1. The SMF determines that the SMF need to be reallocated due to events that may benefit from reallocation.

2-3. Same steps as 2-3 figure 4.3.5.2-1 of TS 23.502 [201].

4. UE initiates PDU session establishment procedure to SMF2 selected by the AMF (new PDU session Id), and UPF2 is selected by the SMF2.

4ch-a. The SMF2 creates a Charging Id for new PDU session in UPF2, and sends Charging Data Request[initial] to CHF for authorization for the subscriber to start the new PDU session (with UPF2) which is triggered by start of PDU session charging event.

4ch-b. The CHF opens CDR for new PDU session in UPF2.

4ch-c. The CHF acknowledges by sending Charging Data Response[initial] to the SMF2.

5. Old PDU session for UPF1 release.

5ch-a. The SMF1 sends Charging Data Request[Termination] to the CHF for terminating the charging associated with old PDU session in UPF1.

5ch-b. The CHF closes the CDR for old PDU session in UPF1.

5ch-c. The CHF acknowledges by sending Charging Data Response[Termination] to the SMF1.

5.2.2.6 PDU session Charging SSC Mode 3 IPv6 Multi Homed from SMF

5.2.2.6.1 General

The subclause below describes PDU session charging for service continuity with SSC mode 3 using the multi-homed PDU Session.

5.2.2.6.2 PDU session Charging SSC Mode 3 IPv6 Multi Homed

The following figure 5.2.2.6.2.1 describes a PDU session anchor relocation in SSC mode 3 with IPv6 Multi homed PDU Session charging, based on clause 4.3.5.3 TS 23.502 [202] description:

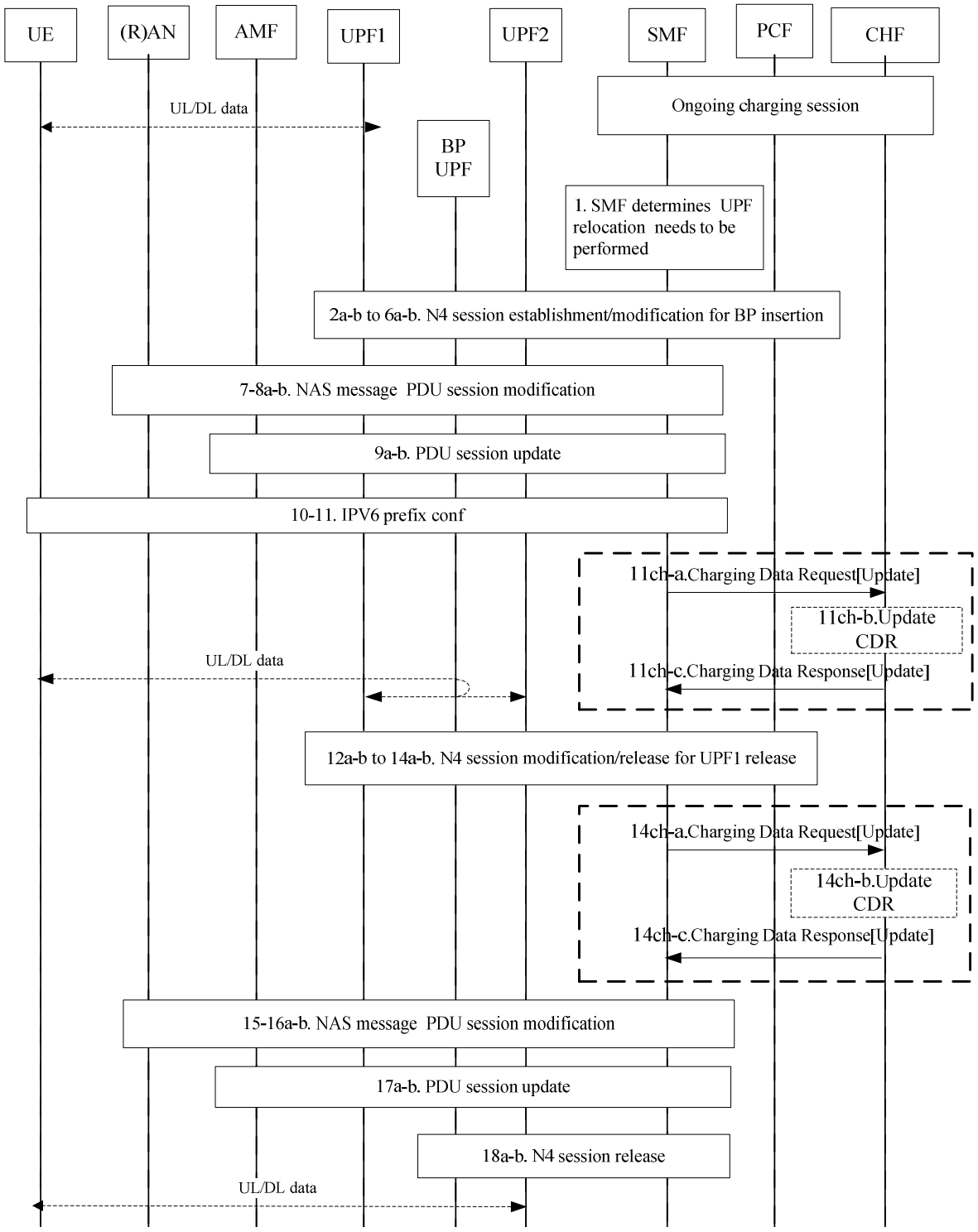

Figure 5.2.2.6.2.1: PDU session anchor relocation in SSC mode 3 with IPv6 Multi homed PDU Session

Ongoing charging interaction associated with the established PDU session (UPF1).

1. The SMF determines to relocate the PDU Session with a new PDU Session Anchor UPF2.

[2a-b to 6a-b] The SMF exchange N4 messages to UPF2, BP UPF and UPF1 to insert BP UPF in the path with Tunnel Info exchange. A new IPv6 prefix is allocated.

[7-8a-b] The SMF sends NAS message to the UE via the AMF to update the PDU session with tunnel info.

[9a-b] The AMF sends the message from the R(AN) to the SMF.

[10-11] IPv6 configuration.

11ch-a. The SMF sends Charging Data Request[Update] to the CHF for request quota for UPF2 which is triggered by start of service data flow charging event, if quota management per UPF.

11ch-b. The CHF updates CDR for this PDU session

11ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

[12a-b to 14a-b] The SMF releases the UE's old IPv6 prefix (IP@1), and exchange N4 messages to release the path between BP UPF and UPF1.

14ch-a. The SMF sends Charging Data Request[Update] to the CHF for usage reporting for UPF1 which is triggered by termination of service data flow charging event, if quota management per UPF.

14ch-b. The CHF updates CDR for this PDU session.

14ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

[15-16a-b] The SMF sends NAS message to the UE via the AMF to update the PDU session with tunnel info to release the BP in the path.

[17a-b] PDU session update.

[18a-b] N4 session release to release the BP UPF in the path.

In this scenario, the PDU session Id is maintained during the whole procedure.

5.2.2.7 Addition of additional PDU Session Anchor and Branching Point or UL CL

The following figure 5.2.2.7.1 describes the charging procedure to add a PDU Session Anchor and a Branching Point or UL CL for an established PDU Session as defined in clause 4.3.5.4 TS 23.502[201].

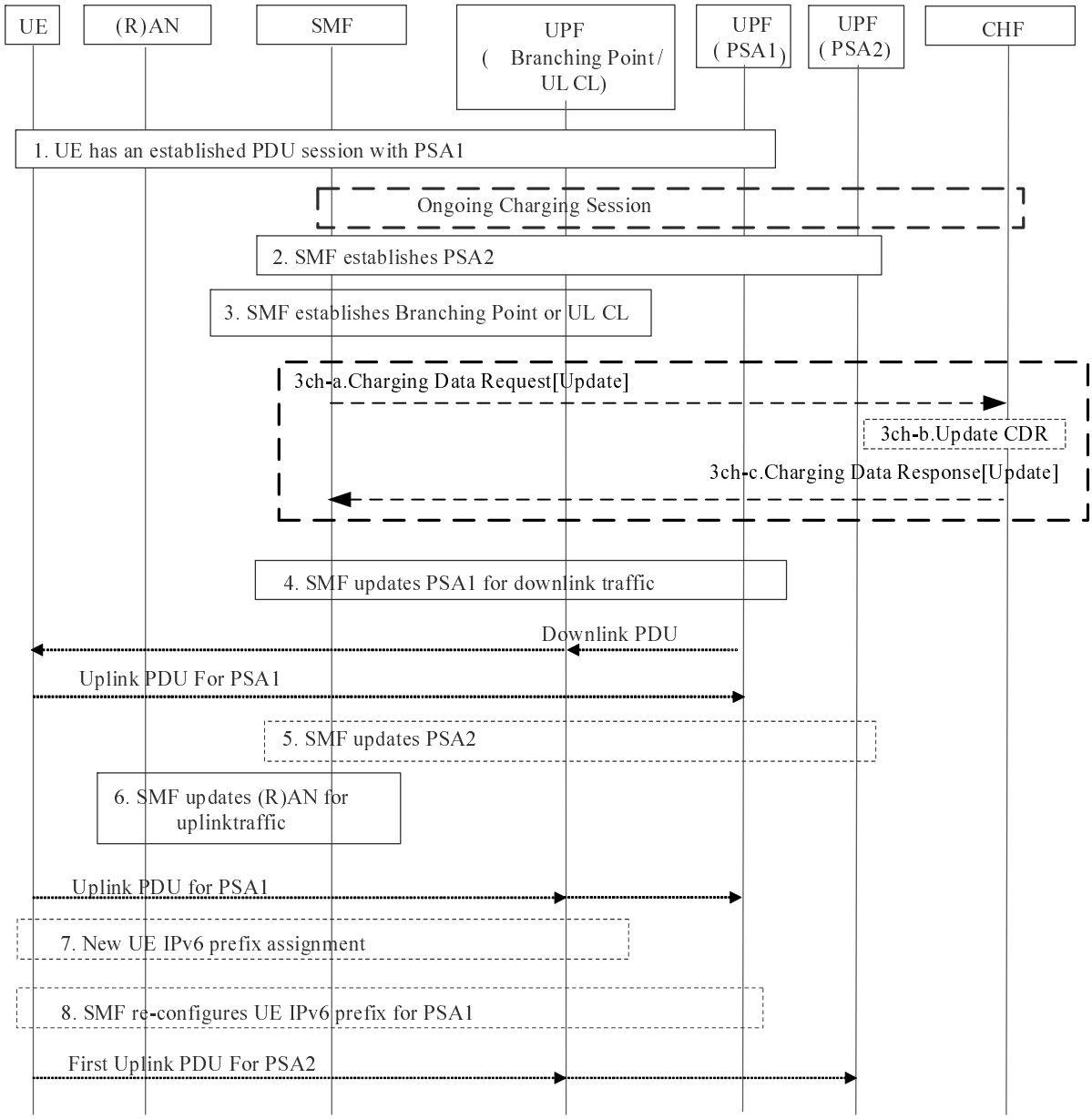

Figure 5.2.2.7.1: Addition of additional PDU Session Anchor and Branching Point or UL CL

1. UE has an established PDU Session with a UPF including the PDU Session Anchor 1 (PSA1).

   Ongoing charging interaction associated with the established PDU session (UPF).

2. At some point the SMF decides to establish a new PDU Session Anchor.

3. The SMF selects a UPF and using N4 establish the Branching Point (in case of IPv6 multi-homing) or a UL CL for the PDU Session.

3ch-a. The SMF sends Charging Data Request[Update] to the CHF for the additional of UPF (PSA 2) if quota management is granted per UPF by trigger "Addition of UPF".

3ch-b. The CHF updates the CDR for the charging information of UPF (PSA 2).

3ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

4-6. The SMF updates the PSA1, PSA2 and (R)AN.

7. In case of IPv6 multi-homing, the SMF notifies the UE of the availability of the new IP prefix @ PSA2.

8. In case of IPv6 multi-homing, the SMF may re-configure the UE for the original IP prefix @ PSA1.

5.2.2.8 Removal of additional PDU Session Anchor and Branching Point or UL CL

The following figure 5.2.2.8.1 describes charging procedure to remove a PDU Session Anchor and (optionally) remove Branching Point or UL CL for an established PDU Session as defined in clause 4.3.5.5 TS 23.502[201].

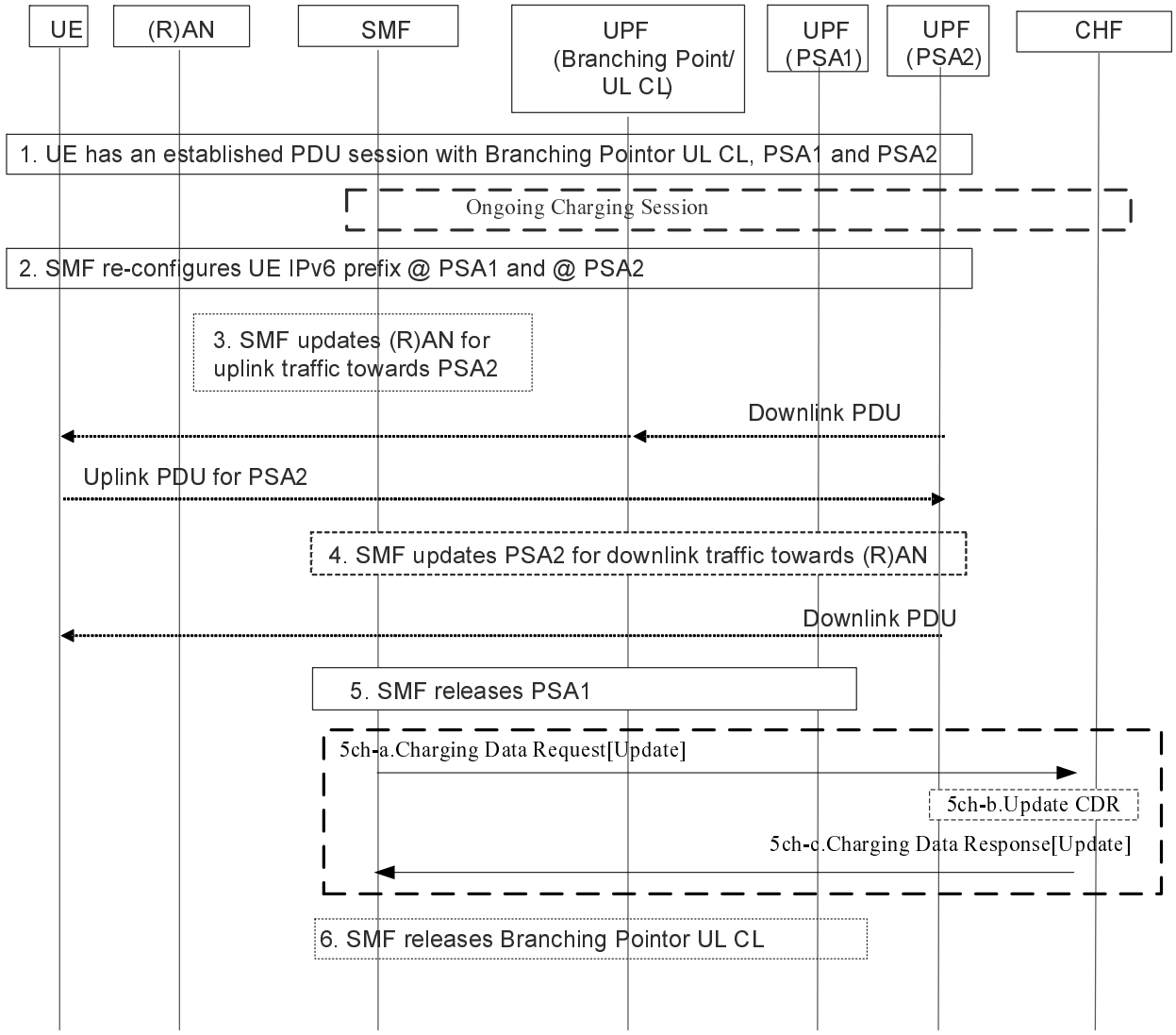

Figure 5.2.2.8.1: Removal of additional PDU Session Anchor and Branching Point or UL CL

1. UE has an established PDU Session with a UPF including the Branching Point or UL CL, the PDU Session Anchor 1 (PSA1) and the PDU Session Anchor 2 (PSA2).

   Ongoing charging interaction associated with the established PDU session (UPF).

   At some point the SMF decides to remove the PDU Session Anchor 1 e.g. due to UE mobility, flow terminated.

2. In case of IPv6 multi-homing, the SMF notifies the UE to stop using the IPv6 prefix corresponding to PSA1.

3-4. If the Branching Point or UL CL is to be released, the SMF updates the (R)AN and PSA2.

5. The SMF releases via N4 the PSA1.

5ch-a. The SMF sends Charging Data Request[Update] to the CHF for the removal of UPF (PSA 1) if quota management is granted per UPF by trigger "Removal of UPF".

5ch-b. The CHF updates the CDR for the charging information of UPF (PSA 1).

5ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

6. If steps 4 and 5 were executed, the SMF releases the Branching Point / UL CL.

5.2.2.9 Change of additional PDU Session Anchor for IPv6 multi-homing or UL CL

The following figure 5.2.2.9.1 charging procedure to establish a new additional PDU Session Anchor (i.e., PSA2) and conditionally releases the existing additional PDU Session Anchor (i.e. PSA1), while modifying IPv6 multi-homing or UL CL rule in the same Branching Point or UL CL under controlled by the same SMF as defined in clause 4.3.5.6 TS 23.502[201].

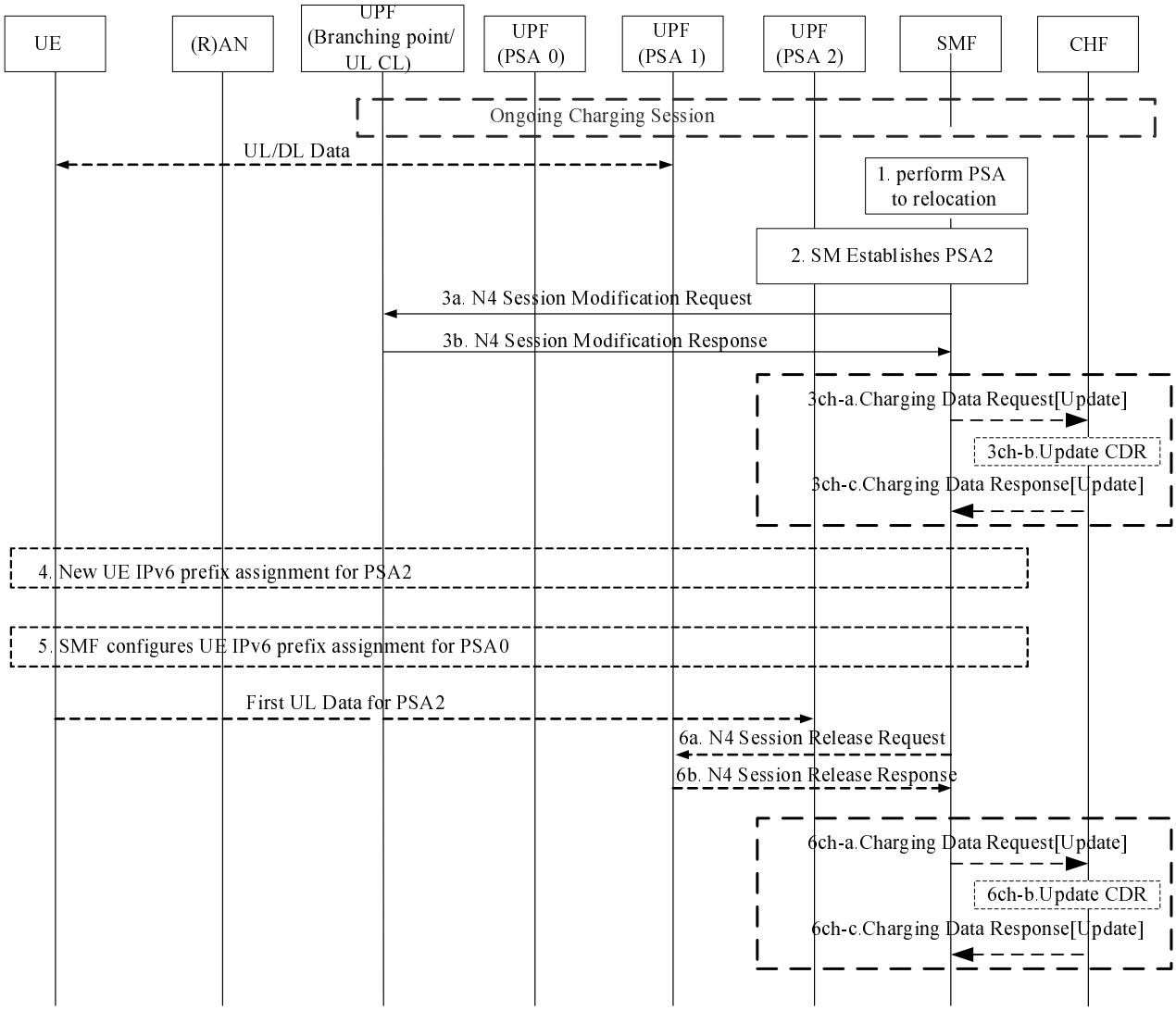

Figure 5.2.2.9.1: Change of additional PSA for a PDU Session in IPv6 multi-homing or UL CL case

Ongoing charging interaction associated with the established PDU session (UPF).

1. The SMF decides to change one additional PSA of a PDU Session with IPv6 multi-homing or UL CL.

2. The SMF sends an N4 Session Establishment Request to PSA2.

3a-b. The SMF exchange the N4 message toBranching Point or UL CL .

3ch-a. The SMF sends Charging Data Request[Update] to the CHF for the additional of UPF (PSA 2) if quota management is granted per UPF by trigger "Addition of UPF".

3ch-b. The CHF updates the CDR for the charging information of UPF (PSA 2).

3ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

4-5. In case of IPv6 multi-homing PDU Session, The SMF notifies and may re-configure the UE for IP prefix.

6. Step 6 occurs only if the Branching Point or UL CL does not have any traffic filter on the PDU Session which forwards a traffic flow to PSA1.

6ch-a. The SMF sends Charging Data Request[Update] to the CHF for the removal of UPF (PSA 1) if quota management is granted per UPF by trigger "Removal of UPF".

6ch-b. The CHF updates the CDR for the charging information of UPF (PSA 1).

6ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

5.2.2.10 Simultaneous change of Branching Point or UL CL and additional PSA for a PDU Session

The following figure 5.2.2.10.1 describe the charging procedure to change the Branching Point or the UL CL and additional PSA serving a PDU Session for a UE triggered by SMF ((just an example call flow triggered by Xn based handover) as defined in clause 4.3.5.7 TS 23.502[201].

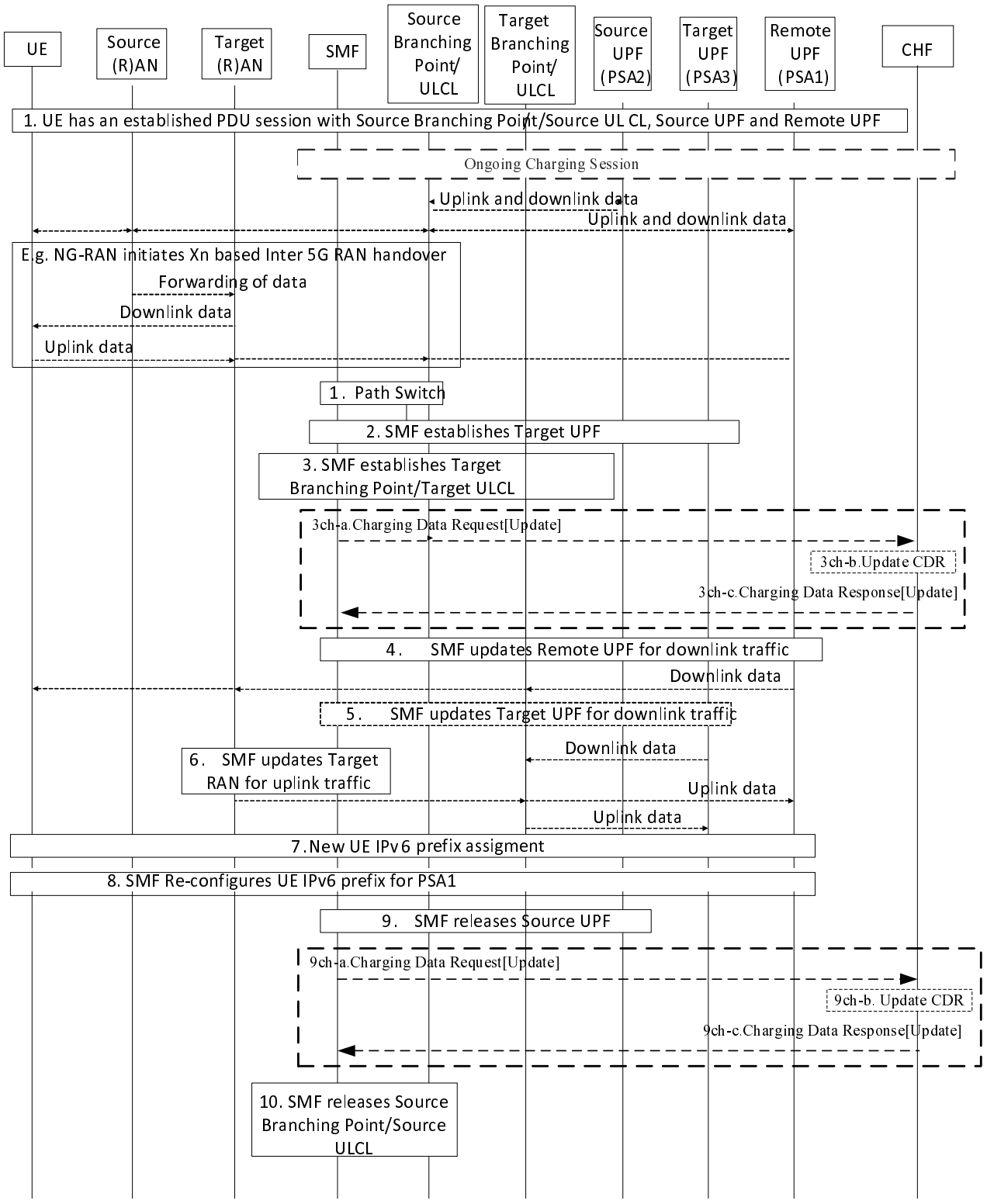

Figure 5.2.2.10.1: Simultaneous change of Branching Point or UL CL and additional PSA for a PDU Session

1. At some point SMF decides to change the Branching Point or the UL CL due to UE mobility.

   Ongoing charging interaction associated with the established PDU session (UPF).

2. The SMF selects a local Target UPF (PSA3) and using N4 establishes the local Target UPF for the PDU Session.
3. The SMF selects a UPF and using N4 establishes the Target Branching Point or Target UL CL for the PDU Session.

3ch-a. The SMF sends Charging Data Request[Update] to the CHF for the additional of Target UPF if quota management is granted per UPF by trigger "Addition of UPF".

3ch-b. The CHF updates the CDR for the charging information of Target UPF.

3ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

4-6. The SMF updates the PSA1 PSA3 and (R)AN.

7-8. In case of IPv6 multi-homing, the SMF notifies the UE and may re-configure the UE the IP prefix.

9. The SMF releases PSA2.

9ch-a. The SMF sends Charging Data Request[Update] to the CHF for the removal of Source UPF if quota management is granted per UPF by trigger "Removal of UPF".

9ch-b. The CHF updates the CDR for the charging information of Source UPF.

9ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

10. The SMF releases the Source Branching Point or the Source UL CL.

5.2.2.11 PDU session charging for interworking with EPC

5.2.2.11.1 General

In order to interwork with EPC, the N26 interface is introduced as an inter-CN interface between the MME in EPC and 5GS AMF in order to enable provide seamless session continuity for single registration mode UE for inter-system change in the clause 5.17.2.2 TS 23.501[201].

PCF + PCRF, PGW-C + SMF and UPF + PGW-U are dedicated for interworking between 5GS and EPC, which are optional and are based on UE MM Core Network Capability and UE subscription in the clause 4.3 TS 23.501 [201]. The procedures for interworking with EPS based on N26 interface are specified in clause 4.11.1 TS 23.502 [202].

Interaction beween the PGW-C + SMF and CHF is using the same interface as for interaction between SMF and CHF.

5.2.2.11.2 5GS to EPS handover using N26 interface

The following figure 5.2.2.11.2.1 describes a PDU session charging handover from 5GS to EPS when N26 is supported, based on clause 4.11.1.2.1 TS 23.502 [202] description:

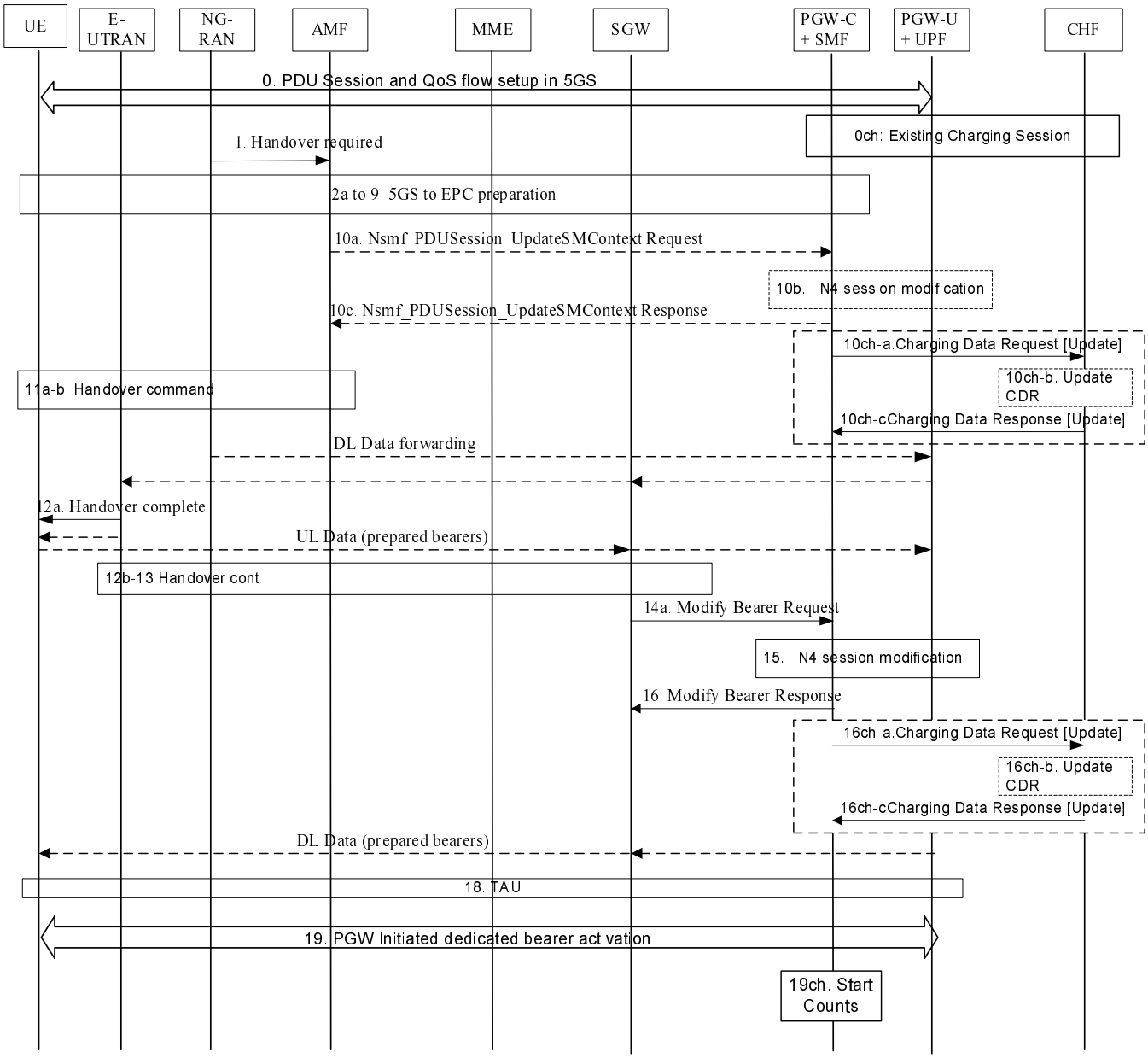

Figure 5.2.2.11.2.1: PDU session charging: 5GS to EPS handover using N26

0. A PDU session is established in 5GS with multiple QoS Flows.

0ch. A charging session exist for this PDU session.

1. 5G RAN decides that the UE should be handed over to the E-UTRAN.

2a-9. 5GS to EPC handover preparation between AMF, PGW-C+SMF, MME, SGW and E-UTRAN:

- bearer(s) setup in EPC, based on NG-RAN indicated bearers corresponding to the 5G QoS Flows for data forwarding (PGW-C+SMF indication that EPS Bearer IDs need to be assigned to the QoS Flows).

- non-IP PDN Type in EPC, for PDU Sessions with PDU Session Type Ethernet or Unstructured in 5GS.

10a-c. If indirect forwarding applies, the AMF forwards to the PGW-C+SMF the information related to data forwarding to the SGW. The PGW-C+SMF maps the EPS bearers for Data forwarding to the 5G QoS flows based on the association between the EPS bearer ID(s) and QFI(s) for the QoS flow(s).

10ch-a. This step occurs if steps 10a-c occurred. All counts are closed and a Charging Data Request [Update] is sent to CHF. New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

10ch-b. The CHF updates CDR for this PDU session.

10ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the PGW-C+SMF.

12a-13. 5GS to EPC handover continuation.

14a-16. User Plane path switch for the default bearer and the dedicated GBR bearers between the UE and PGW-U+UPF via SGW.

16ch-a. All counts are closed and a Charging Data Request [Update] is sent to CHF, if required by "radio access type change" trigger. New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

16ch-b. The CHF updates CDR for this PDU session.

16ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the PGW-C+SMF.

18. TAU procedure.

19. Dedicated bearer activation procedure for non-GBR QoS flows initiated by PGW-C+SMF.

19ch. Needed counts are started on start of service data flows of corresponding non-GBR Qos Flows.

5.2.2.11.3 EPS to 5GS handover using N26 interface

The following figures 5.2.2.11.3.1 and 5.2.2.11.3.2 describe a PDU session charging handover from EPS to 5GS when N26 is supported, based on clause 4.11.1.2.2 TS 23.502 [202] description:

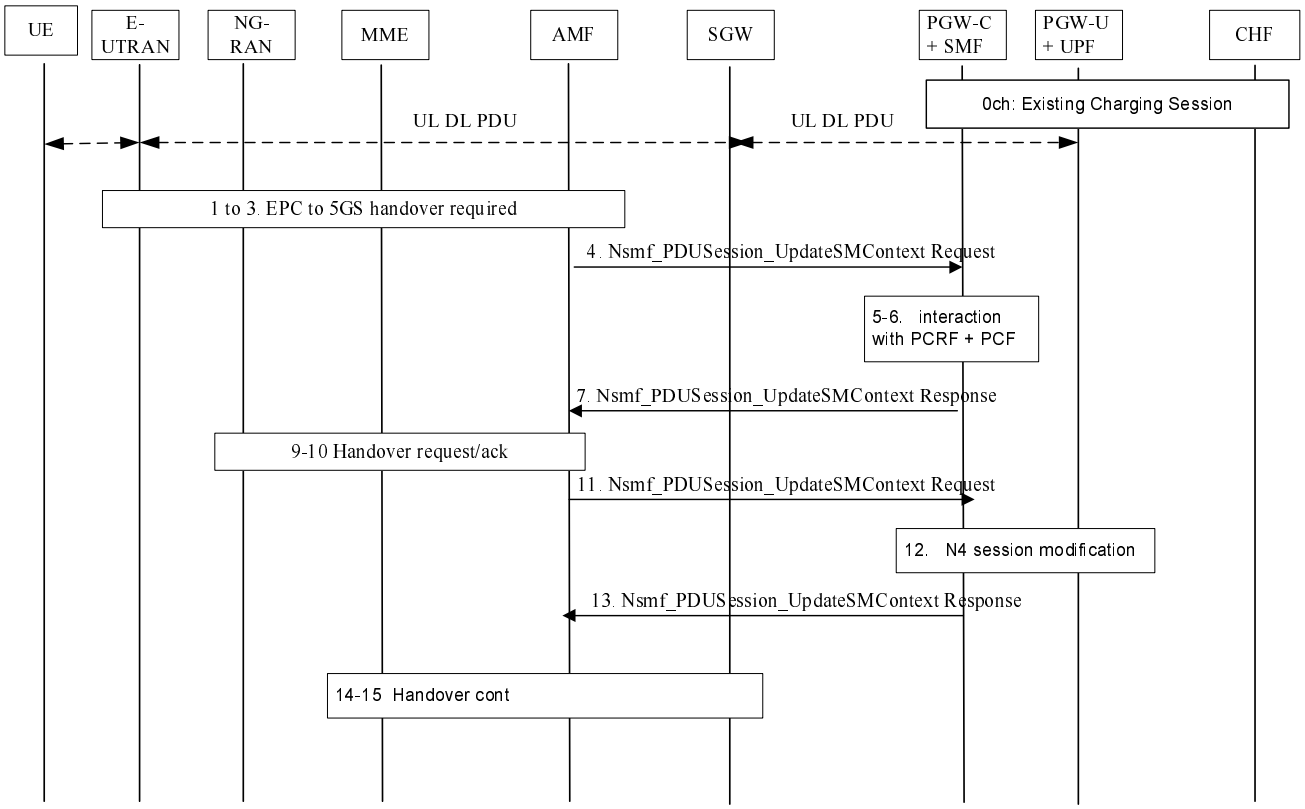

Figure 5.2.2.11.3.1: PDU session charging: EPS to 5GS handover using N26 - preparation

0. A PDU session is established in EPC with default bearer and dedicated bearers. Association between the EPS bearer and the corresponding 5G QoS Rules is stored by the PGW-C+SMF.

0ch. A charging session exist for this PDU session with multiple QoS Flows associated to the default bearer and dedicated bearers.

1-3. E-UTRAN decides that the UE should be handed over to the NG-UTRAN, this is forwarded from MME to AMF.

4-10. EPC to 5GS handover preparation to 5GS between AMF, PGW-C+SMF, AMF, NG-RAN:

- QFI(s), QoS Profile(s), EPS Bearer Setup List, mapping between QoS flows and EPS bearers are forwarded from the PGW-C+SMF.

- If the PDN Type of a PDN Connection in EPS is non-IP, and is locally associated in UE and SMF to PDU Session Type Ethernet or Unstructured, the PDU Session Type in 5GS is set to Ethernet or Unstructured respectively.

11-13. The AMF sends an Nsmf_PDUSession_UpdateSMContext Request with the list of accepted QFI(s). Based on this list, the SMF+PGW-C generates the list of EPS bearer Identifiers successfully handover to 5GC.

14-15. Handover continuation.

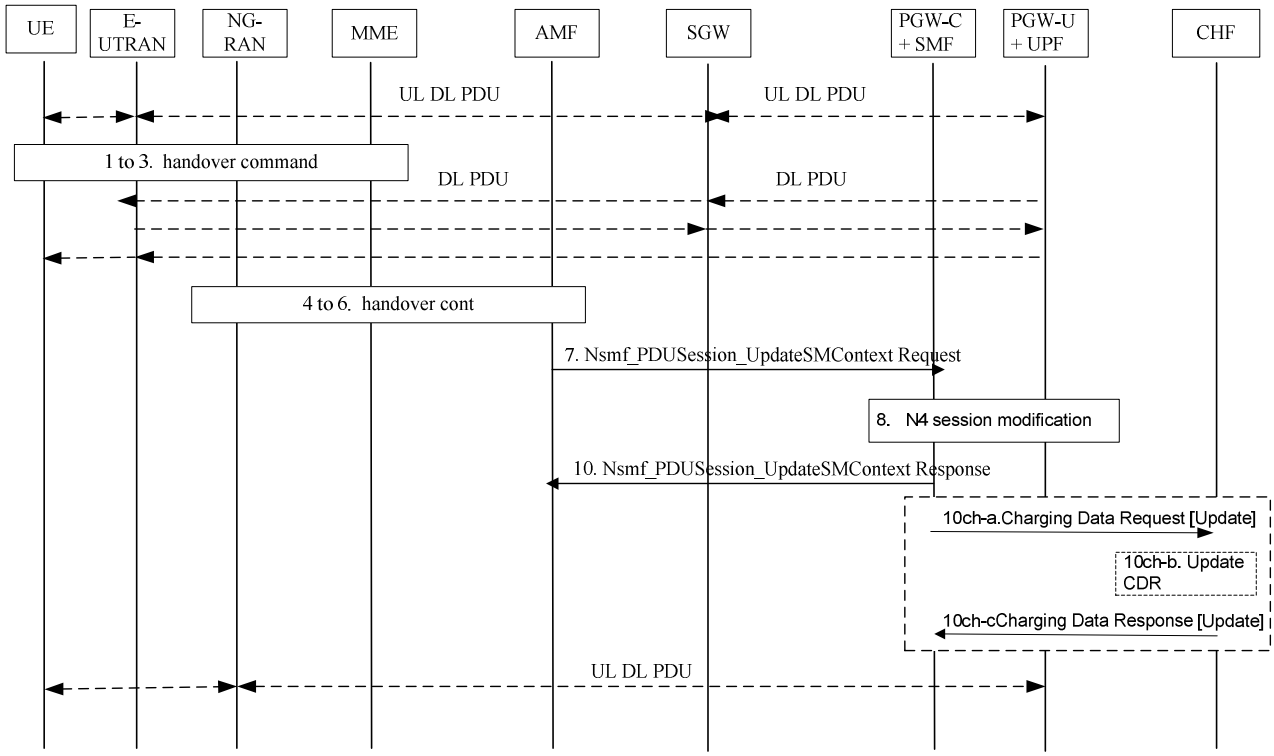

Figure 5.2.2.11.3.2: PDU session charging: EPS to 5GS handover using N26 - execution

1-6. Handover execution continuation.

7-10. The AMF sends an Nsmf_PDUSession_UpdateSMContext Request to indicate handover completion. The downlink User Plane is switched to NG-RAN.

10ch-a. All counts are closed and a Charging Data Request [Update] is sent to CHF, if required by "radio access type change" trigger. New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

10ch-b. The CHF updates CDR for this PDU session.

10ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the PGW-C+SMF.

5.2.2.12 PDU session charging for roaming in Home routed scenario

5.2.2.12.1 General

The subclauses below describe PDU session charging for roaming in Home routed scenario focusing on roaming QBC procedures between SMF and a CHF in respective PLMNs.

In H-PLMN, PDU session charging for FBC between H-SMF and a H-CHF occuring within the same charging session is not reflected.

5.2.2.12.2 PDU session establishment

The following figure 5.2.2.12.2.1 describes a PDU session charging establishment in roaming Home routed scenario based on clause 4.3.2.2.2 TS 23.502 [202] description:

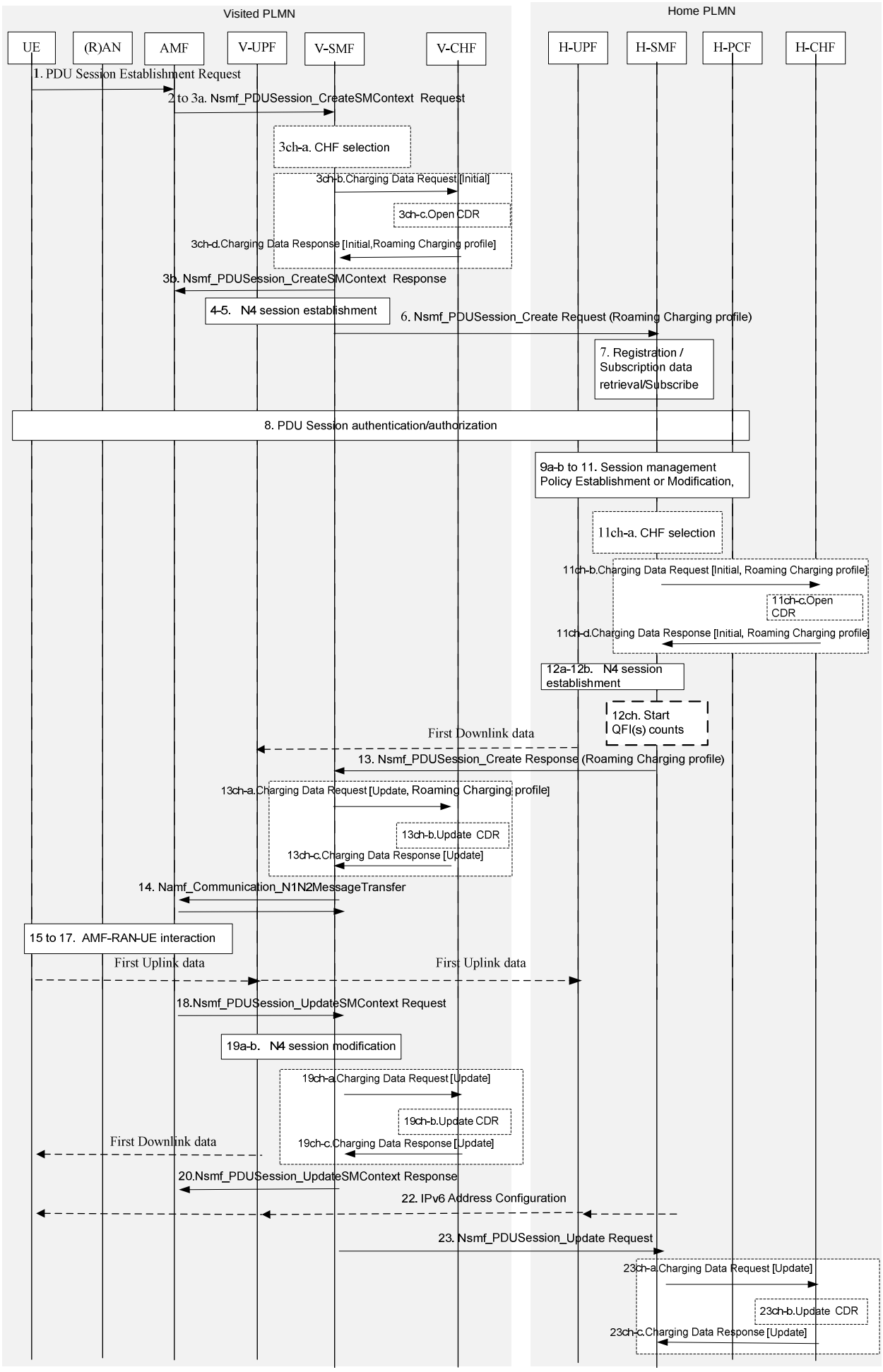
Visited PLMN
Home PLMN
UE
(R)AN
AMF
V-UPF
V-SMF
V-CHF
H-UPF
H-SMF
H-PCF
H-CHF
1. PDU Session Establishment Request
2 to 3a. Nsmf_PDUSession_CreateSMContext Request
3ch-a. CHF selection
3ch-b.Charging Data Request [Initial]
3ch-c.Open CDR
3ch-d.Charging Data Response [Initial,Roaming Charging profile]
3b. Nsmf_PDUSession_CreateSMContext Response
4-5. N4 session establishment
6. Nsmf_PDUSession_Create Request (Roaming Charging profile)
7. Registration / Subscription data retrieval/Subscribe
8. PDU Session authentication/authorization
9a-b to 11. Session management Policy Establishment or Modification,
11ch-a. CHF selection
11ch-b.Charging Data Request [Initial, Roaming Charging profile]
11ch-c.Open CDR
11ch-d.Charging Data Response [Initial, Roaming Charging profile]
12a-12b. N4 session establishment
12ch. Start QFI(s) counts
First Downlink data
13. Nsmf_PDUSession_Create Response (Roaming Charging profile)
13ch-a.Charging Data Request [Update, Roaming Charging profile]
13ch-b.Update CDR
13ch-c.Charging Data Response [Update]
14. Namf_Communication_N1N2MessageTransfer
15 to 17. AMF-RAN-UE interaction
First Uplink data
First Uplink data
18.Nsmf_PDUSession_UpdateSMContext Request
19a-b. N4 session modification
19ch-a.Charging Data Request [Update]
19ch-b.Update CDR
19ch-c.Charging Data Response [Update]
First Downlink data
20.Nsmf_PDUSession_UpdateSMContext Response
22. IPv6 Address Configuration
23. Nsmf_PDUSession_Update Request
23ch-a.Charging Data Request [Update]
23ch-b.Update CDR
23ch-c.Charging Data Response [Update]

Figure 5.2.2.12.2.1: PDU session charging: establishment roaming Home Routed

The steps in this figure are the steps of figure 4.3.2.2.2-1 TS 23.502 [202] with corresponding detailed description.

These steps are summarized below to highlight the main charging information relevant for this scenario, and extended with the charging description:

1-3a. UE initiates a new PDU session. V-SMF and H-SMF selection by the AMF.

3ch-a. The UE is identified as a roamer (PLMN ID of the received SUPI is different from VPLMN PLMN ID), the CHF is selected accordingly.

3ch-b. A Charging Data Request [Initial] is sent to CHF, indicating "in-bound roamer".

3ch-c. The CHF opens a CDR (indicating "in-bound roamer")

3ch-d. The CHF acknowledges by sending Charging Data Response[Initial] to the SMF and optionally supplies a "Roaming Charging Profile" to the V-SMF which overrides the default one.

3b-5. V-UPF selection by V-SMF, and N4 establishment.

6. Nsmf_PDUSession_Create Request from V-SMF to H-SMF includes the "Roaming Charging Profile" applicable in V-PLMN..

7. Subscription Data Retrieval in UDM, based on (Subscriber Permanent ID, DNN, VPLMN): Default QoS profile. Subscription data includes the authorized PDU type(s), authorized SSC mode(s), default 5QI and ARP, subscribed Session-AMBR, and charging characteristics.

8. Optional Secondary authorization/authentication.

[9a-b to 11]. If dynamic PCC is deployed, the H-SMF performs PCF selection, and requests for PCC Rules. The H-SMF may be provided with authorized Session-AMBR and the authorized 5QI and ARP. H-SMF selects the H-UPF.

11ch-a. Based on UE is identified as roaming in a different PLMN, the CHF is selected accordingly.

11ch-b. A Charging Data Request [Initial] is sent to CHF, indicating "out-bound roamer", with the "Roaming Charging Profile" received from the VPLMN.

11ch-c. The CHF opens a CDR (indicating "out-bound roamer").

11ch-d. The CHF acknowledges by sending Charging Data Response[Initial] to the H-SMF and supplies the HPLMN selected "Roaming Charging Profile" (either the same as the one received from VPLMN, either its own selected) to the H-SMF.

[12a-b]. The SMF initiates an N4 Session Establishment procedure with the selected UPF.

12ch. Counts per QFI are started.

13. Nsmf_PDUSession_Create Response from H-SMF to V-SMF with selected PDU Session Type SSC mode, HPLMN selected "Roaming Charging Profile", H-CN Tunnel Info, QFI(s), QoS profile(s), Session-AMBR, indication if VPLMN authorized to offload traffic (insert UL CL or Branching Point)). H-SMF ID is stored by V-SMF.

13ch-a. Based on "received PDU session conditions" trigger, a Charging Data Request [Update] is sent to CHF with charging information received from H-SMF, which includes the HPLMN selected "Roaming Charging Profile" and counts per QFI are started.

13ch-b. The CHF updates the CDR.

13ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the V-SMF.

[14-17]. AMF- RAN -UE interaction.

18. Nsmf_PDUSession_UpdateSMContext Request from AMF to V-SMF. The rejected QFI(s) associated QoS profiles are released by the SMF.

19a-b. N4 session modification.

19ch-a. Counts per rejected QFI(s) are closed. A Charging Data Request [Update] is sent to CHF to report if needed.

19ch-b. The CHF updates the CDR.

19ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the V-SMF.

[20-22]. PDU session establishment continuation.

23. Nsmf_PDUSession_UpdateRequest from V-SMF to H-SMF. The rejected QFI(s) are notified to H-SMF.

23ch-a. Counts per rejected QFI(s) are closed. A Charging Data Request [Update] is sent to CHF to report if needed.

23ch-b. The CHF updates the CDR.

23ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the H-SMF.

5.2.2.12.3 PDU session modification

The following figure 5.2.2.12.3.1 describes a PDU Session Modification procedure, home-routed roaming scenario based on clause 4.3.3.3 TS 23.502 [202] description:

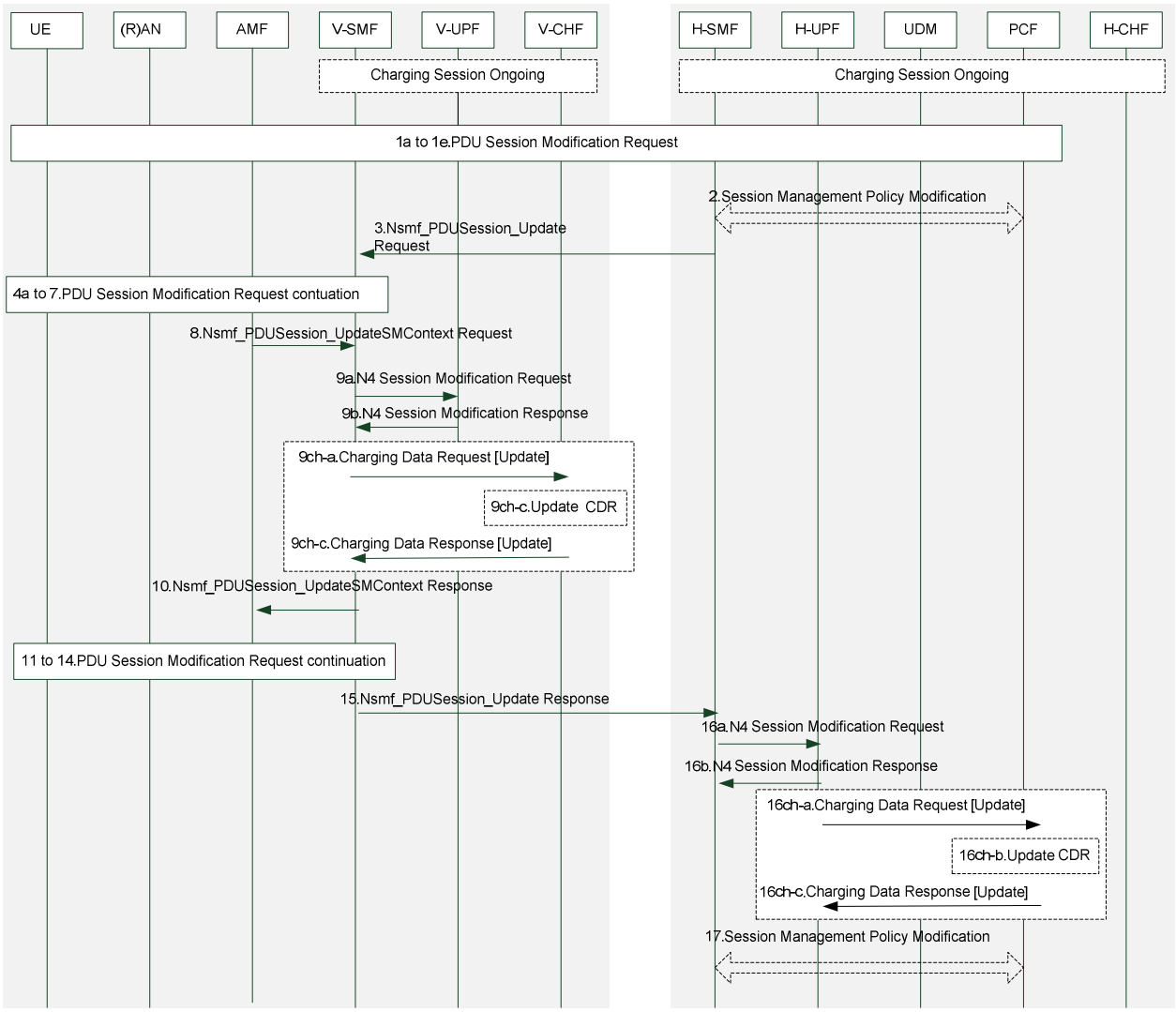

Figure 5.2.2.12.3.1: UE or network requested PDU Session Modification (for home-routed roaming scenario)

The steps in this figure are the steps of figure 4.3.3.3-1 TS 23.502 [202] with corresponding detailed description.

These steps are summarized below to highlight the main charging information relevant for this scenario, and extended with the charging description:

1a-e. The PDU Session Modification procedure is triggered by one of the possible events

2. The SMF may need to report some subscribed event to the PCF by performing a Session Management Policy Modification procedure.

3. The H-SMF invokes the Nsmf_PDUSession_Update Request (PDU Session ID, QoS profiles, Session-AMBR, information needed to build the SM PDU Session Modification Command message towards the UE including the QoS rule(s) and QoS rule operation) service operation to the V-SMF.

4a-7. These steps are the same as step 3a-6 in clause 4.3.3.2 TS 23.502 [202] but controlled from the V-SMF.

8. This step is the same as step 7a in clause 4.3.3.2 TS 23.502 [202] with the difference that the SMF is V-SMF.

9a-9b are the same as step 11a-11b in clause 4.3.3.2 TS 23.502 [202] but executed in Visited PLMN

9ch-a. A Charging Data Request [Update] is sent to V-CHF with charging information received from V-SMF, if needed and new counts per QFI are started.

9ch-b. The CHF updates the CDR.

9ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the V-SMF.

10. This step is the same as step 7b in clause 4.3.3.2 TS 23.502 [202] with the difference that the SMF is V-SMF.

11-14. These steps are the same as steps 8-10b in clause 4.3.3.2 TS 23.502 [202] but executed in Visited PLMN.

15. V-SMF responds to the H-SMF with an Nsmf_PDUSession_Update response carrying the information like ePCO provided by the UE in the SM PDU Session Modification Command Ack message from the UE to the V-SMF. The H-SMF shall modify the PDU Session context.

16. The step is the same as step 11 in clause 4.3.3.2 TS 23.502 [202] with the difference that the SMF is H-SMF.

16ch-a. A Charging Data Request [Update] is sent to H-CHF with charging information received from H-SMF, if needed, and new counts per QFI are started.

16ch-b. The CHF updates the CDR.

16ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the H-SMF.

17. The step is the same as step 12 in clause 4.3.3.2 TS 23.502 [202] with the difference that the SMF is H-SMF.

5.2.2.12.4 PDU session release

The following figure 5.2.2.8.4.1 describes a PDU session charging release in roaming Home routed scenario based on clause 4.3.4.3 TS 23.502 [202] description:

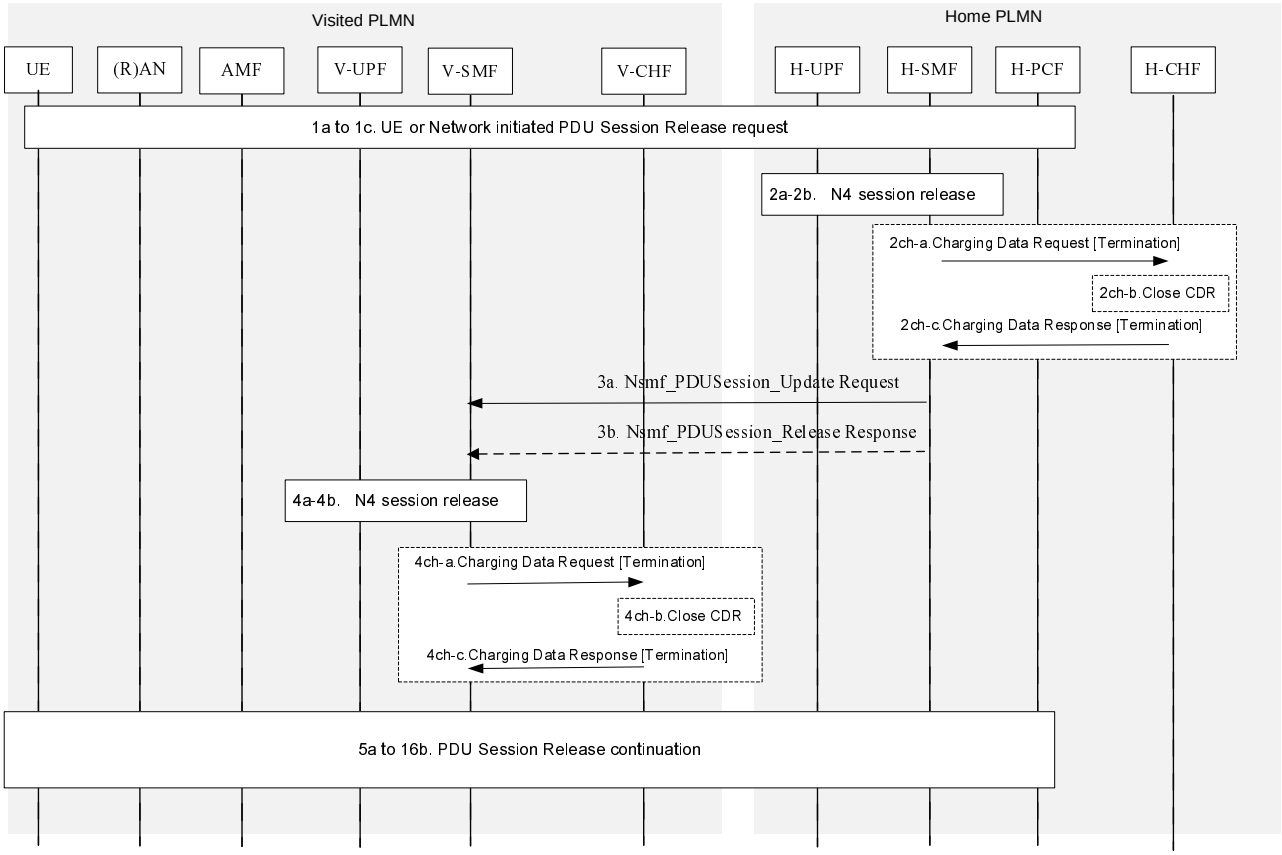

Figure 5.2.2.12.4.1: PDU session charging: release roaming Home Routed

The steps in this figure are the steps of figure 4.3.4.3-1 of TS 23.502 [202] with corresponding detailed description.

These steps are summarized below to highlight the main charging information relevant for this scenario, and extended with the charging description:

1a-1c. UE or Network initiates PDU session release.

2a-2b. N4 session release between H-SMF and H-UPF.

2ch_a. A Charging Data Request [Termination] is sent to CHF with the set of QFI(s) counts.

2ch-b. The CHF closes the CDR

2ch-c. The CHF acknowledges by sending Charging Data Response[Termination] to the H-SMF.

3a. Nsmf_PDUSession_Update Request from H-SMF to V-SMF for releasing the PDU session towards the UE.

3b. (Serving network initiated release) The H-SMF responds to the PDU release request from the V-SMF with a Nsmf_PDUSession_Release response.

4a-4b. N4 session release between V-SMF and V-UPF.

4ch-a. A Charging Data Request [Termination] is sent to CHF with the set of QFI(s) counts.

4ch-b. The CHF closes the CDR

4ch-c. The CHF acknowledges by sending Charging Data Response[Termination] to the V-SMF.

5a to 16b. PDU session release continuation.

5.2.2.13 PDU session charging - non-3GPP access

5.2.2.13.1 General

After UE registration to 5GC via an untrusted non-3GPP access network, a PDU session can be established via this non-3GPP access, as specified in 4.12.5 TS 23.502 [202] for different scenarios:

- UE initiated PDU session establishment;
- Handover of a PDU Session from 3GPP access to untrusted non-3GPP access;
- Service Request procedures via Untrusted non-3GPP Access specified in clause 4.12.4.1 TS 23.502 [202].

Handover procedure of a PDU Session between 3GPP access and untrusted non-3GPP access is achieved by PDU Session Establishment over source access followed by PDU Session Release over the target access for respective N2 Resources Release. The PDU Session ID, IP address/prefix, and SSC mode are maintained during the move.

PDU session over Untrusted non-3GPP Access release is specified in clause 4.12.7 TS 23.502 [202].

5.2.2.13.2 PDU session establishment

The following figure 5.2.2.13.2.1 describes a PDU session charging establishment via an untrusted non-3GPP access network scenario based on clause 4.12.15 in TS 23.502 [202] description:

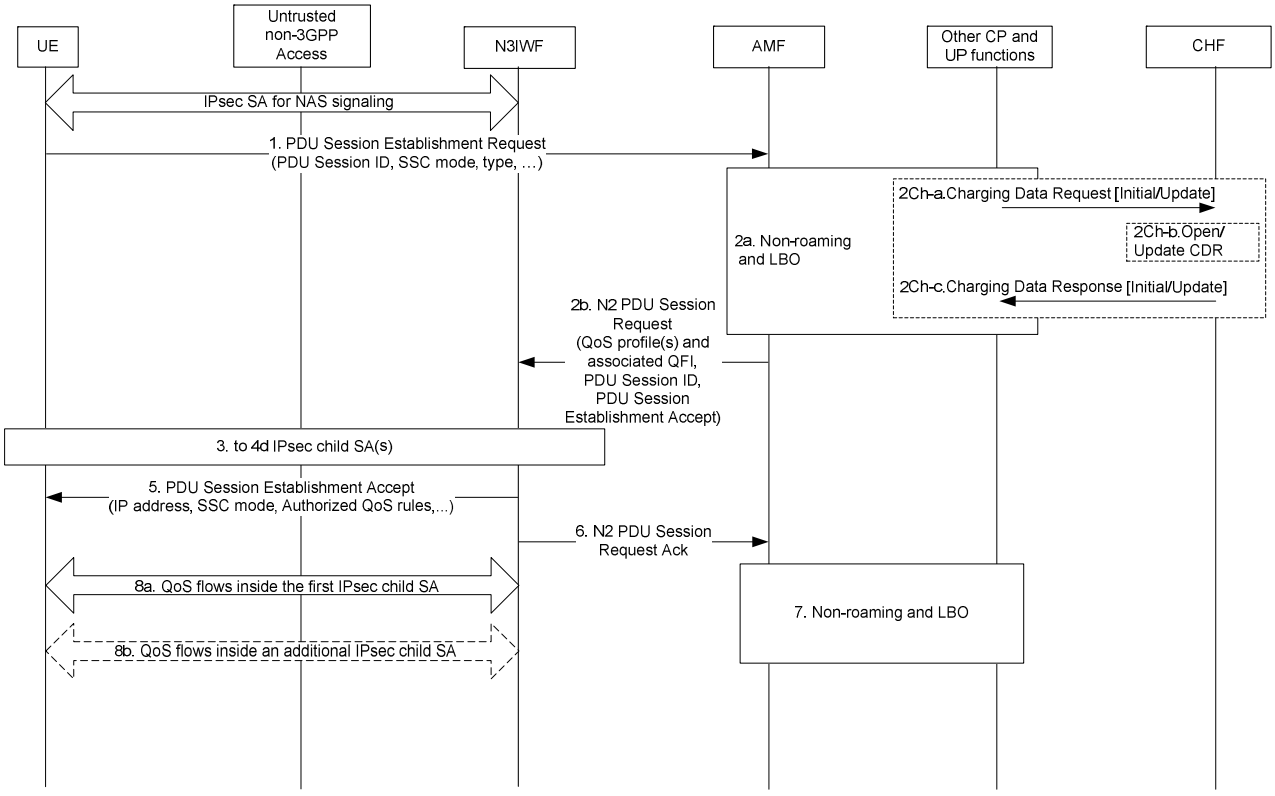

Figure 5.2.2.13.2.1: PDU Session establishment via untrusted non-3GPP access

1. UE PDU Session Establishment Request transparently forwarded by the N3IWF to AMF in the 5GC, indicating either "Initial request" in case of a new PDU session, either "Existing PDU Session" in case of handover from 3GPP access.

2a. PDU Session Establishment as per steps 2-11 Figure 5.2.2.2.1, with Access Type indicating non-3GPP access, user location information including the N3GPP TAI (unique reserved TAI value dedicated to Non-3GPP).

[2ch-a to 2ch-c]. Two cases:

- In case of "Initial request" the same steps as steps 7ch-a to 7ch-c in figure 5.2.2.2.1 apply, for initial SMF interaction with CHF, with Charging Data Request [Initial].

- In case of "Existing PDU Session" the "radio access type change" trigger may apply for SMF interaction with CHF, with Charging Data Request [Update].

2b. AMF sends a N2 PDU Session Request message to N3IWF to establish the access resources for this PDU Session.

[3 to 4d]. One or multiple IPsec child Security Association (SA) establishment and association with the QoS profiles.

[5 to 8]. After all IPsec child SAs are established, and N3IWF exchanges with UE and AMF, the PDU Session Establishment procedure continues as per steps after 14 in Figure 5.2.2.2.1. QoS flows traffic occurs based on IPsec child SA associated with the QFI.

5.2.2.13.3 PDU session modification

The following figure 5.2.2.13.3.1 describes a PDU session charging modification via an untrusted non-3GPP access network scenario based on clause 4.12.16 in TS 23.502 [202] description:

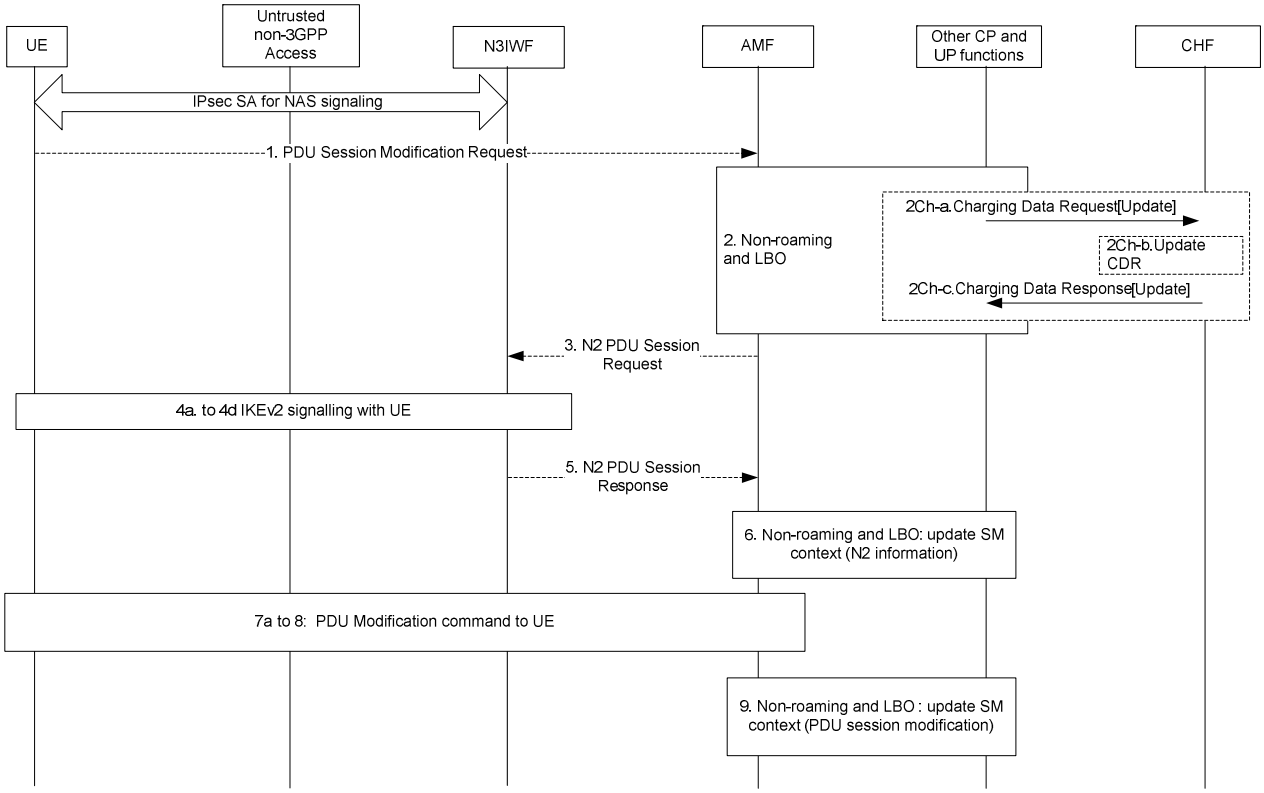

Figure 5.2.2.13.3.1: PDU Session modification via untrusted non-3GPP access

1. UE PDU Session Modification Request transparently forwarded by the N3IWF to AMF in the 5GC.

2. PDU Session Modification procedure as steps 1a (from AMF) to 1e and steps 2-3 in clause 4.3.3.2 TS 23.502 [202] are executed.

[2ch-a to 2ch-c]: Interaction between SMF and CHF triggered by the modification applied to the PDU session (e.g. QoS handling).

[3 to 6]. PDU Session Modification procedure continuation.

5.2.2.13.4 PDU session release

The following figure 5.2.2.13.4.1 describes a PDU session charging release via an untrusted non-3GPP access network scenario based on clause 4.12.17 in TS 23.502 [202] description:

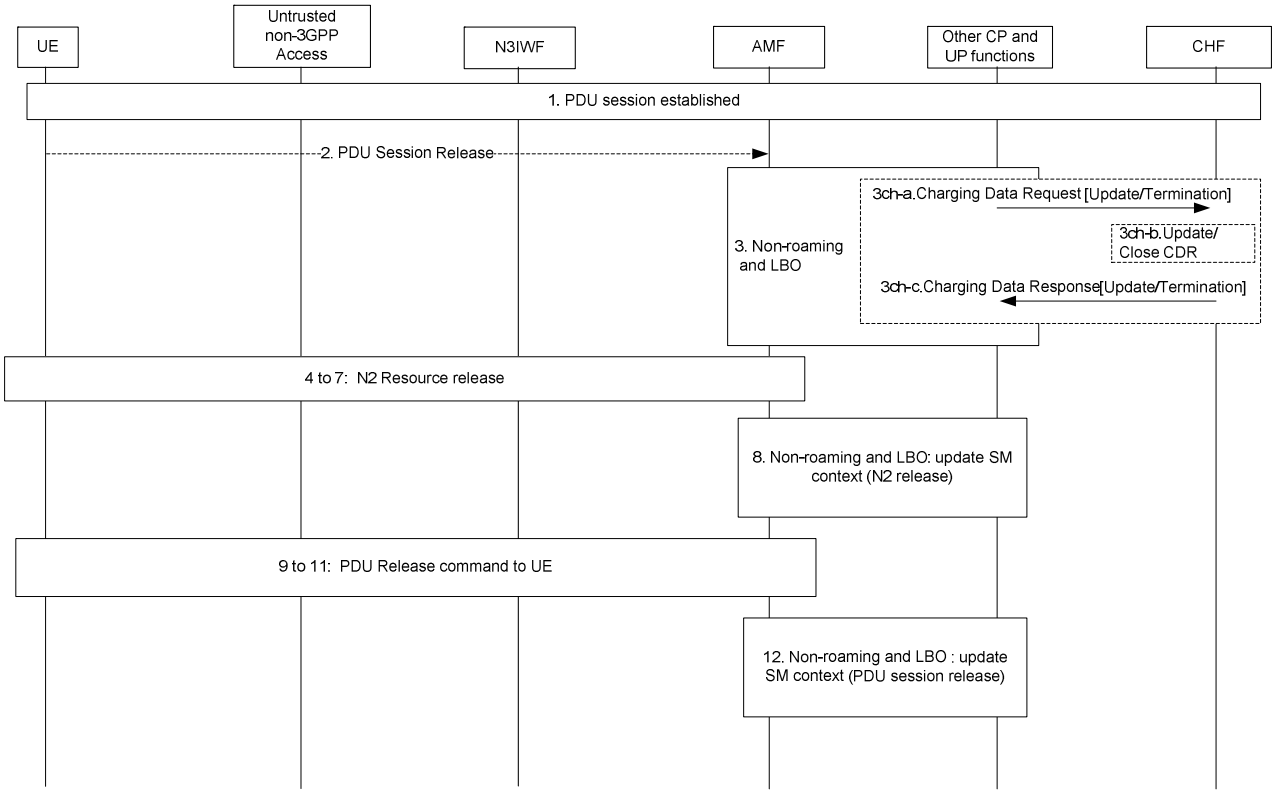

Figure 5.2.2.13.4.1: PDU Session release via untrusted non-3GPP access

[1 to 2]. A PDU Session is established and the UE sends a PDU Session Release Request message to the SMF via the N3IWF.

3. PDU Session Release as steps 1a (from AMF) to 4 in clause 4.3.4.2 TS 23.502 [202] are executed.

[3cha-3chb]. Two cases:

- In case the PDU session needs to be released, SMF interaction with CHF for release, with Charging Data Request [Termination].
- In case of handover from non-3GPP access to 3GPP access, SMF may interacts with CHF, with Charging Data Request [Update].

NOTE 1: the "radio access type change" trigger, if enabled, applied during the PDU session establishment over the 3GPP access which was performed prior to this PDU session release over non-3GPP access.

[4 to 7]. PDU Session Release procedure for N2 Resource release.

8. PDU Session Release procedure continuation related to N2 Resource release.

[9 to 12]. These steps do not apply to PDU session release due to handover from non-3GPP access to 3GPP access.

5.2.3 CDR generation

5.2.3.1 Introduction

The CHF CDRs for PDU session charging and roaming QBC are generated by the CHF to collect charging information that they subsequently transfer to the Charging Gateway Function (CGF).

The following clauses describe in details the conditions for opening, adding information to, and closing the CHF CDR, which shall be supported by the CHF as the default behavior.

As an alternative to the default CHF behaviour, the "Individual Partial record" mechanism can be used based on Operator's policy configured in the CHF..

5.2.3.2 Triggers for CHF CDR

5.2.3.2.1 General

A PDU session charging CHF CDR is used to collect charging information related to the PDU session data information for a UE in Flow Based Charging. Multiple service data flow containers per PDU session can be added in the CHF CDR by the CHF, upon receiving a Charging Data Request including new counts as defined in subclause 5.2.1.1.

A CHF CDR shall be opened when the CHF receives Charging Data Request[Initial].

5.2.3.2.2 Triggers for CHF CDR charging information addition

When the CHF receives Charging Data Request[Update], with the change conditions identified in Table 5.2.3.2.2.1 the charging information shall be added in the PDU session charging CHF CDR, and the CDR shall remain open, as the default supported mechanism.

Table 5.2.3.2.2.1: Triggers for CHF CDR charging information addition

Trigger Conditions
Change of Charging conditions
QoS change
User Location change
AMF change
Change of UE presence in Presence Reporting Area(s)
Change of 3GPP PS Data off Status
Limit per Rating Group
Expiry of data time limit per RG
Expiry of data volume limit per RG
Expiry of data event limit per RG
Quota management triggers
Time threshold reached
Volume threshold reached
Unit threshold reached
Time quota exhausted
Volume quota exhausted
Unit quota exhausted
Expiry of quota validity time
Re-authorization request by CHF

In case the "Individual Partial record" mechanism is enabled, this sub-clause is not applicable.The charging information received from the CHF consists of a set of containers, which are added as "List of Multiple Unit Usage" parameter of the CHF CDR. Each container identifies the configured counts (volume separated for uplink and downlink, elapsed time or number of events) per rating group or combination of the rating group and service id, associated with the changed charging conditions.

5.2.3.2.3 Triggers for CHF CDR partial record closure

When the CHF receives Charging Data Request[Update],with the change conditions identified in Table 5.2.3.2.3.1, the charging information shall be added in the PDU session charging CHF CDR, before the CDR is closed and a subsequent CHF CDR shall be opened with an incremented Sequence Number, as the default supported mechanism.

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Table 5.2.3.2.3.1: Triggers for CHF CDR partial record closure

Trigger Conditions
Change of Charging conditions
UE time zone change
PLMN change
RAT type change
DNN-AMBR change
Removal of UPF
Management intervention
Limit per PDU session
Expiry of data time limit per PDU session
Expiry of data volume limit per PDU session
Expiry of data event limit per PDU session
Expiry of limit of number of charging condition changes

In case the "Individual Partial record" mechanism is enabled, the Table 5.2.3.4.1 is not relevant: instead, the charging information shall be added in the CHF CDR, before the CDR is closed and a subsequent CHF CDR shall be opened with an incremented Sequence Number for each Charging Data Request[Update] received by the CHF.

5.2.3.2.4 Triggers for CHF CDR closure

When the CHF receives Charging Data Request[Termination], the charging information shall be added in the PDU session charging CHF CDR and the CDR shall be closed.

5.2.3.3 Triggers for CHF CDR for roaming QBC

5.2.3.3.1 General

A Roaming QBC CHF CDR is used to collect charging information related to Roaming QBC in V-SMF, and the PDU session charging CHF CDR is used to collect charging information related to Roaming QBC in H-SMF. QoS flow containers per PDU session can be added in the CHF CDRs by the CHF, upon receiving a Charging Data Request.

The charging information received from the CHF consists of a set of containers, which are added as "List Multiple QFI container" parameter of the CHF CDRs. Each container identifies the configured counts (volume separated for uplink and downlink, elapsed time) per QoS Flow, associated with the changed charging conditions.

A roaming CHF CDR shall be opened when the CHF receives Charging Data Request[Initial] indicating "in-bound roamer".

5.2.3.3.2 Triggers for CHF CDR charging information addition for roaming QBC

When the CHF receives Charging Data Request[Update], with the change conditions identified in Table 5.2.3.3.2.1 the charging information shall be added in the CHFCDR, and the CDR shall remain open, as the default supported mechanism.

Table 5.2.3.3.2.1: Triggers for CHF CDR charging information addition for roaming QBC

Trigger Conditions
Change of Charging conditions
QoS change
User Location change
AMF change
Change of UE presence in Presence Reporting Area(s)
Change of 3GPP PS Data off Status
Limit per QoS Flow
Expiry of data time limit per QoS Flow
Expiry of data volume limit per QoS Flow
Others
End of QoS Flow

In case the "Individual partial record" mechanism is enabled, this sub-clause is not applicable.

5.2.3.3.3 Triggers for CHF CDR partial record closure for roaming QBC

When the CHF receives Charging Data Request[Update] with the change conditions identified in Table 5.2.3.3.3.1, the charging information shall be added in the CHF CDR, before the CDR is closed and a subsequent CHF CDR shall be opened with an incremented Sequence Number, as the default supported mechanism.

Table 5.2.3.3.3.1: Triggers for CHF CDR partial record closure for roaming QBC

Trigger Conditions
Change of Charging conditions
UE time zone change
PLMN change
RAT type change
DNN-AMBR change
Removal of UPF
Management intervention
Limit per PDU session
Expiry of data time limit per PDU session
Expiry of data volume limit per PDU session
Expiry of data event limit per PDU session
Expiry of limit of number of charging condition changes

In case the "Individual partial record" mechanism is enabled, the Table 5.2.3.3.3.1 is not relevant: instead, the charging information shall be added in the CHF CDR, before the CDR is closed and a subsequent CHF CDR shall be opened with an incremented Sequence Number for each Charging Data Request[Update] received by the CHF.

5.2.3.3.4 Triggers for roaming QBC CHF CDR closure

When the CHF receives Charging Data Request[Termination], the charging information shall be added in the roaming QBC CHF CDR and the CDR shall be closed.

5.2.4 Ga record transfer flows

In 5G, both fully qualified partial CDRs (FQPC) and reduced partial CDRs (RPC), as specified in TS 32.240 [1] may be supported on the Ga interface. In line with TS 32.240 [13], the support of FQPCs is mandatory, the support of RPCs is optional. For further details on the Ga protocol application refer to TS 32.295 [54].

5.2.5 Bd CDR file transfer

In 5G, both fully qualified partial CDRs (FQPC) and reduced partial CDRs (RPC), as specified in TS 32.240 [1] may be supported on the Bd interface. In line with TS 32.240 [13], the support of FQPCs is mandatory, the support of RPCs is optional. For further details on the Bd protocol application refer to TS 32.297 [52].

6. Definition of charging information

6.1 Data description for 5G data connectivity charging

6.1.1 Message contents

6.1.1.1 General

The Charging Data Request and Charging Data Response are specified in TS 32.290 [57] and include charging information. The Charging Data Request can be of type [Initial, Update, Termination].

Table 6.1.1.1.1 describes the use of these messages for converged charging.

Table 6.1.1.1.1: Converged charging messages reference table

Message	Source	Destination
Charging Data Request	SMF	CHF
Charging Data Response	CHF	SMF

The following clauses describe the different fields used in the Charging Data messages and the category in the tables is used according to the charging data configuration defined in clause 5.4 of TS 32.240 [1].

6.1.1.2 Charging Data Request message

Table 6.1.1.2.1 illustrates the basic structure of a Charging Data Request message from the SMF as used for 5G data connectivity converged charging.

Table 6.1.1.2.1: Charging Data Request message contents

Information Element	Category	Description
Session Identifier	O_C	Described in TS 32.290 [57]
Subscriber Identifier	M	Described in TS 32.290 [57]
NF Consumer Identification	M	Described in TS 32.290 [57]
NF Functionality	O_C	Described in TS 32.290 [57]
NF Name	O_C	Described in TS 32.290 [57]
NF Address	O_C	Described in TS 32.290 [57]
NF PLMN ID	O_C	Described in TS 32.290 [57]
Invocation Timestamp	M	Described in TS 32.290 [57]
Invocation Sequence Number	M	Described in TS 32.290 [57]
Notify URI	O_C	Described in TS 32.290 [57]
Triggers	O_C	This field is described in TS 32.290 [57] and holds the 5G data connectivity specific triggers described in clause 5.2.1.
Multiple Unit Usage	O_C	Described in TS 32.290 [57] This field is not applicable to QBC.
Rating Group	M	Described in TS 32.290 [57]
Requested Unit	O_C	Described in TS 32.290 [57]
Used Unit Container	O_C	Described in TS 32.290 [57]
Triggers	O_C	This field is described in TS 32.290 [57] and holds the 5G data connectivity specific triggers described in clause 5.2.1.
PDU Container Information	O_C	This field holds the 5G data connectivity PDU session container specific information described in clause 6.2.
UPF ID	O_C	This field holds the UPF identifier used to identify the UPF when quota granted per UPF by CHF for Requested unit and reporting the usage of the UPF for Used unit.
PDU Session Charging Information	O_M	This field holds the 5G data connectivity specific information described in clause 6.2.
Roaming QBC information	O_M	This field holds the roaming QBC specific information defined in clause 6.2.1.4 This field is not applicable to FBC.

6.1.1.3 Charging data response message

Table 6.1.1.3.1 illustrates the basic structure of a Charging Data Response message from the CHF as used for 5G data connectivity converged charging.

Table 6.1.1.3.1: Charging Data Response message contents

Information Element	Category	Description
Session Identifier	O_C	Described in TS 32.290 [57]
Invocation Timestamp	M	Described in TS 32.290 [57]
Invocation Result	M	Described in TS 32.290 [57]
Result code	M	Described in TS 32.290 [57]
Failed parameter	O_C	Described in TS 32.290 [57]
Failure Handling	O_C	Described in TS 32.290 [57]
Invocation Sequence Number	M	Described in TS 32.290 [57]
Session Failover	O_C	Described in TS 32.290 [57]
Multiple Unit information	O_C	Described in TS 32.290 [57] This field is not applicable to QBC.
Result Code	O_C	Described in TS 32.290 [57]
Rating Group	M	Described in TS 32.290 [57]
UPF ID	O_C	This field holds the UPF identifier used for quota granted per UPF by CHF
Granted Unit	O_C	Described in TS 32.290 [57]
Validity Time	O_C	Described in TS 32.290 [57]
Final Unit Indication	O_C	Described in TS 32.290 [57]
Time Quota Threshold	O_C	Described in TS 32.290 [57]
Volume Quota Threshold	O_C	Described in TS 32.290 [57]
Unit Quota Threshold	O_C	Described in TS 32.290 [57]
Quota Holding Time	O_C	Described in TS 32.290 [57]
Triggers	O_C	This field is described in TS 32.290 [57] and holds the 5G data connectivity specific triggers described in clause 5.2.1.
Quota Consumption Time	O_C	Described in TS 32.290 [57]
Triggers	O_C	This field is described in TS 32.290 [57] and holds the 5G data connectivity specific triggers described in clause 5.2.1.
PDU Session Charging Information	O_M	This field holds the 5G data connectivity specific information described in clause 6.2.
Roaming QBC information	O_M	This field holds the roaming QBC specific information defined in clause 6.2.1.4 This field is not applicable to FBC.

6.1.2 Ga message contents

6.1.3 CDR description on the B_d interface

6.1.3.1 General

This clause describes the CDR content and format generated for 5G data connectivity - PDU session charging.

The following tables provide a brief description of each CDR parameter. The category in the tables is used according to the charging data configuration defined in clause 5.4 of TS 32.240 [1]. Full definitions of the CDR parameters, sorted by the name in alphabetical order, are provided in TS 32.298 [51].

6.1.3.2 PDU session charging CHF CDR data

If enabled, CHF CDRs for PDU session charging shall be produced for each PDU session. In roaming Home routed scenario, the PDU session charging CHF CDR shall cover both Flow based Charging and Qos flow Based Charging (QBC) from H-SMF.

The fields of PDU session charging CHF CDR are specified in table 6.1.3.2.1.

Table 6.1.3.2.1: PDU session charging CHF record data

Field	Category	Description
Record Type	M	CHF record.
Recording Network Function ID	O_M	This field holds the name of the recording entity, i.e. the CHF id.
Subscriber Identifier	O_M	This field holds the 5G Subscription Permanent Identifier (SUPI) of the served party. This fields should be present except for emergency session.
NF Information	O_C	This field holds the information of the SMF that used the charging service.
NF Functionality	M	This field contains the function of the node (i.e. SMF)
NF Name	O_C	This field holds the name of the SMF used.
NF Address	O_C	This fields holds the IP Address of the SMF used.
NF PLMN ID	Oc	This field holds the PLMN identifier (MCC MNC) of the SMF.
List of Multiple Unit Usage	O_M	This field holds a list of changes in charging conditions for all service data flows within this PDU session.This list is categorized per rating group or per combination of rating group and service id or per combination of rating group, sponsor identity and application service provider identity. In addition, usage is differentiated between with and without quota management. Each change is time stamped. Charging conditions are used to categorize traffic volumes, elapsed time and number of events, such as per tariff period.
Rating Group	O_M	This filed holds the rating group.
Used Unit Container	O_C	This field holds the used units and information connected to the reported units.
Service Identifier	O_C	This field holds the Service Identifier.
Quota management Indicator	O_M	This field holds an indicator on whether the used units are with or without quota management.
Triggers	O_C	This field holds the reason for closing the used unit container.
Trigger Timestamp	O_C	This field holds the timestamp of the trigger.
Time	O_C	This field holds the amount of used time.
Total Volume	O_C	This field holds the amount of used volume in both uplink and downlink directions.
Uplink Volume	O_C	This field holds the amount of used volume in uplink direction.
Downlink Volume	O_C	This field holds the amount of used volume in downlink direction.
Service Specific Unit	O_C	This field holds the amount of used service specific units.
Event Time Stamps	O_C	This field holds the timestamps of the event reported in the Service Specific Units, if the reported units are event based.
Local Sequence Number	O_C	This field holds the container sequence number.
PDU Container Information	O_C	This field holds the 5G data connectivity specific information defined in clause 6.2.1.3.
UPF ID	O_C	This field holds the UPF identifier used to identify the UPF when reporting the usage for the UPF.
Record Opening Time	M	Time stamp when the PDU session is activated in the SMF or record opening time on subsequent partial records.
Duration	M	This field holds the duration of this record.
Record Sequence Number	C	Partial record sequence number, only present in case of partial records.
Cause for Record Closing	M	The reason for the release of the record.
Diagnostics	O_M	This field holds a more detailed reason for the release of the PDU session, when a single cause is applicable.
Local Record Sequence Number	O_M	Consecutive record number created by the CDF. The number is allocated sequentially including all CDR types.
Record Extensions	O_C	A set of network operator/manufacturer specific extensions to the record. Conditioned upon the existence of an extension.
PDU Session Charging Information	O_M	This field holds the 5G data connectivity specific information defined in clause 6.2.1.2.
Roaming QBC information	O_C	This field holds the roaming QBC specific information defined in clause 6.2.1.4, when applicable.

6.1.3.3 Roaming QBC CHF CDR data

If enabled, CHF CDRs for Roaming QBC shall be produced in VPLMN for each PDU session established for an in-bound roamer. The fields of Roaming QBC CHF CDR are specified in table 6.1.3.3.1.

Table 6.1.3.3.1: Roaming QBC CHF record data

Field	Category	Description
Record Type	M	CHF record.
Recording Network Function ID	O_M	This field holds the name of the recording entity, i.e. the CHF id.
Subscriber Identifier	M	This field holds the 5G Subscription Permanent Identifier (SUPI) of the served party, if available.
NF Information	O_C	This field holds the information of the V-SMF that used the charging service.
NF Functionality	M	This field contains the function of the node.
NF Name	O_C	This field holds the name of the V-SMF used.
NF Address	O_C	This fields holds the IP Address of the V-SMF used.
NF PLMN ID	Oc	This field holds the PLMN identifier (MCC MNC) of the V-SMF.
Record Opening Time	M	Time stamp when the PDU session is activated in the SMF or record opening time on subsequent partial records.
Duration	M	This field holds the duration of this record.
Record Sequence Number	C	Partial record sequence number, only present in case of partial records.
Cause for Record Closing	M	The reason for the release of the record.
Diagnostics	O_M	This field holds a more detailed reason for the release of the PDU session, when a single cause is applicable.
Local Record Sequence Number	O_M	Consecutive record number created by the CHF. The number is allocated sequentially including all CDR types.
Record Extensions	O_C	A set of network operator/manufacturer specific extensions to the record. Conditioned upon the existence of an extension.
PDU Session Charging Information	O_M	This field holds the 5G data connectivity specific information defined in clause 6.2.1.2.
Roaming QBC Information	O_M	This field holds the 5G data connectivity Roaming QBC specific information defined in clause 6.2.1.4

6.2 5G data connectivity charging specific parameters

6.2.1 Definition of 5G data connectivity charging information

6.2.1.1 General

The Charging Information parameter used for 5G data connectivity charging is provided in the following sub-clauses.

6.2.1.2 Definition of PDU session charging information

PDU session specific charging information used for 5G data connectivity charging is provided within the PDU session charging Information.

The detailed structure of the PDU Session Charging Information can be found in table 6.2.1.2.1.

Table 6.2.1.2.1: Structure of PDU Session Charging Information

Information Element	Category	Description
Charging Id	O_C	This field holds the Charging Id for PDU session.
User Information	M	Group of user information.
User Identifier	O_C	This field contains the identification of the user (i.e. GPSI).
User Equipment Info	O_C	This field holds the identification of the terminal (i.e. PEI, MAC Address) It is used for identifying the user in case IMSI is not present during emergency bearer service.
unauthenticatedFlag	O_C	This field indicates the served IMSI is not authenticated.
Roamer In Out	O_C	This field holds an indication if the roamer is in-bound or out-bound. This field is present only if UE is identified as a roamer.
User Location Info	O_C	This field indicates details of where the UE is currently located (access-specific user location information).
User Location Time	O_C	The NTP time at which the UE was last known to be in the location.
UE Time Zone	O_C	This field holds the Time Zone of where the UE is located, if available where the UE currently resides.
Presence Reporting Area Information	O_C	This field contains part of the Presence Reporting Area Information of UE as defined in TS 23.501[200], comprising the Presence Reporting Area identifier(s) and an indication on whether the UE is inside or outside the Presence Reporting Area, if available.
PDU Session Information	M	Group of PDU session information.
PDU Session ID	M	This field holds identifier of PDU session.
Network Slice Instance Identifier	O_M	This field holds network slice information the PDU session belongs to.
PDU Type	O_M	This field holds the type of PDU session.
PDU Address	Oc	Group of UE IP address. It may have multiple occurrences.
PDU IP Address	O_C	This field holds the IP Address of the served SUPI allocated for PDU session, i.e. IPv4 address or IPv6 prefix.
PDU Address prefix length	O_C	PDP/PDN Address prefix length of an IPv6 typed Served PDU Address. The field needs not available for prefix length of 64 bits.
Dynamic Address Flag	O_C	This field indicates whether served PDP/PDN address is dynamically allocated. This field is missing if address is static.
SSC Mode	O_C	This field holds SSC mode of PDU session.
SUPI PLMN ID	O_C	This field holds PLMN ID of the SUPI.
GUAMI	Oc	This field holds the AMF's GUAMI.
Serving Network Function ID	Oc	Group of serving Network Function identifer
Serving Network Function Name	Oc	This field holds the name of the serving Network Function (i.e. AMF).
Serving Network Function instance id		This field holds the identifier of the serving Network Function instance.
Serving CN PLMN ID	Oc	This field holds the serving Core Network Operator PLMN ID selected by the UE if different from SMF PLMN ID.
RAT Type	O_C	This field holds the Radio Access Technology (RAT) currently serving the UE.
Data Network Name Identifie	M	This field contains the identifier of the DNN the user is connected to.
QoS Information	O_C	This field holds the authorized QoS applied to PDU session.
PDU session start Time	O_C	This field holds the timestamp when PDU session starts.
PDU session stop Time	O_C	This field holds the timestamp when PDU session terminates.
Diagnostics	O_C	This field holds a more detailed reason for the release of the PDU session and complements the "Change Condition" information.
Charging Characteristics	O_C	This field holds the Charging Characteristics for this PDU session.
Charging Characteristics Selection Mode	O_C	This field holds information about how the "Charging Characteristics" was selected.
3GPP PS Data Off Status	O_C	This field holds the 3GPP Data off Status when UE's 3GPP Data Off status is Activated or Deactivated.
Session Stop Indicator	O_C	This field indicates to the CHF that the PDU session has been terminated.
Unused Quota Timer	O_C	This field holds the threshold for the time period unused quota. It holds either the value configured in SMF, if it is supported, or the value to be used as received from the CHF. A value of zero indicates that this mechanism shall not be used. This field is not applicable to QBC.

6.2.1.3 Definition of PDU Container information

Used Unit container specific charging information used for 5G data connectivity charging is provided within the PDU Container Information described in table 6.2.1.3.1.

Table 6.2.1.3.1: Structure of PDU Container Information

Information Element	Category	Description
Time of First Usage	O_C	This field holds the Timestamp when the first transmitted IP packet of the service data flow matching the current used unit container
Time of Last Usage	O_C	This field holds the Timestamp when the last transmitted IP packet of the service data flow matching the current used unit container
QoS Information	O_C	This field holds the QoS applied during the service data container interval
AF Correlation Information	O_C	An identifier, provided from the AF, correlating the measurement for the Charging key/Service identifier values in this PCC rule with application level reports.
User Location Information	O_C	This field holds the user location during the used unit container interval
UE Time Zone	O_C	This field holds the Time Zone of where the UE is located, during the used unit container interval.
Presence Reporting Area Information	O_C	This field holds the Presence Reporting Area Information of UE during the used unit container interval.
Serving Network Function ID	Oc	Serving Network Function identifer.
RAT Type	O_C	This field holds the RAT type during the used unit container interval
Sponsor Identity	O_C	This field holds the identifier of the sponsor when sponsored data connectivity is used
Application Service Provider Identity	O_C	This field holds the identifier of the application service provider that is delivering a service to the end user.
Charging Rule Base Name	O_C	This field holds the reference to group of PCC rules predefined at the SMF
3GPP PS Data Off Status	O_C	This field holds the 3GPP Data off Status during the used unit container interval

6.2.1.4 Definition of roaming QBC information

Roaming QBC specific charging information used for 5G data connectivity charging is provided within the Roaming QBC Information.

The detailed structure of the Roaming QBC Information can be found in table 6.2.1.4.1.

Table 6.2.1.4.1: Structure of Roaming QBC Information

Information Element	Category	Description
Multiple QFI container	O_C	This field holds a list of QFI containers. It may have multiple occurences
Triggers	O_C	This field holds the reason for closing the QFI unit container.
Trigger Timestamp	O_C	This field holds the timestamp of the trigger.
Time	O_C	This field holds the amount of used time.
Total Volume	O_C	This field holds the amount of used volume in both uplink and downlink directions.
Uplink Volume	O_C	This field holds the amount of used volume in uplink direction.
Downlink Volume	O_C	This field holds the amount of used volume in downlink direction.
Local Sequence Number	O_C	This field holds a QFI data container sequence number
QFI Container information	O_C	This field holds the QFI data container information defined in clause 6.2.1.5
UPF ID	O_C	This field holds the UPF identifier used to identify the UPF when reporting the usage for the UPF.
Roaming Charging Profile	O_C	This field holds the Roaming Charging Profile associated to the PDU session for roaming QBC.
Trigger	O_C	This field holds the trigger applicable to QBC. This field has multiple occurrences
Trigger type	O_C	This field holds the chargeable event defined in table 5.2.1.6.1.
Trigger category	O_C	This field holds the trigger category (i.e. immediate or deferred reporting)
Time Limit	O_C	This field holds the limit value in seconds when the trigger type is "Expiry of data time limit"
Volume Limit	O_C	This field holds the limit value in octets when the trigger type is "Expiry of data volume limit"
Max Number of charging condition changes	O_C	This field holds the limit value when the trigger type is "Expiry of limit of number of charging condition changes"
Partial record method	O_C	This field holds the method uses by the CHF for partial record closure: default or Individual.

6.2.1.5 Definition of QFI Container information

Multiple Unit Usage specific charging information used for 5G data connectivity QBC charging is provided within the QFI Container Information described in table 6.2.1.4.1.

Table 6.2.1.4.1: Structure of QFI Container Information

Information Element	Category	Description
QoS Flow Id	M	This field holds the QoS flow Identifier (QFI)
Time of First Usage	O_C	This field holds the Timestamp when the first transmitted IP packet of the service data flow matching the current QFI data container
Time of Last Usage	O_C	This field holds the Timestamp when the last transmitted IP packet of the service data flow matching the current QFI data container
QoS Information	O_C	This field holds the QoS applied during the QFI data container interval
User Location Information	O_C	This field holds the user location during the QFI data container interval

Information Element	Category	Description
UE Time Zone	O_C	This field holds the Time Zone of where the UE is located, during the QFI data container interval
Presence Reporting Area Information	O_C	This field holds the Presence Reporting Area Information of UE during the QFI data container interval.
RAT Type	O_C	This field holds the RAT type during the QFI data container interval
Report Time	M	This field holds the Timestamp when the QFI data container was closed
Serving Network Function ID	Oc	Group of serving Network Function identifer.
3GPP PS Data Off Status	O_C	This field holds the 3GPP Data off Status during the QFI data container interval

6.2.2 Detailed message format for converged charging

The following clause specifies per Operation Type the charging data that are sent by SMF for 5G data connectivity converged charging.

The Operation Types are listed in the following order: I (Initial)/U (Update)/T (Termination)/E (Event). Therefore, when all Operation Types are possible it is marked as IUTE. If only some Operation Types are allowed for a node, only the appropriate letters are used (i.e. IUT or E) as indicated in the table heading. The omission of an Operation Type for a particular field is marked with "-" (i.e. IU-E). Also, when an entire field is not allowed in a node the entire cell is marked as "-".

Table 6.2.2.1 defines the basic structure of the supported fields in the *Charging Data* Request message for 5G data connectivity converged charging.

Table 6.2.2.1: Supported fields in *Charging Data Request* message

Information Element	Node Type	SMF (FBC)	SMF (QBC)
	Supported Operation Types	I/U/T/E	
Session Identifier		-UT-	-UT-
Subscriber Identifier		IUT-	IUT-
NF Consumer Identification		IUT-	IUT-
Invocation Timestamp		IUT-	IUT-
Invocation Sequence Number		IUT-	IUT-
Notify URI		I---	I---
Triggers		-UT-	-UT-
Multiple Unit Usage		IUT-	-
Rating Group		IUT-	-
Requested Unit		IU--	-
Used Unit Container		-UT-	-
Triggers		-UT-	-
PDU Container Information		-UT-	-
UPF ID		IUT-	IUT-
PDU Session Charging Information		IUT-	IUT-
Charging Id		IUT-	IUT-
User Information		IUT-	IUT-
User Location Info		IUT-	IUT-
UE Time Zone		IUT-	IUT-
Presence Reporting Area Information		-UT-	-UT-
PDU Session Information		IUT-	IUT-
PDU Session ID		IUT-	IUT-
Network Slice Instance Identifier		IUT-	IUT-
PDU Type		IUT-	IUT-
PDU Address		IUT-	IUT-
SSC Mode		IUT-	IUT-
SUPI PLMN ID		IUT-	IUT-
Serving Network Function ID		IUT-	IUT-
Serving CN PLMN ID		IUT-	IUT-
RAT Type		IUT-	IUT-
Data Network Name Identifier		IUT-	IUT-
QoS Information		IUT-	IUT-
PDU session start Time		I---	I---
PDU session stop Time		--T-	--T-
Diagnostics		--T-	--T-
Charging Characteristics		IUT-	IUT-
Charging Characteristics Selection Mode		IUT-	IUT-
Charging Rule Base Name		IUT-	-
3GPP PS Data Off Status		IUT-	IUT-
Session Stop Indicator		--T-	--T-
Unused Quota Timer		IU--	-
Roaming QBC information		-	IUT-
Multiple QFI container		-	IUT-
UPF ID		-	IUT-
Roaming Charging Profile		-	IU--

Table 6.2.2.2 defines the basic structure of the supported fields in the *Charging Data* Response message for 5G data connectivity converged charging.

Table 6.2.2.1: Supported fields in *Charging Data Response* message

Information Element	Node Type	SMF (FBC)	SMF (QBC)
	Supported Operation Types	I/U/T/E	
Session Identifier		I---	I---
Invocation Timestamp		IUT-	IUT-
Invocation Result		IUT-	IUT-
Invocation Sequence Number		IUT-	IUT-
Session Failover		IU--	IUT-
Triggers		IU--	IU--
Multiple Unit information		IU--	-
Result Code		IU--	-
Rating Group		IU--	-
UPF ID		IU--	-
Granted Unit		IU--	-
Validity Time		IU--	-
Final Unit Indication		IU--	-
Time Quota Threshold		IU--	-
Volume Quota Threshold		IU--	-
Unit Quota Threshold		IU--	-
Quota Holding Time		IU--	-
Triggers		IU--	-
PDU Session Charging Information		IU--	IU--
Charging Id		-	-
User Information		-	-
User Location Info		-	-
UE Time Zone		-	-
Presence Reporting Area Information		IU--	IU--
PDU Session Information		IU--	IU--
PDU Session ID		-	-
Network Slice Instance Identifier		-	-
PDU Type		-	-
PDU Address		-	-
SSC Mode		-	-
SUPI PLMN ID		-	-
Serving Network Function ID		-	-
Serving CN PLMN ID		-	-
RAT Type		-	-
Data Network Name Identifier		-	-
QoS Information		-	-
PDU session start Time		-	-
PDU session stop Time		-	-
Diagnostics		-	-
Charging Characteristics		-	-
Charging Characteristics Selection Mode		-	-
Charging Rule Base Name		-	-
3GPP PS Data Off Status		-	-
Session Stop Indicator		-	-
Unused Quota Timer		IU--	-
Roaming QBC information		-	IU--
Multiple QFI container		-	-
UPF ID		-	-
Roaming Charging Profile		-	IU--

Annex A (normative): Charging Characteristics

A.1 General

A subscriber may have Charging Characteristics assigned to his subscription and/or his subscribed DNNs. Default Charging Characteristics may also be pre-provisioned on the SMF.

During UE PDU session establishment, when the SMF retrieves subscription data from the UDM, if a subscribed Charging Characteristics for the requested DNN is identified, it may override the SMF pre-provisioned Charging Characteristics.

The Charging Characteristics parameter consists of a string of 16 bits designated as Behaviours (B), freely defined by Operators, as shown in TS 32.298 [51]. Each bit corresponds to a specific charging behaviour which is configured on a per operator basis, and pointed when bit is set to "1" value.

A charging behaviour is defined as an association to a specific usage designed according to following guidance:

One usage may consist of a set of trigger profiles associated to the PDU session in converged charging as described in the Table A.1 example:

Table A.1: Example of Charging Characteristics behaviours for SMF

	Converged charging							
Behaviour index	**Default charging method**	**Primary and Secondary CHF addresses**	**Active**	**Time Limit Per PDU session**	**Vol Limit Per PDU session**	**Change Cond. Per PDU session**	**Tariff times**	**…**
0	Online	URI 1 URI 2	Yes	10 min	1Mb	2	0-7, 7-12	...
1	Offline	URI 1 URI 2	Yes	15 min	5Mb	3	0-24	…
2	Online	URI 1 URI 2	Yes	30 min	2Mb	2	0-7, 7-12	...
3	Offline	URI 1 URI 2	No	-	-	-	-	...
…	…	…	…	…	…	…	…	…

Associated to the behaviour, the following may also be configured:

- the CHF addresses to be used by the SMF;
- the "Default charging method" (online or offline) to be used as the default one for every PCC rules of the PDU Session.

The "Default charging method" and CHF addresses configured in the applicable Charging Characteristics behaviour, are superseded by "Default charging method" and CHF addresses supplied by the PCF if any, during SMF interaction with the PCF at PDU session establishment, as described in TS 23.503 [202]

Annex B (informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2018-02	SA5#117	S5-181327 S5-181325 S5-181326				Update skeleton Scope and References Introduction of architecture description	0.1.0
2018-04	SA#118	S5-182343 S5-182344 S5-182352 S5-182353 S5-182354 S5-182355 S5-182356 S5-182359				Charging principle clause 5.1 Introduction of charging requirements and principles clauses 5.1.3 and 5.1.4 PDU session converged charging triggers description PDU session converged charging triggers from CHF Message flows Additional References and abbreviations Definition of charging information Introduction of SMF-PDU-CDR description	0.2.0
2018-05	SA5#119	S5-183369 S5-183370 S5-183371 S5-183372 S5-183373 S5-183374 S5-183375 S5-183376 S5-183377 S5-183378 S5-183379 S5-183380 S5-183381 S5-183382 S5-183383 S5-183384				Update Triggers Description Charging Triggers Charging Identifier description Update of 5.2.1 Basic Principles with trigger time handling Message flows for 5G Data Connectivity Charging for support of Network Slicing CDR Generation Addition of Charging Information Reporting Update of Requirements and Charging information Update Charging Information Addition of Charging Information Update of charging information Addition of charging support of Service Continuity Introduce Roaming Introduce Interworking with EPC Update SMF-PDU-CDR description	0.3.0
2018-06	SA#80	SP-180405				Presented for information	1.0.0
2018-06	SA5#119 AH	S5-184017 S5-184031 S5-184124 S5-184198 S5-184199 S5-184200 S5-184201 S5-184202 S5-184205 S5-184206 S5-184208 S5-184209 S5-184210 S5-184211 S5-184213 S5-184214 S5-184215 S5-184216 S5-184217 S5-184218				Update the category of charging information Proposal on the Chargeable Events Edithelp Clean-up Proposal on the Triggers Proposal on the Trigger Configuration Update Triggers description Change to table format for trigger conditions Proposal on PCC Rules for Converged Charging Proposal on the Message Content Proposal for the Charging Session Proposal on requirement clarifications Correction on the message flow for PDU Session establishment Proposal on the Roaming Requirement Roaming handling clarification New flow for PDU session modification Introduce non-3GPP access Update CDR generation description Introduce Charging characteristics Update CDR description for usage Addition of rating output in CDR	1.1.0

2018-08	SA5#120	S5-185219 S5-185228 S5-185370 S5-185371 S5-185372 S5-185374 S5-185375 S5-185376 S5-185377 S5-185378 S5-185379 S5-185380 S5-185381 S5-185383 S5-185384 S5-185385 S5-185386 S5-185387 S5-185400 S5-185464				Remove Editor's Note for CTF Abbreviations Correction on the charging characteristics Correction on the Trigger Addition of PCC rules and chargeable event Addition of Message Flow of the SSC Mode Addition of General description for interworking with EPC Complete set of flows Introduce Network sharing (MOCN) Clarify per UPF charging information Update PDU session information Update of PDU session charging information Update SMF-PDU-CDR Clarification on Charging Data generation in case of Roaming Clarification on Roaming flows description Introduce CDR generation for roaming Update PDU session charging information for roaming Detailed message format for converged charging Update partial CDR triggers description Introduce CHF selection	1.2.0
2018-09	SA#81	SP-180801				Presented for approval	2.0.0
2018-09	SA#81					Upgrade to change control version	15.0.0

History

Document history		
V15.0.0	October 2018	Publication