ETSI TS 104 038 V4.1.0 (2024-10)

Publicly Available Specification (PAS); E2 interface: General Aspects and Principles (O-RAN.WG3.E2GAP-R003-v04.01)

CAUTION

The present document has been submitted to ETSI as a PAS produced by O-RAN Alliance and approved by the ETSI Technical Committee Mobile Standards Group (MSG).

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Foreword

This Technical Specification (TS) has been produced by O-RAN Alliance and approved by ETSI Technical Committee Mobile Standards Group (MSG).

The present document is part of a TS-family covering the E2 interface as identified below:

- "E2 interface: General Aspects and Principles";
- "E2 interface: Application Protocol"; and
- "E2 interface: Service Model".

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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1 Scope

The present document describes the general aspects and principles of the E2 interface between Near-RT RIC and one or more E2 Nodes, including the interaction with applications hosted in the Near-RT RIC.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE 1: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

NOTE 2: 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 3GPP Release 17.

The following referenced documents are necessary for the application of the present document.

[1] Void.

[2] ETSI TS 104 039: "Publicly Available Specification (PAS); E2 interface: Application Protocol (O-RAN.WG3.E2AP-R003-v04.00)".

[3] Void.

[4] Void.

[5] ETSI TS 136 401: "LTE; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Architecture description (3GPP TS 36.401)".

[6] ETSI TS 138 401: "5G; NG-RAN; Architecture description (3GPP TS 38.401)".

[7] Void.

[8] Void.

[9] Void.

[10] Void.

[11] Void.

[12] IETF RFC 4960: "Stream Control Transmission Protocol".

[13] Void.

[14] Void.

[15] ETSI TS 103 985: "Publicly Available Specification (PAS); A1 interface: Use Cases and Requirements (O-RAN.WG2.A1UCR-R003-v01.01)".

[16] ETSI TS 138 300: "5G; NR; NR and NG-RAN Overall description; Stage-2 (3GPP TS 38.300)".

[17] ETSI TS 104 040: "Publicly Available Specification (PAS); E2 interface: Service Model (O-RAN.WG3.E2SM-R003-v04.00)".

[18] ETSI TS 103 982: "Publicly Available Specification (PAS); O-RAN Architecture Description (O-RAN.WG1.OAD-R003-v08.00)".

[19] Void.

[20] IETF RFC 4303: "IP Encapsulating Security Payload (ESP)".

[21] ETSI TS 133 210: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Network Domain Security (NDS); IP network layer security (3GPP TS 33.210)".

[22] ETSI TS 133 310: "Universal Mobile Telecommunications System (UMTS); LTE; 5G; Network Domain Security (NDS); Authentication Framework (AF) (3GPP TS 33.310)".

[23] IETF RFC 6335: "Internet Assigned Numbers Authority (IANA) Procedures for the Management of the Service Name and Transport Protocol Port Number Registry".

[24] Void.

2.2 Informative references

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NOTE 1: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

NOTE 2: 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 3GPP Release 17.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 121 905: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Vocabulary for 3GPP Specifications (3GPP TR 21.905)".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI TR 121 905 [i.1], ETSI TS 103 982 [18] and the following apply:

RAN Function: specific function in an E2 Node; examples include X2AP, F1AP, E1AP, S1AP, NGAP interfaces and RAN internal functions handling UEs, Cells, etc.

RIC Service: service provided on an E2 Node to provide access to messages and measurements and / or enable control of the E2 Node from the Near-RT RIC

SCTP association: As defined in IETF RFC 4960 [12]. In the present document, SCTP association is interchangeably used by TNL (Transport Network Layer) association.

SCTP endpoint (or end-point): As defined in IETF RFC 4960 [12].

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI TR 121 905 [i.1], ETSI TS 103 982 [18] and the following apply:

RAT	Radio Access Technology
TNL	Transport Network Layer
TNLA	TNL Association

4 E2 Interface Architecture

4.1 General Architecture Principles

The general principles guiding the definition of the E2 interface between Near-RT RIC and E2 Nodes are the following:

- Near-RT RIC and E2 Node functions are fully separated from transport functions. Addressing scheme used in Near-RT RIC and the E2 Nodes shall not be tied to the addressing schemes of transport functions.
- The E2 Nodes support all protocol layers and interfaces defined within 3GPP radio access networks that include eNB for E-UTRAN [5] and gNB/ ng-eNB for NG-RAN [16].
- Near-RT RIC and hosted "xApp" applications shall use a set of services exposed by an E2 Node that is described by a series of RAN function and Radio Access Technology (RAT) dependent "E2 Service Models".
- E2 interfaces are defined along the following principles:
  - Interfaces are based on a logical model of the entity controlled through this interface.
  - One physical network element can implement multiple logical nodes.

4.2 O-RAN Architecture Considerations

The Near-RT RIC and E2 Nodes connected by the E2 interface, as presented in Figure 4.2-1, are part of the overall O-RAN Architecture [18].

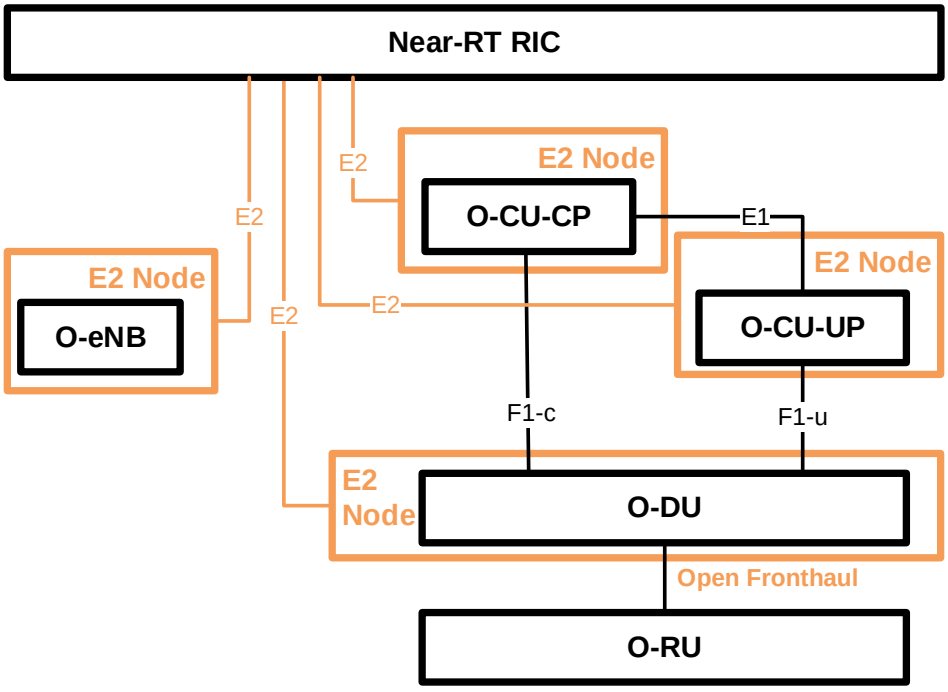


Figure 4.2-1: O-RAN Architecture Overview showing Near-RT RIC interfaces

With respect to the E2 interface:

- E2 is a logical interface connecting the Near-RT RIC with an E2 Node:
  - The Near-RT RIC is connected to the O-CU-CP.
  - The Near-RT RIC is connected to the O-CU-UP.
  - The Near-RT RIC is connected to the O-DU.
  - The Near-RT RIC is connected to the O-eNB.
- An E2 Node is connected to only one Near-RT RIC.
- A Near-RT RIC can be connected to multiple E2 Nodes, i.e. multiple O-CU-CPs, O-CU-UPs, O-DUs and O-eNBs.
- F1 (F1-C, F1-U) and E1 are logical 3GPP interfaces, whose protocols, termination points and cardinalities are specified in [6].

The Near-RT RIC use E2 interface to collect near real-time information (e.g. UE basis, Cell basis) and provide value added services.

The protocols over E2 interface are based exclusively on Control plane protocols and are defined in ETSI TS 104 039 [2].

On E2 or Near-RT RIC failure, the E2 Node is able to provide services but there may be an outage for certain value-added services that may only be provided using the Near-RT RIC.

5 E2 Interface

5.1 E2 interface requirements and general principles

5.1.1 E2 Interface Requirements

The E2 interface shall support the following requirements:

- E2 interface shall uniquely identify each E2 Node configured to directly provide RIC Services to the Near-RT RIC.
- A given Near-RT RIC may support E2 connections from multiple E2 Nodes, each supporting a specific RAT type.
- E2 interface shall expose from the E2 Node a list of functions supporting RIC Services and the corresponding E2 Service Model.
- E2 interface shall allow the Near-RT RIC to address specific RAN Functions in a specific E2 Node.
- E2 node shall function independently of the Near-RT RIC when and if the E2 interface and/or Near-RT RIC fails.
- E2 interface shall support latency requirements for near-real-time optimization, i.e. from 10 milliseconds up to 1 second [18].
- RRM functional allocation between the Near-RT RIC and the E2 Node shall be subject to the capability of the E2 node exposed over the E2 interface by means of the E2 Service Model, in order to support the use cases such as in [15].
- E2 service model shall describe the functions in the E2 Node that may be controlled by the Near RT RIC, thus defining a function-specific RRM split between the E2 node and the Near RT RIC.

- For a function exposed in the E2 service model, the Near-RT RIC may e.g. monitor, suspend/stop, override or control via policies the behaviour of E2 node.

5.1.2 E2 interface general principles

The general principles for the specification of the E2 interface are as follows:

- E2 interface is open.
- E2 interface supports the exchange of control signalling information between the endpoints.
- E2 is a point-to-point interface between the endpoints on Near-RT RIC and E2 Node.
- E2 interface definition supports interface management procedures based on principles from 3GPP RAN interfaces.
- E2 interface provides the capability to send predefined information towards the Near-RT RIC based on a pre-configured trigger event.
- E2 interface supports the ability to provide UE ID information towards the Near-RT RIC based on a pre-configured trigger event.
- E2 interface enables the Near-RT-RIC to direct the E2 Node to suspend an RRM procedure by interrupting the E2 Node local process and forwarding the relevant information to the Near-RT RIC for processing.
- E2 interface supports the ability to send control messages (e.g. UE basis, Cell basis) to the E2 Node.
- E2 interface supports the ability to provide the E2 Node with a set of policies to use when defined events occur.
- E2 interface supports the ability for E2 Node to notify the Near-RT RIC of what functionality it supports.
- E2 interface supports the ability to query the E2 Node for relevant RAN- and/or UE-related information.

With respect to the E2 interface, the E2 Node consists of:

- Logical E2 Agent used to terminate the E2 interface, support global services and to forward/receive RIC service messages towards RAN Functions.
- One or more RAN Functions that support RIC services exposed by the E2 Node to the Near-RT RIC.
- Other RAN functions that do not support RIC Services.

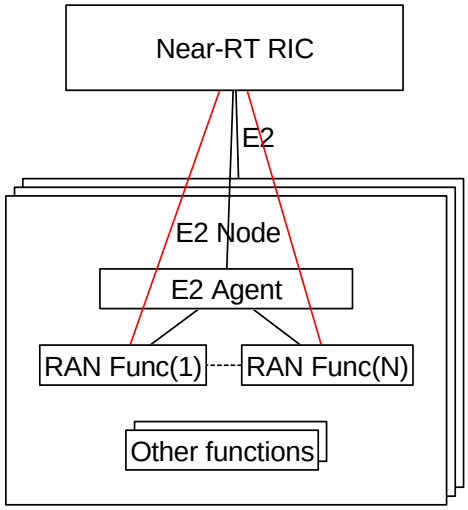


Figure 5.1.2-1: Relationship between Near-RT RIC and E2 Node

5.2 E2 interface specification objectives

The E2 interface specifications shall facilitate the following:

- Connectivity between Near-RT RIC and E2 Node supplied by different vendors.
- Exposure of selected E2 Node data (e.g. configuration information (cell configuration, supported slices, PLMNs, etc.), network measurements, context information, etc.) towards the Near-RT RIC.
- Enables the Near-RT RIC to control selected RAN functions on the E2 Node.

5.3 Functions of the E2 Interface

5.3.1 General

The E2 functions are grouped into the following categories:

RIC services:

- RIC Services (**REPORT**, **INSERT**, **CONTROL**, **POLICY** and **QUERY**), as described in clause 5.3.2) supported by RIC functional procedures (RIC Subscription, RIC Subscription Modification, RIC Subscription Modification Required, RIC Subscription Delete, RIC Subscription Delete Required, RIC Indication, RIC Control, RIC Query).

E2 support services:

- Interface Management services supported by Global Procedures (E2 Setup, E2 Reset, E2 Node Configuration Update, E2 Removal, Reporting of General Error Situations).
- RAN Function services supported by Global Procedures (RIC Service Update, RIC Service Query).

5.3.2 RIC services and related procedures

5.3.2.1 RIC services

Near-RT RIC may use the following RIC services provided by an E2 node:

- **REPORT**: Near-RT RIC uses a RIC Subscription and/or RIC Subscription Modification procedures to request that E2 Node sends a **REPORT** message to Near-RT RIC and the associated procedure continues in the E2 Node after each occurrence of a defined RIC Subscription procedure Event Trigger.
- **INSERT**: Near-RT RIC uses a RIC Subscription and/or RIC Subscription Modification procedures to request that E2 Node sends an **INSERT** message to Near-RT RIC and suspends the associated procedure in the E2 Node after each occurrence of a defined RIC Subscription procedure Event Trigger.
- **CONTROL**: Near-RT RIC sends a **CONTROL** message to E2 Node to initiate a new associated procedure or resume a previously suspended associated procedure in the E2 Node.
- **POLICY:** Near-RT RIC uses a RIC Subscription and/or RIC Subscription Modification procedures to request that E2 Node executes a specific **POLICY** during functioning of the E2 Node after each occurrence of a defined RIC Subscription procedure Event Trigger.
- **QUERY**: Near-RT RIC sends a **QUERY** message to the E2 node to retrieve RAN-related and/or UE-related information from the E2 Node.

5.3.2.2 REPORT service

The **REPORT** service involves following steps:

1) Near-RT RIC configures, and subsequently may modify, a RIC Subscription in the E2 Node with information for Indication (Report) that is to be sent by the E2 Node with each occurrence of RIC trigger event condition.

2) During normal functioning of an associated procedure in the E2 Node, a RIC Event Trigger is detected.

3) After completing any previous RIC actions, E2 Node sends RIC INDICATION message to Near-RT RIC containing the requested **REPORT** information along with the originating Request ID.

4) Associated procedure instance continues in the E2 Node, including any subsequent RIC actions.

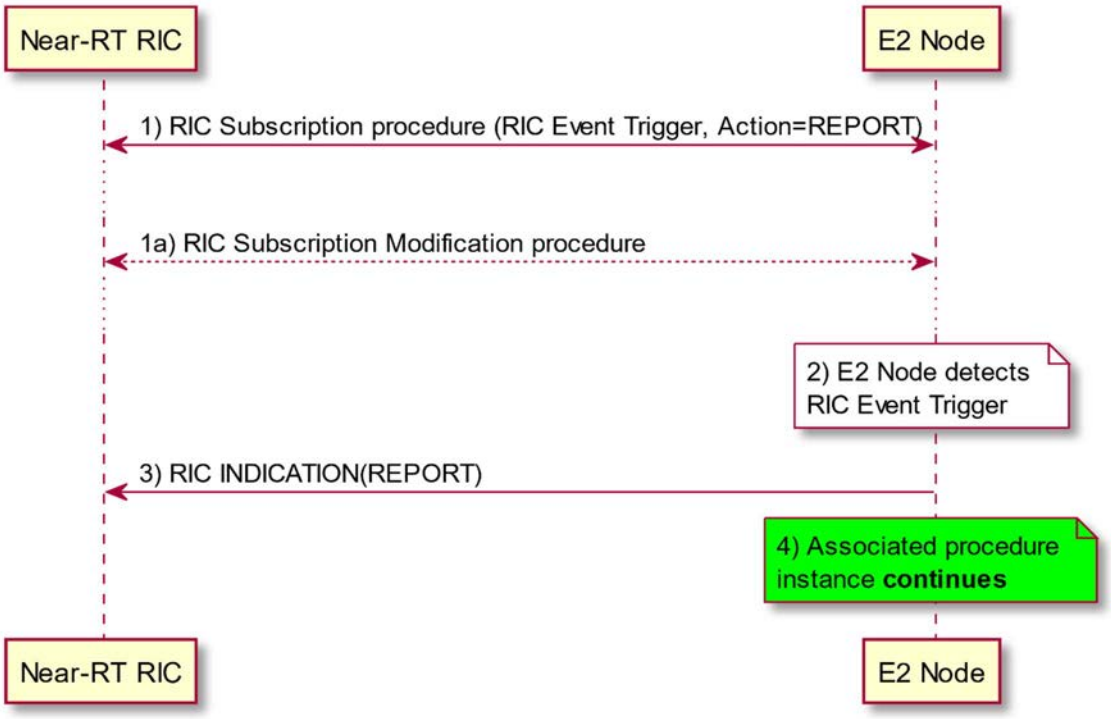


Figure 5.3.2.2-1: RIC Service REPORT

5.3.2.3 INSERT service

The **INSERT** service involves following steps:

1) Near-RT RIC configures, and subsequently may modify, a RIC Subscription in the E2 Node with information for an INSERT action, along with an associated Subsequent Action Information (Subsequent Action type, Time to Wait timer), that is to be performed by E2 Node with each occurrence of Event.

2) During normal functioning of an associated procedure instance in the E2 Node, a trigger event is detected.

3) After completing any previous RIC actions, E2 Node suspends associated procedure instance for up to a defined Time to Wait period.

4) E2 Node sends RIC INDICATION message to Near-RT RIC containing the requested **INSERT** information along with the originating Request ID and information to identify the suspended associated procedure instance.

5) According to the Time to Wait timer state, arrival of RIC CONTROL procedure, and Subsequent Action parameter in the RIC Subscription, the E2 Node may then:

   a) RIC CONTROL REQUEST message arrives in time:
   This case is described in clause 5.3.2.4.

   b) The associated Time to Wait timer expires and Subsequent Action Type set to Continue:
   Continue the original associated procedure instance, including any subsequent RIC actions, if and when the associated Time to Wait timer expires. If the Near-RT RIC subsequently sends a RIC CONTROL REQUEST message with the Call Process ID for the same associated procedure, then the E2 Node shall respond with the RIC CONTROL FAILURE message with a cause to indicate that the timer has expired. See also clause 5.3.2.4.

c) The associated Time to Wait timer expires and Subsequent Action Type set to Halt:
Halt the original associated procedure instance, including any subsequent RIC actions, if and when the associated Time to Wait timer expires. If the Near-RT RIC subsequently sends a RIC CONTROL REQUEST message with the Call Process ID for the same associated procedure, then the E2 Node shall respond with the RIC CONTROL FAILURE message with a cause to indicate that the timer has expired. See also clause 5.3.2.4.

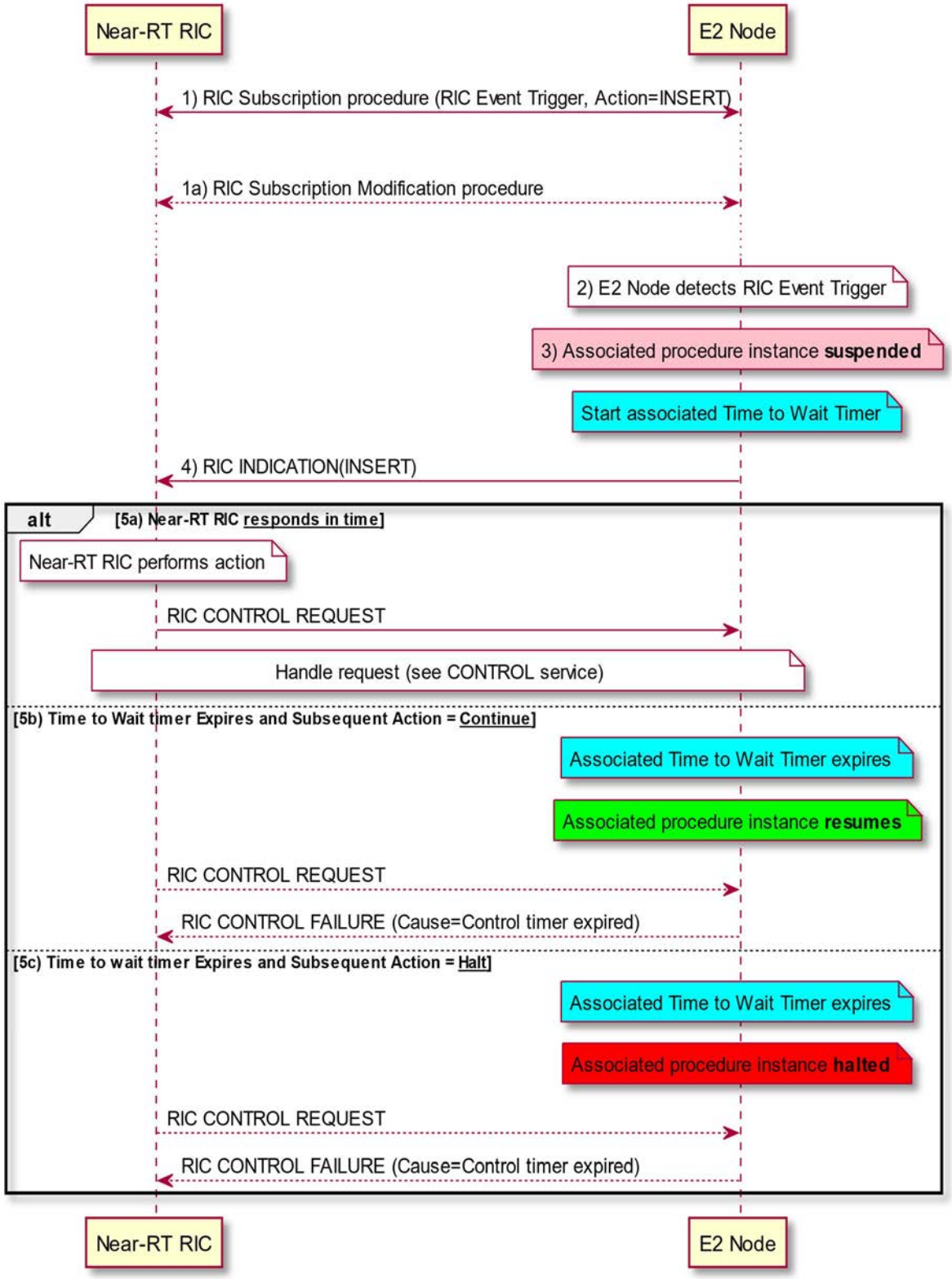


Figure 5.3.2.3-1: RIC Service INSERT with subsequent RIC Service CONTROL responses

5.3.2.4 CONTROL service

The **CONTROL** service involves following steps:

Near-RT RIC detects an event trigger. This step may be triggered by either:

a) a previous RIC INDICATION message sent by E2 Node;

b) internal to Near-RT RIC.

1) Near-RT RIC performs an action.

2) Near-RT RIC sends a RIC CONTROL REQUEST message to E2 Node. This message may contain information to identify the previously suspended procedure instance, and may request acknowledgement from the E2 Node. The Near-RT RIC shall set the timer $T_{RICcontrol}$ if either acknowledgement has been requested or the optional acknowledgement request was not present in the RIC CONTROL REQUEST message.

3) The request is validated. The E2 Node cancels the associated Time to Wait timer if previously set, and initiates or resumes the associated procedure.

4) E2 Node then:

   i) If the requested control service is successfully executed, and if acknowledgement was requested or if the optional RIC Control Ack Request was not present, the E2 Node sends the RIC CONTROL ACKNOWLEDGE message with the optional RIC Control Outcome providing information about the result of the request Control service.

   ii) If the requested control service fails to execute or the request is not validated, the E2 Node sends the RIC CONTROL FAILURE message with a cause indicating the reason for failure or rejection and the optional RIC Control outcome providing information about the reason for failure to execute.

5) If previously set, the Near-RT RIC shall cancel the $T_{RICcontrol}$ timer.

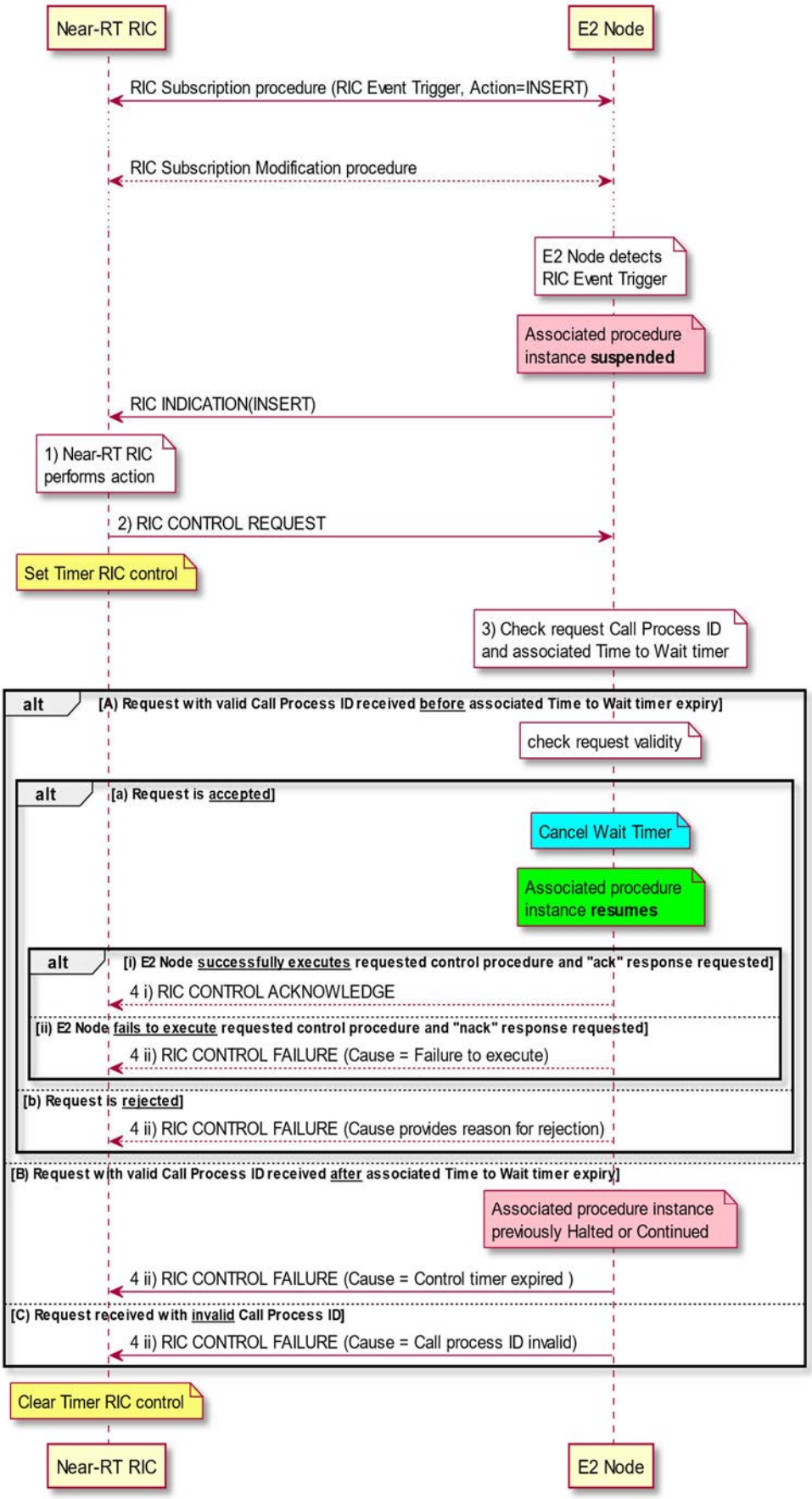


Figure 5.3.2.4-1: RIC Service CONTROL as response to RIC Service INSERT

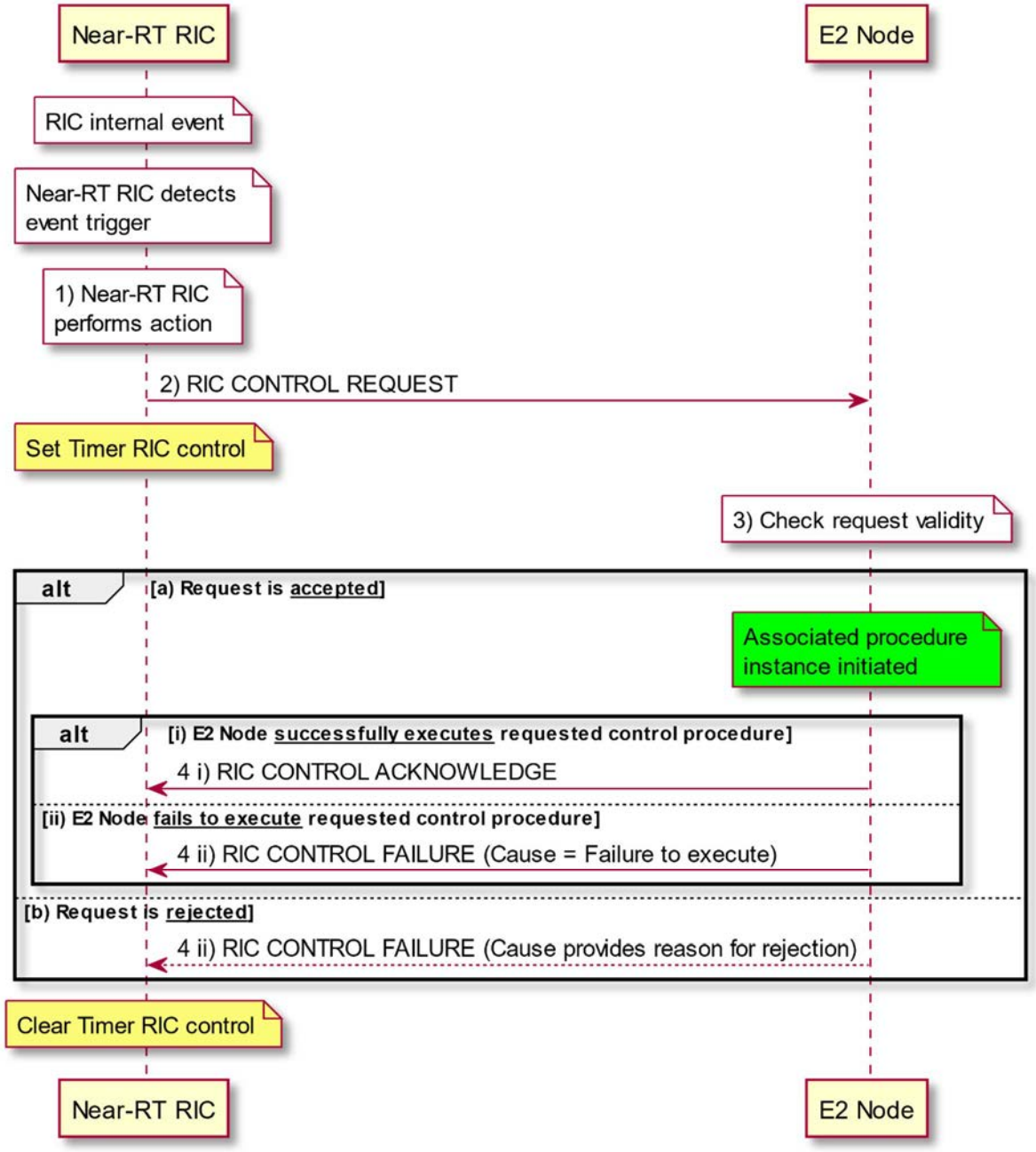


Figure 5.3.2.4-2: RIC Service CONTROL initiated by NEAR-RT RIC

5.3.2.5 POLICY service

The **POLICY** service involves following steps:

1) Near-RT RIC configures, and subsequently may modify, a RIC Subscription in the E2 Node with information used to configure a **POLICY** that is to be performed by E2 Node with each occurrence of trigger event.

2) During normal functioning of the E2 Node, a trigger event is detected.

3) After completing any previous RIC actions, E2 Node modifies ongoing call process according to information contained in the **POLICY** description statement.

4) Associated procedure instance continues in the E2 Node, including any subsequent RIC actions.

Note that if previously configured with a dedicated RIC Subscription, the E2 Node may send a REPORT used to provide information on the associated procedure outcome. See clause 5.3.2.2 for details.

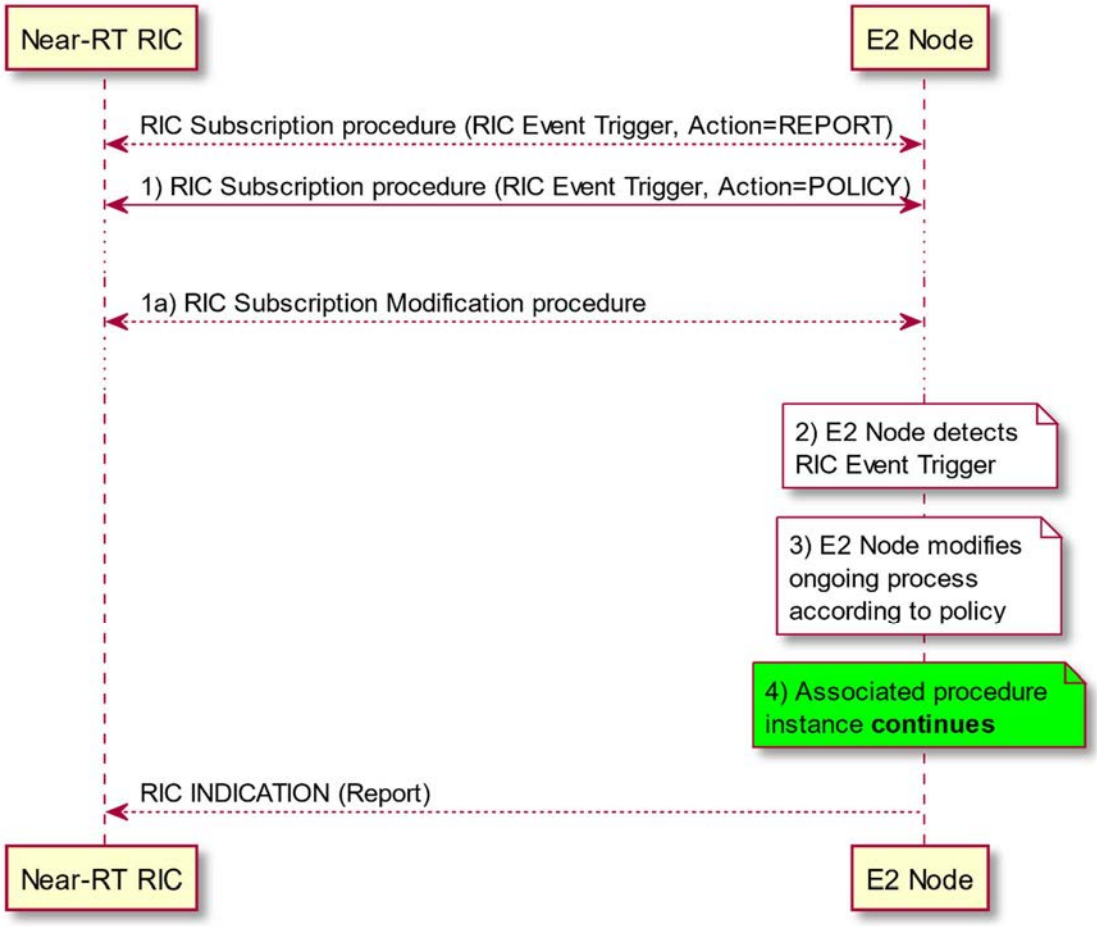


Figure 5.3.2.5-1: RIC Service POLICY

5.3.2.5A QUERY service

The **QUERY** service involves following steps:

1) Near-RT RIC determines need for RAN and/or UE-related information from the E2 node.

2) Near-RT RIC sends a RIC QUERY REQUEST message to E2 Node. This message contains the requested information that needs to be fetched from the E2 Node. The Near-RT RIC shall set the timer $T_{RICquery}$ awaiting response from the E2 node.

3) E2 node performs validation and attempts to retrieve the requested information for the Near-RT RIC.

4) E2 Node then:

   i) If the E2 node successfully validates and retrieves the requested information for the Near-RT RIC, then the E2 node sends the RIC QUERY RESPONSE message containing the desired information.

   ii) If the E2 node fails to validate the request or fails to retrieve the requested information for the Near-RT RIC, then the E2 node sends the RIC QUERY FAILURE message along with the cause for failure.

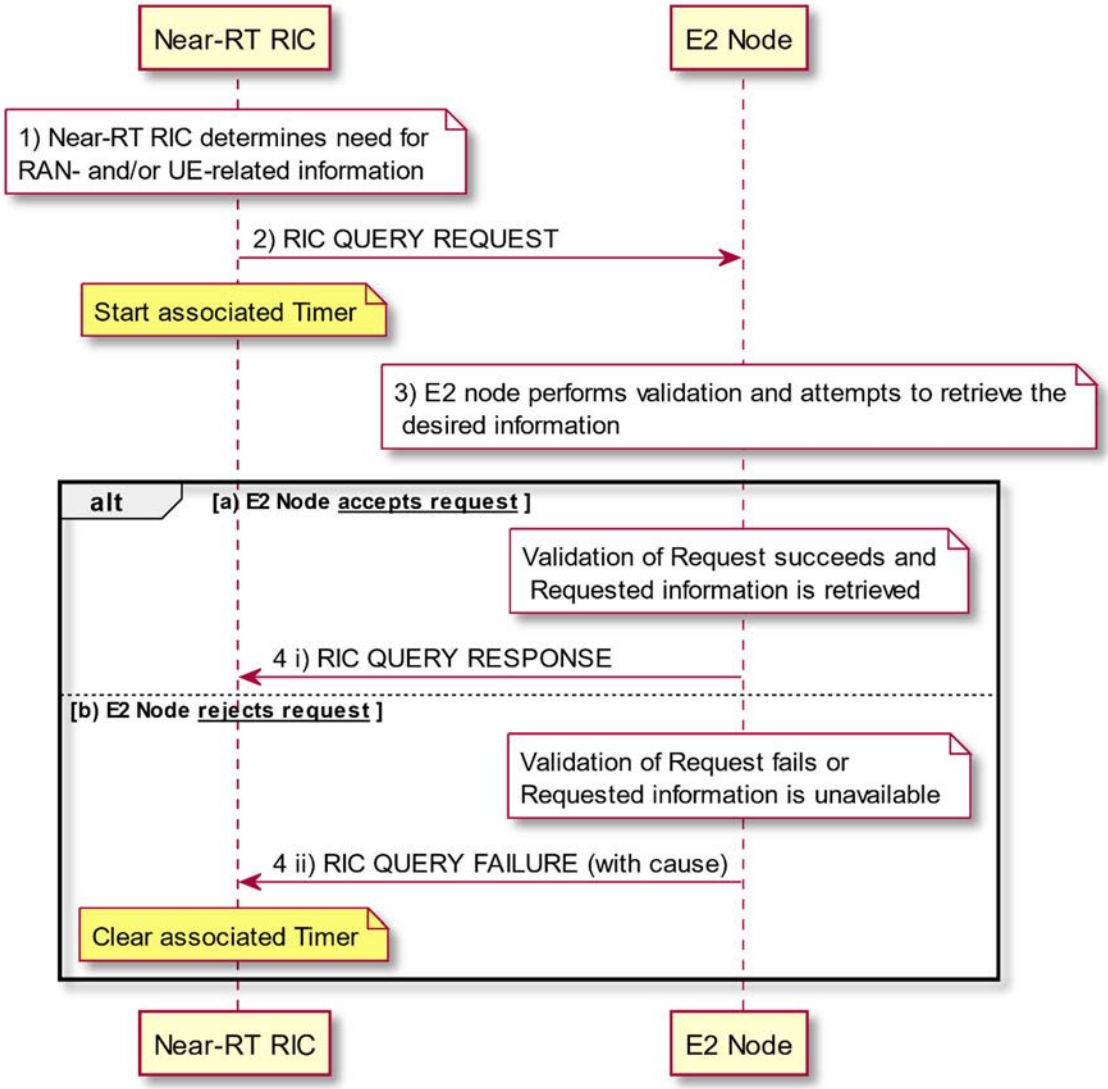


Figure 5.3.2.5A-1: RIC Service QUERY

5.3.2.6 RIC service realization and relationship with E2AP procedures

The RIC Services may be realized using the following RIC Functional procedures:

RIC Subscription procedure (Near-RT RIC initiated):

- Used to install Event Trigger and associated sequence of Actions corresponding to one or more RIC services **REPORT**, **INSERT** and/or **POLICY**.

RIC Subscription Modification procedure (Near-RT RIC initiated):

- Used to modify Event Trigger and/or add, modify and/or remove associated sequence of Actions corresponding to one or more RIC services **REPORT**, **INSERT** and/or **POLICY**.

RIC Subscription Modification Required procedure (E2 Node initiated):

- Used to request modification and/or removal of associated sequence of Actions corresponding to one or more RIC services **REPORT**, **INSERT** and/or **POLICY**.

RIC Subscription Delete procedure (Near-RT RIC initiated):

- Used to delete previously installed RIC Subscription.

RIC Subscription Delete Required procedure (E2 Node initiated):

- Used to indicate that one or more previously installed RIC Subscriptions are required to be deleted.

RIC Indication procedure (E2 Node initiated):

- Used to carry outcome of RIC services **REPORT** and **INSERT**.

RIC Control procedure (Near-RT RIC initiated):

- Used to initiate RIC service **CONTROL**.

RIC Query procedure (Near-RT RIC initiated):

- Used to request RAN and/or UE related information from E2 Node.

Table 5.3.2.6-1: Relationship between RIC Services and E2AP Procedures

E2AP Procedure	RIC Service				
	REPORT	**INSERT**	**CONTROL**	**POLICY**	**QUERY**
RIC Subscription	Installs one or more REPORT Services associated with a RIC Subscription	Installs one or more INSERT Services associated with a RIC Subscription		Installs one or more POLICY Services associated with a RIC Subscription	
RIC Subscription Modification	Adds, Modifies and/or Removes one or more REPORT Services associated with a RIC Subscription	Adds, Modifies and/or Removes one or more INSERT Services associated with a RIC Subscription		Adds, Modifies and/or Removes one or more POLICY Services associated with a RIC Subscription	
RIC Subscription Modification Required	Requests Modification and/or Removal of one or more REPORT Services associated with a RIC Subscription	Requests Modification and/or Removal of one or more INSERT Services associated with a RIC Subscription		Requests Modification and/or Removal of one or more POLICY Services associated with a RIC Subscription	
RIC Subscription Delete	Deletes all REPORT Services associated with one or more RIC Subscriptions	Deletes all INSERT Services associated with one or more RIC Subscriptions		Deletes all POLICY Service associated with one or more RIC Subscriptions	
RIC Subscription Delete Required	Requests Near-RT RIC to delete all REPORT Services associated with one or more RIC Subscriptions	Requests Near-RT RIC to delete all INSERT Services associated with one or more RIC Subscriptions		Requests Near-RT RIC to delete all POLICY Services associated with one or more RIC Subscriptions	
RIC Indication	Carries outcome of REPORT Service	Carries outcome of INSERT Service			
RIC Control			Initiates CONTROL Service		
RIC Query					Initiates QUERY service

The RIC Subscription, RIC Subscription Modification, RIC Subscription Modification Required, RIC Subscription Delete, and RIC Subscription Delete Required procedures are used to establish, modify or delete RIC subscriptions on the E2 Node.

The RIC Subscription, RIC Subscription Modification and RIC Subscription Delete procedures are initiated by the Near-RT RIC (Figure 5.3.2.6-1). In addition, the E2 Node may initiate a RIC Subscription Delete Required procedure to request removal of one or more existing RIC Subscriptions (Figure 5.3.2.6-2) and a RIC Subscription Modification Required procedure to request the modification or removal of one or more existing RIC services within an existing RIC Subscription (Figure 5.3.2.6-3).

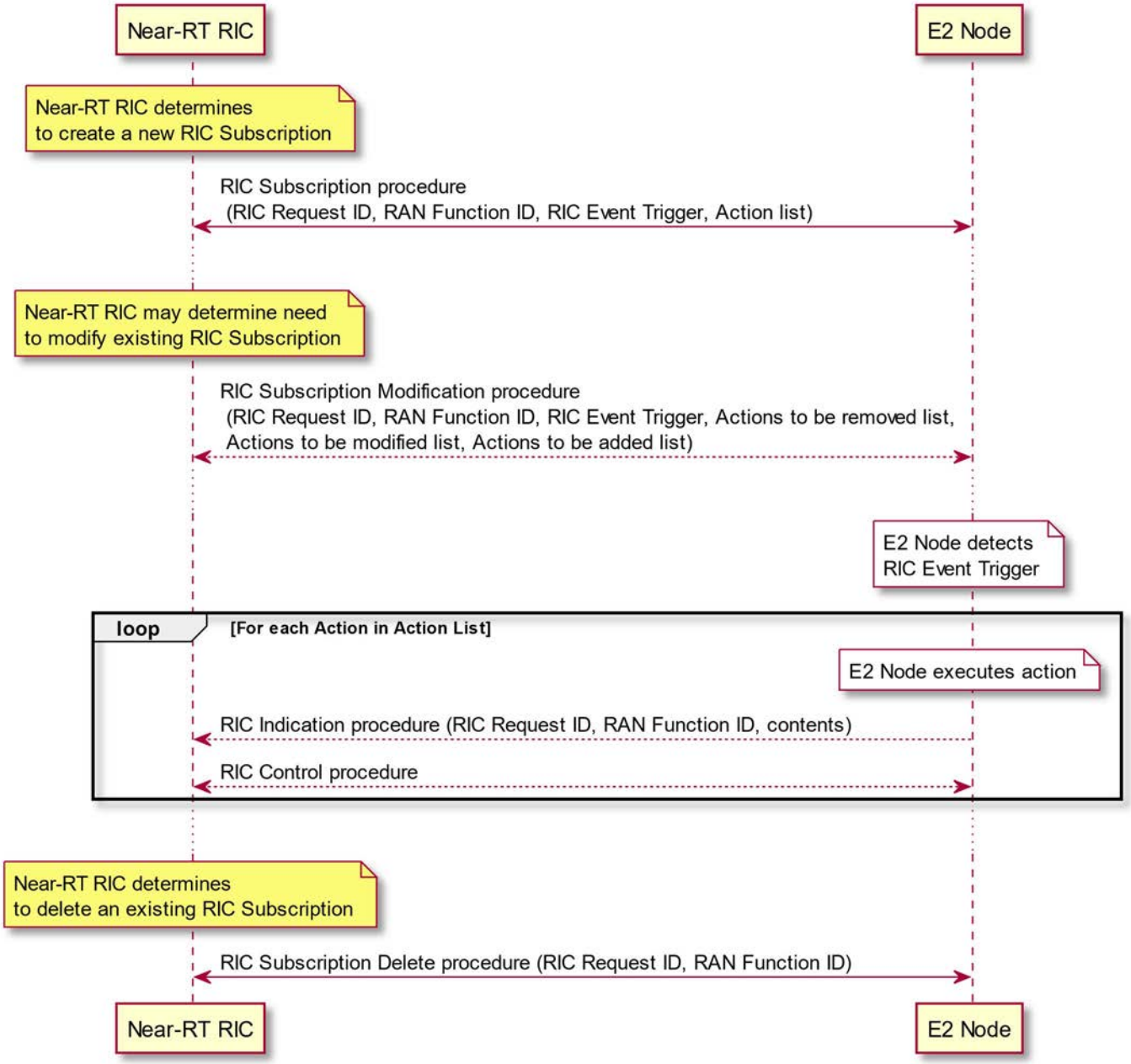


Figure 5.3.2.6-1: RIC Subscription, RIC Subscription Modification and RIC Subscription Delete procedures

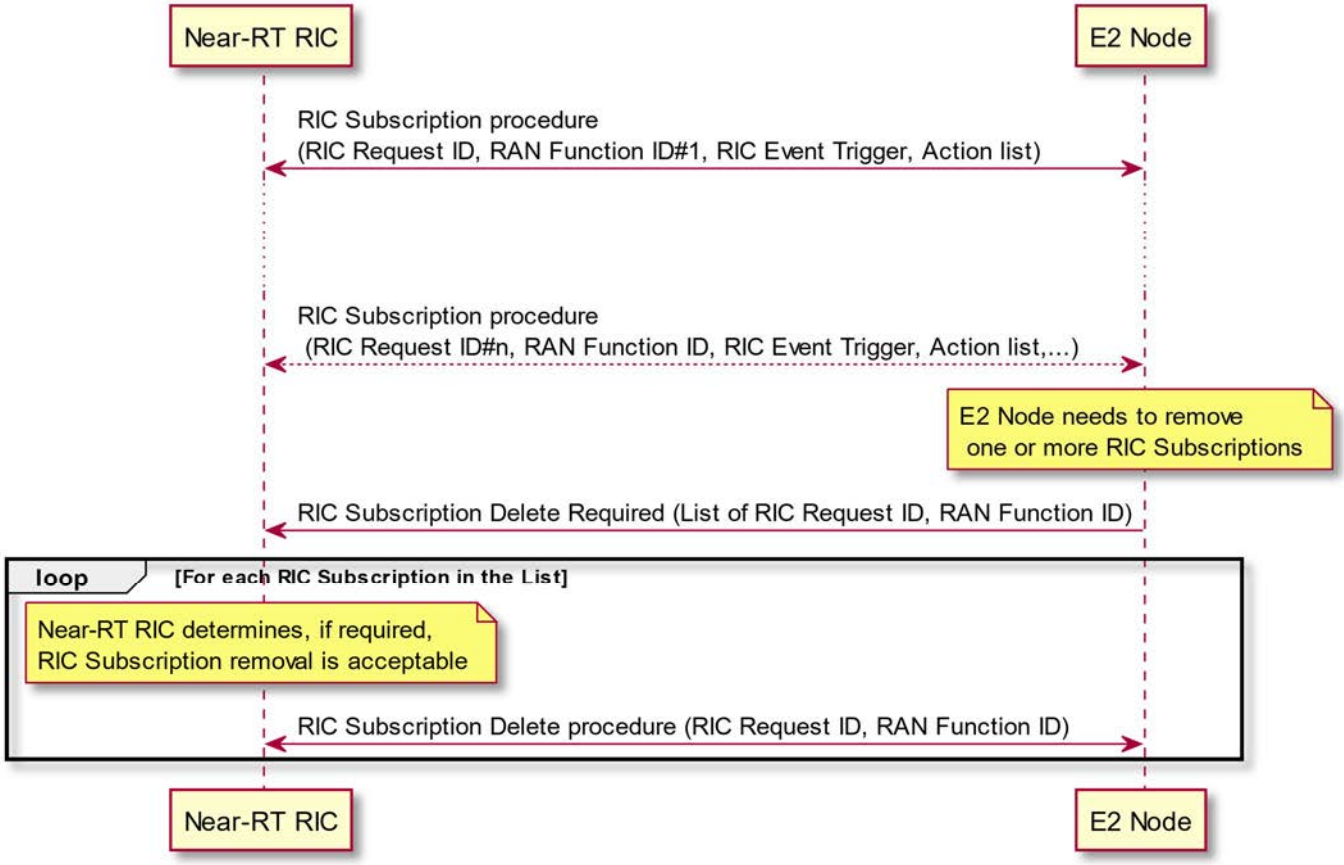


Figure 5.3.2.6-2: RIC Subscription Delete Required and RIC Subscription Delete procedures

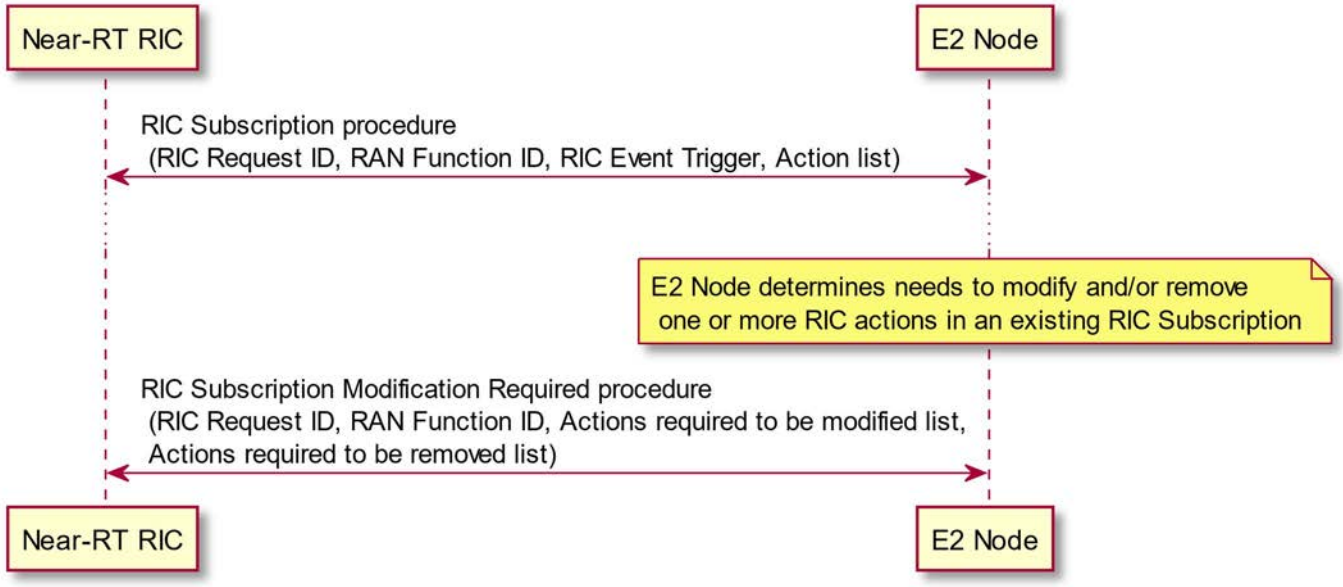


Figure 5.3.2.6-3: RIC Subscription Modification Required procedure

5.3.3 Combining RIC services within a common RIC Subscription

RIC services defined in clause 5.3.2 may be combined within a common Subscription with each RIC Service implemented as part of a sequence of Actions.

Where appropriate in these cases, successive **REPORT** or **INSERT** messages sent to Near-RT RIC under the same subscription event trigger would contain the same assigned Subscription Request identifier, the same optional sequence number and each message with the unique assigned Action identifier.

Examples include:

- **POLICY** then **REPORT**. In this case, at each occurrence of the defined Event Trigger, the E2 Node would be instructed to first execute a defined POLICY and then send a defined REPORT message.
- **REPORT** then **REPORT**. In this case, at each occurrence of the defined Event Trigger, the E2 Node would be instructed to first send a defined REPORT message to be followed by a second defined REPORT message containing normally different information.

When more than one RIC service action has been accepted by the E2 Node then actions shall be executed as specified in ETSI TS 104 039 [2].

5.3.4 Combining RIC services as a sequence of RIC services

RIC services defined in clause 5.3.2 may be combined using a sequence of different RIC services implemented using a procedure executed within the Near-RT RIC.

Examples include:

- **REPORT** followed by **POLICY.** In this case, at each occurrence of the defined Event Trigger, the E2 Node would be instructed to send a defined **REPORT** message. The Near-RT RIC would use the information from one or more successive **REPORT** messages as input to a procedure that may result in a change or establishment of a RIC **POLICY** service.
- **INSERT** followed by **CONTROL.** In this case, at each occurrence of the defined Event Trigger, the E2 Node would be instructed to send a defined **INSERT** message containing information used to identify the suspended associated procedure instance and then the Near-RT RIC would send a corresponding **CONTROL** message containing information used to identify a previous suspended associated procedure instance.
- **REPORT** followed by **CONTROL.** In this case, at each occurrence of the defined Event Trigger, the E2 Node would be instructed to send a defined **REPORT** message. The Near-RT RIC would use the information from one or more successive REPORT messages as input to a procedure that may result in a RIC **CONTROL** service message being sent to initiate an associated procedure instance in the E2 Node.

5.4 RAN Function E2 Service Model

As described in clause 5.1 the E2 interface is used to carry messages between a given E2 Node and Near-RT RIC. These messages may contain RAN Function specific content which is described in the corresponding RAN Function specific E2 Service Model.

Each RAN Function is described in the following terms:

- *RAN Function Definition*. Defines the RAN Function Name and describes the RIC Services that the specific RAN Function is currently configured to present over the E2 interface.
- *RIC Event Trigger Definition* approach. Describes the approach to be used in RIC Subscription and RIC Subscription Modification procedures to set or modify the RIC Event Trigger Definition in the RAN Function for RIC Services **REPORT**, **INSERT** and/or **POLICY**.
- *RIC Action Definition* approach. Describes the approach to be used in RIC Subscription and RIC Subscription Modification procedures to set or modify the required sequence of RIC Action in the RAN Function for RIC Services REPORT, INSERT and/or POLICY.
- *RIC Indication Header* and *RIC Indication Message* approach. Describes the approach to be used in RIC Indication procedure for RIC Services REPORT and INSERT.
- *RIC Control Header* and *RIC Control Message* approach. Describes the approach to be used in RIC Control procedure for RIC Service CONTROL.

- *RIC Call Process ID* approach. Describes the approach to be used by the E2 node in RIC Indication procedure for RIC Service INSERT. The same IE is used in the subsequent RIC Control procedure for RIC Service CONTROL.
- *RIC Control Outcome* approach. Describes the approach to be used by the E2 node in RIC Control procedure for RIC service CONTROL.
- RAN Function Policies. Describes the set of policies that the RAN Function is configured to support and the corresponding Parameters that may be used to configure the policy using RIC Service POLICY.
- *RIC Query Header* and *RIC Query Definition* approach. Describes the approach to be used by the Near-RT RIC in RIC Query procedure for RIC Service QUERY.
- *RIC Query Outcome* approach. Describes the approach to be used by the E2 node in RIC Query procedure for RIC Service QUERY.

5.5 E2 support services

5.5.1 General

The E2 support services are supported by the following global procedures:

- E2 Setup.
- E2 Reset.
- RIC Service Update.
- E2 Node Configuration Update.
- E2 Removal.
- Reporting of General Error Situations.

The E2 Setup, E2 Reset, RIC Service Update, E2 Node Configuration Update and E2 Removal procedures are described in further details in the following clauses.

5.5.2 E2 Setup procedure

The E2 Setup procedure is used to establish the E2 interface between the Near-RT RIC and an E2 Node. During this procedure the E2 Node provides:

- List of supported RIC services and mapping of services to functions within the E2 Node. This information is specific to each RAN Function in the E2 node and is defined by a specific E2 Service Model as described in clause 5.4.
- List of E2 Node configuration information. This information is specific to the E2 Node type (see clause 4.2) and defined by the E2 Node system specifications.

If the E2 Setup procedure fails, the Near-RT RIC may provide an alternative Transport Layer Information for the E2 Node to use when reinitiating the E2 Setup procedure.

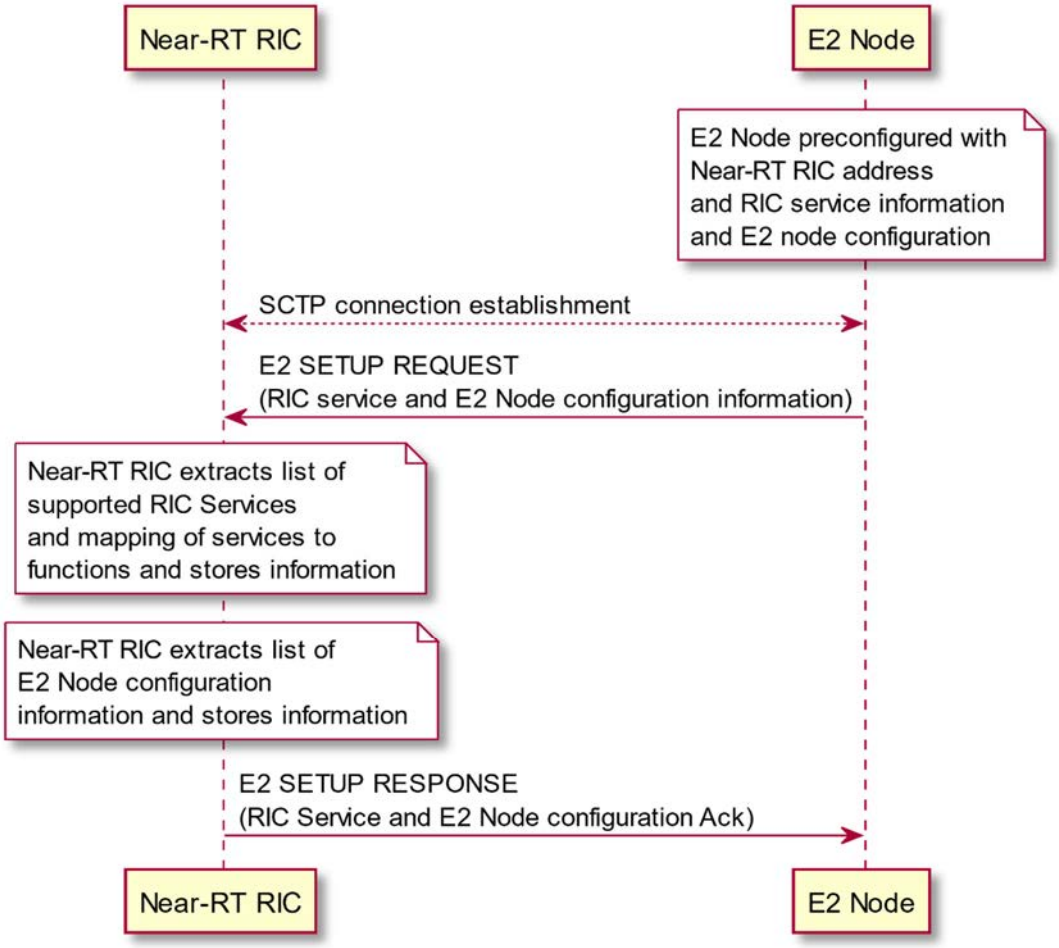


Figure 5.5.2-1: E2 Setup procedure

5.5.3 E2 Reset procedure

The E2 Reset procedure is used by either the E2 Node or Near-RT RIC to reset the E2 interface.

Information previous exchanged during E2 Setup, E2 Node Configuration Update and RIC Service Update procedures shall be maintained however the outcome of all previous RIC Subscription shall be deleted from the E2 Node and E2 Node gracefully terminates any ongoing RIC Services.

The Near-RT RIC may then proceed to re-establish any RIC Subscriptions as required.

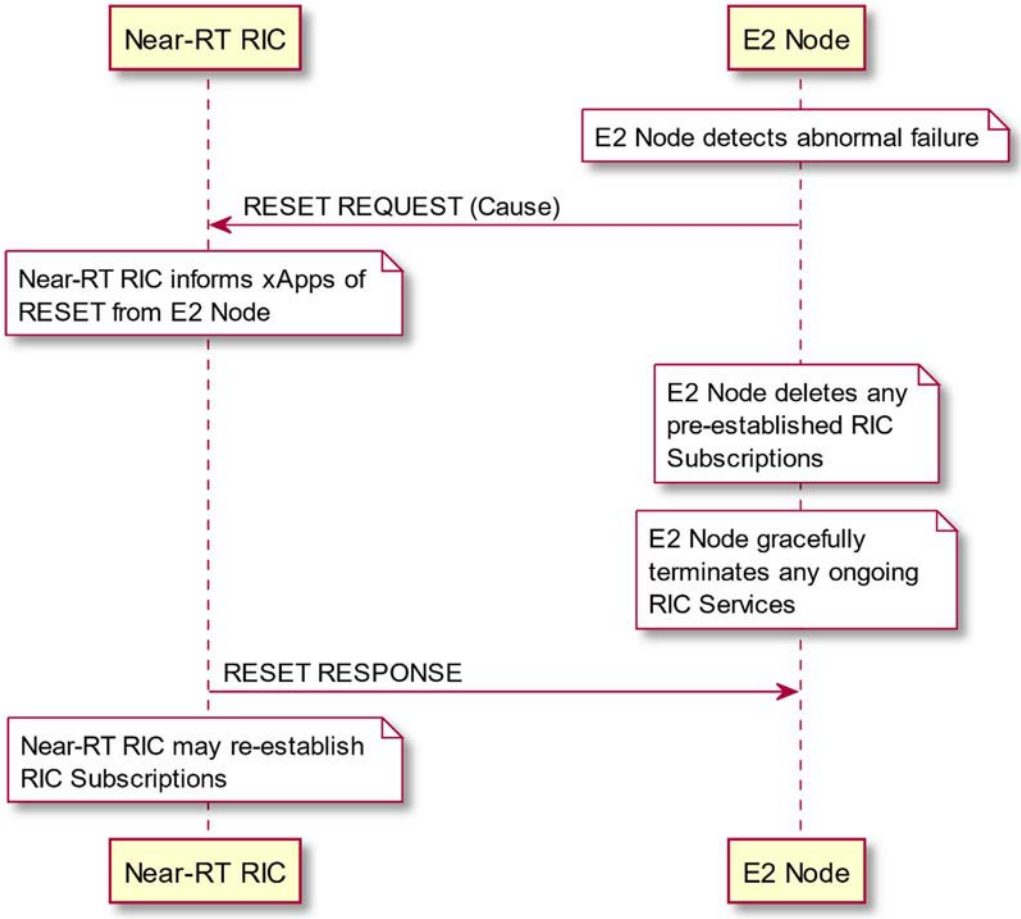


Figure 5.5.3-1: E2 Reset procedure (E2 Node initiated)

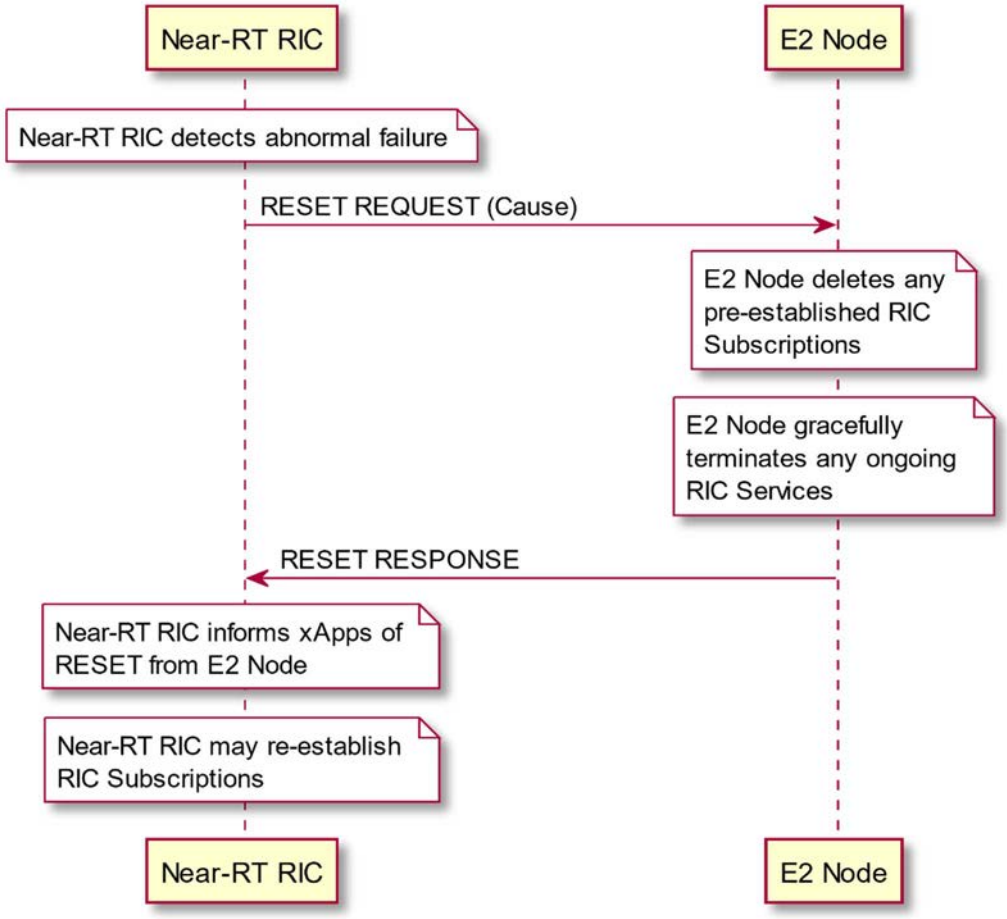


Figure 5.5.3-2: E2 Reset procedure (Near-RT RIC initiated)

5.5.4 RIC Service Update procedure

The RIC Service Update procedure is used by the E2 Node to inform the Near-RT RIC of any change to the list of supported RIC services and mapping of services to functions within the E2 Node. This information is specific to each RAN Function in the E2 node and is defined by a specific E2 Service Model as described in clause 5.4.

This procedure may also be initiated by the Near-RT RIC sending a RIC SERVICE QUERY message.

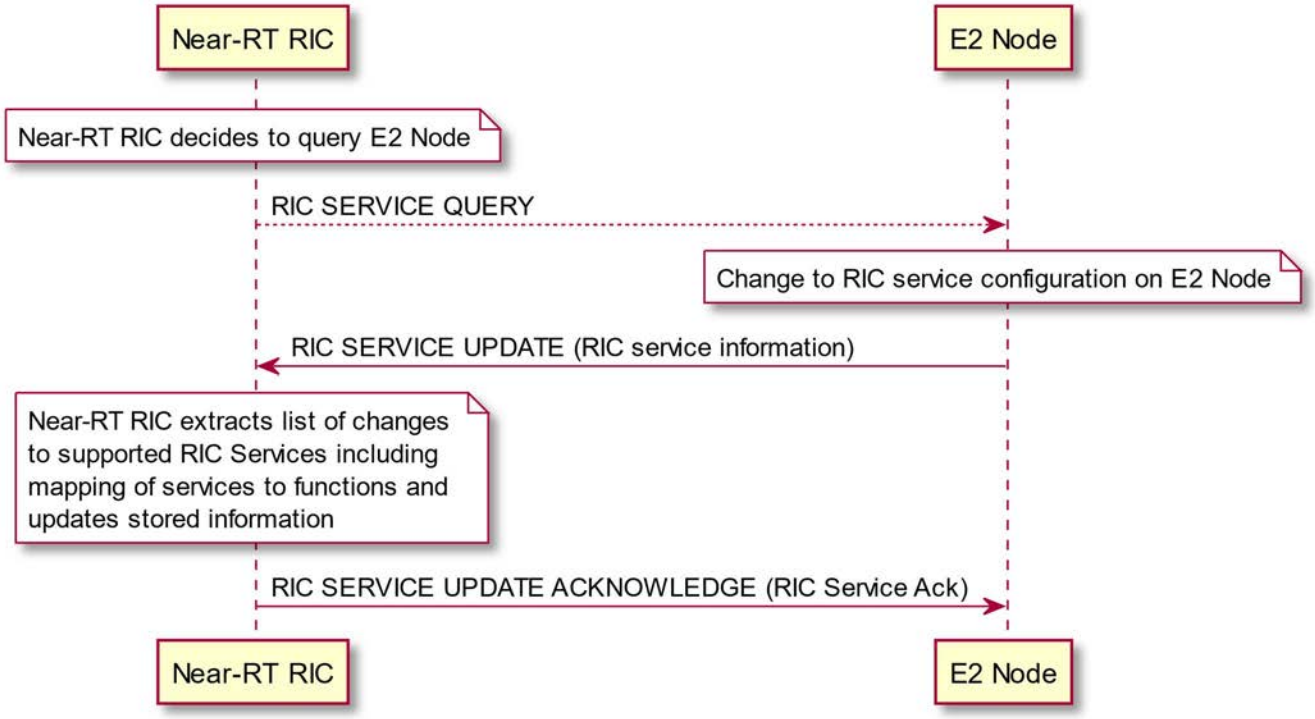


Figure 5.5.4-1: RIC Service update procedure

5.5.5 E2 Node Configuration Update procedure

The E2 Node Configuration Update procedure is used by the E2 Node to inform the Near-RT RIC of any change to the configuration of the E2 Node and/or E2 Node initiated changes to TNL Associations associated with the E2 interface. This information is specific to the E2 Node type and defined by the E2 Node system specifications as described in clause 4.2.

See clause 6.2 for further details on E2 Node Configuration Update procedure usage for E2 Node initiated changes to TNL Associations associated with the E2 interface.

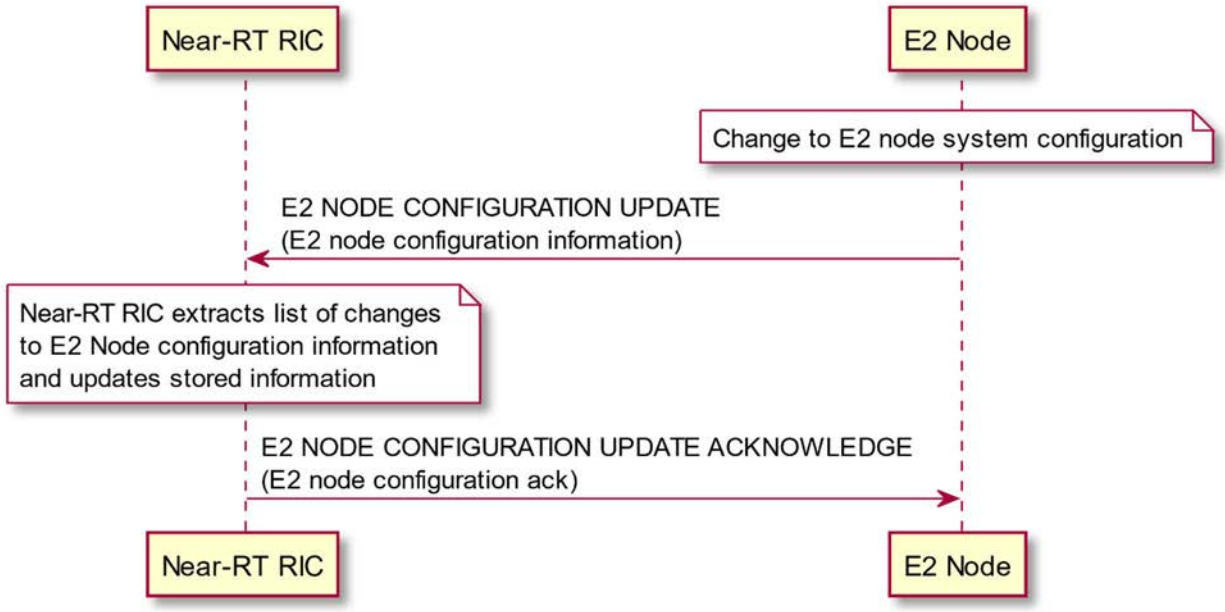


Figure 5.5.5-1: E2 Node configuration update procedure

5.5.6 E2 Removal procedure

The E2 Removal procedure is used by either the E2 Node or Near-RT RIC to release the E2 signalling connection.

If the procedure is E2 node initiated, after the E2 REMOVAL RESPONSE is received, the E2 node initiates termination of all TNL associations associated with this E2 interface. The Near-RT RIC and E2 nodes releases all resources associated with this E2 interface. If the E2 Removal procedure fails, the E2 node may retry the E2 Removal procedure.

If the procedure is Near-RT RIC initiated, after the E2 REMOVAL RESPONSE is received, the Near-RT RIC initiates termination of all TNL associations associated with this E2 interface. The Near-RT RIC and E2 nodes releases all resources associated with this E2 interface. If the E2 Removal procedure fails, the Near-RT RIC may retry the E2 Removal procedure.

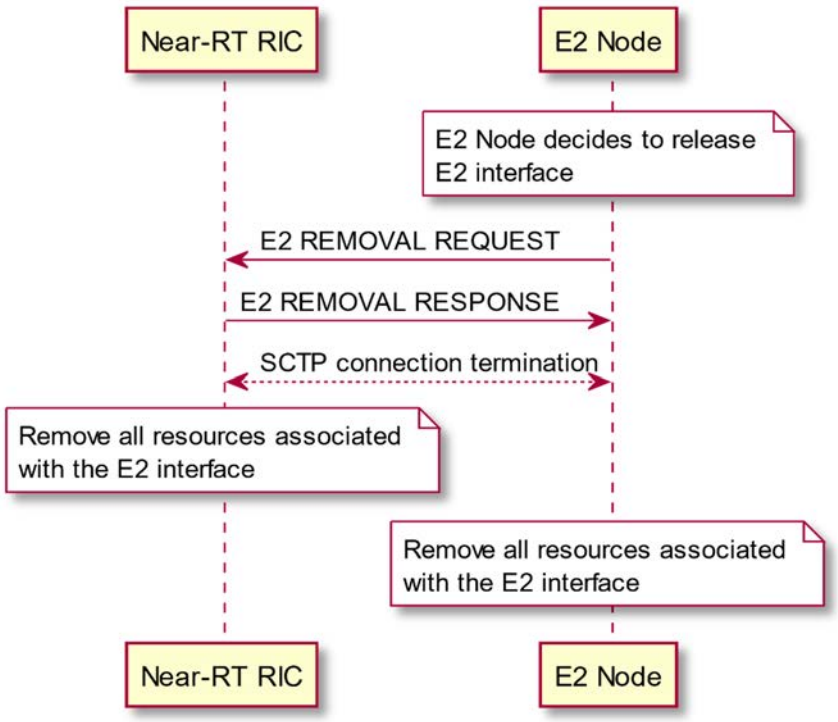


Figure 5.5.6-1: E2 Removal procedure (E2 Node initiated)

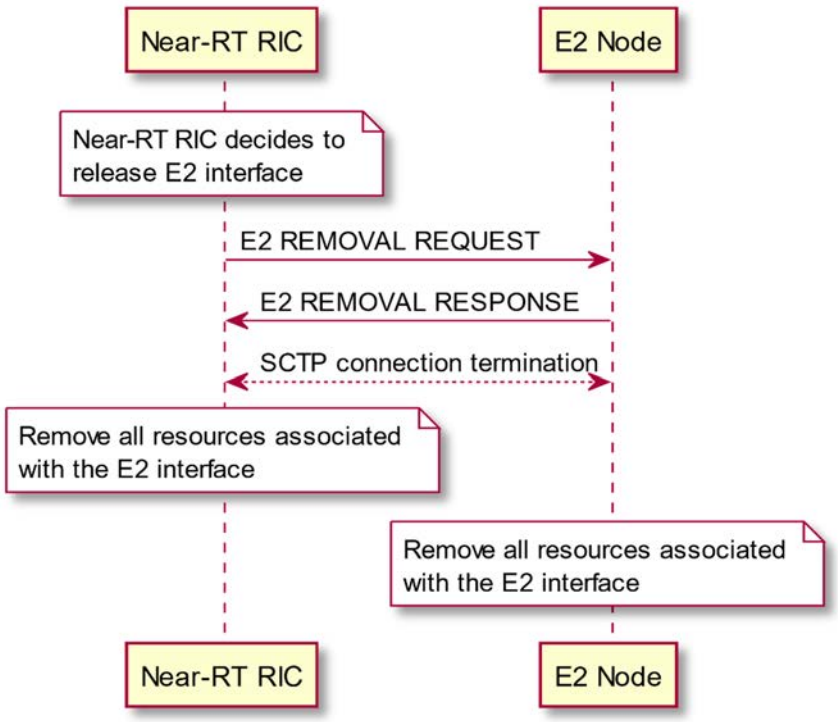


Figure 5.5.6-2: E2 Removal procedure (Near-RT RIC initiated)

6 E2 interface signalling

6.1 E2 Control Plane Protocol (E2AP)

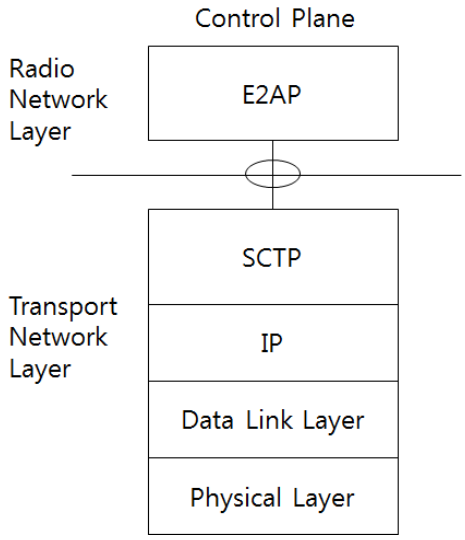
The control plane protocol stack of the E2AP interface is shown on Figure 6.1-1.

The transport network layer is built on IP transport. For the reliable transport of signalling messages, IETF RFC 4960 [12] is added on top of IP.

When configurations with multiple SCTP associations are supported, the Near-RT RIC may request to dynamically add/remove SCTP associations between the E2 Node/Near-RT RIC pair. Within the set of SCTP associations established between one Near-RT RIC and E2 node pair, the Near-RT RIC may request the E2 Node to restrict the usage of SCTP association for certain types of E2 signalling. If no restriction information is provided for an SCTP association, any type of E2 signalling is allowed via the SCTP association.

The application layer signalling protocol is referred to as E2AP (E2 Application Protocol). The Payload Protocol Identifier assigned by IANA to be used by SCTP for the application layer protocol E2AP is 70. This value is to be used for all deployment configurations described in the present document. Payload Protocol Identifiers 71 and 72, also assigned by IANA for E2, are reserved for future use.

No SCTP Destination Port number value was assigned by IANA for the E2AP protocol and so networks shall rely on E2 node and Near-RT RIC configuration to select a suitable port number.



NOTE: E2AP messages are transported over the E2 interfaces.

Figure 6.1-1: E2AP protocol stack

6.2 Multiple TNLAs over E2

The Near-RT RIC and E2 Node supports multiple TNL associations over E2 interface.

An initial TNL association is established during E2 Setup procedure with E2 Node initiating SCTP connection. At this point the single TNL association is configured to be used for both RIC Services (clause 5.3) and E2 Support functions (clause 5.5).

TNL associations may then be added, modified or removed during subsequent E2 Connection Update and E2 Node Configuration Update procedures with E2 Node initiating SCTP connections where required.

When the Near-RT RIC requests to dynamically add additional SCTP associations between the Near-RT RIC/E2 Node pair, the Near-RT RIC sends additional SCTP endpoints using the E2 Connection Update procedure. The E2 Node shall establish the SCTP associations. The SCTP Destination Port number value may be the same port number used for the initial E2 Setup procedure, or any dynamic port value (IETF RFC 6335 [23]).

Within the set of SCTP associations established between one Near-RT RIC and E2 node pair, a single SCTP association shall be employed for E2AP elementary procedures utilized for E2 Support Function signalling (i.e. defined in ETSI TS 104 039 [2] clause 8.3) with the possibility of fail-over to a new association to enable robustness.

When the configuration with multiple SCTP endpoints per E2 node is supported and E2 node wants to add an additional SCTP association, the E2 Node Configuration Update procedure shall be the first E2AP procedure triggered on an additional TNLA of an already setup E2 interface after the TNL association has become operational. The E2 Node uses a SCTP endpoint of the Near-RT RIC already in use for existing TNL associations between the Near-RT RIC/E2 Node pair when establishing the additional SCTP association, and the Near-RT RIC shall associate the TNLA to the E2 interface using the included Global E2 Node ID. The E2 Node uses the E2 Node Configuration Update procedure when it wants to remove additional SCTP association.

The RIC Subscription TNLA binding is a binding between a specific TNL association and RIC Service signalling (i.e. defined in ETSI TS 104 039 [2] clause 8.2) of a specific RIC Subscription. After the RIC Subscription TNLA binding is created, the Near-RT RIC can update the RIC Subscription TNLA binding by sending the E2AP message for the RIC Subscription to the E2 Node via a different TNLA. The E2 Node shall update the RIC Subscription TNLA binding with the new TNLA. The E2 Configuration Update procedure also allows the E2 Node to inform the Near-RT RIC that the indicated TNLA(s) will be removed by the E2 Node.

Between one Near-RT RIC and E2 Node pair:

- A single pair of stream identifiers shall be reserved over an SCTP association for the sole use of E2AP elementary procedures utilized for E2 Support Function signalling (i.e. defined in ETSI TS 104 039 [2] clause 8.3).

- At least one pair of stream identifiers over one or several SCTP associations shall be reserved for the sole use of E2AP elementary procedures utilized for RIC Service signalling (i.e. defined in ETSI TS 104 039 [2] clause 8.2). However, a few pairs (i.e. more than one) should be reserved.
- For any RIC service signalling (i.e. defined in ETSI TS 104 039 [2] clause 8.2) of a single RIC Subscription, the E2 Node shall use one SCTP association and one SCTP stream, and the SCTP association/stream should not be changed until after the current SCTP association is failed, or the RIC Subscription TNLA binding update is performed.

Transport network redundancy may be achieved by SCTP multi-homing between two end-points, of which one or both is assigned with multiple IP addresses. SCTP end-points shall support a multi-homed remote SCTP end-point. For SCTP endpoint redundancy an INIT may be sent from a Near-RT RIC or E2 Node, at any time for an already established SCTP association, which shall be handled as defined in IETF RFC 4960 [12] in clause 5.2.

The SCTP congestion control may, using an implementation specific mechanism, initiate higher layer protocols to reduce the signalling traffic at the source and prioritize certain messages.

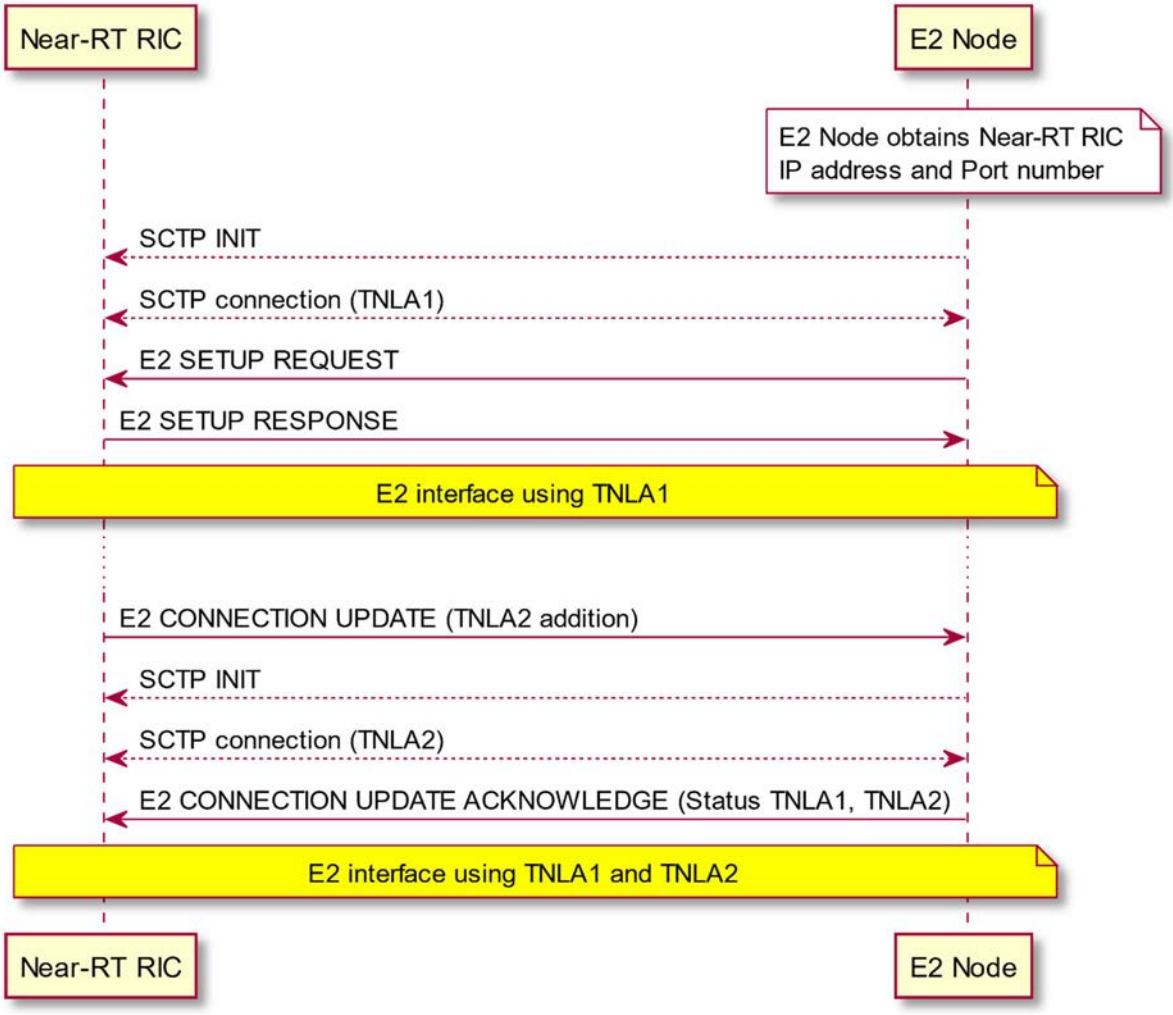


Figure 6.2-1: TNL management examples
(E2 Setup and Near-RT RIC initiated TNL Addition)

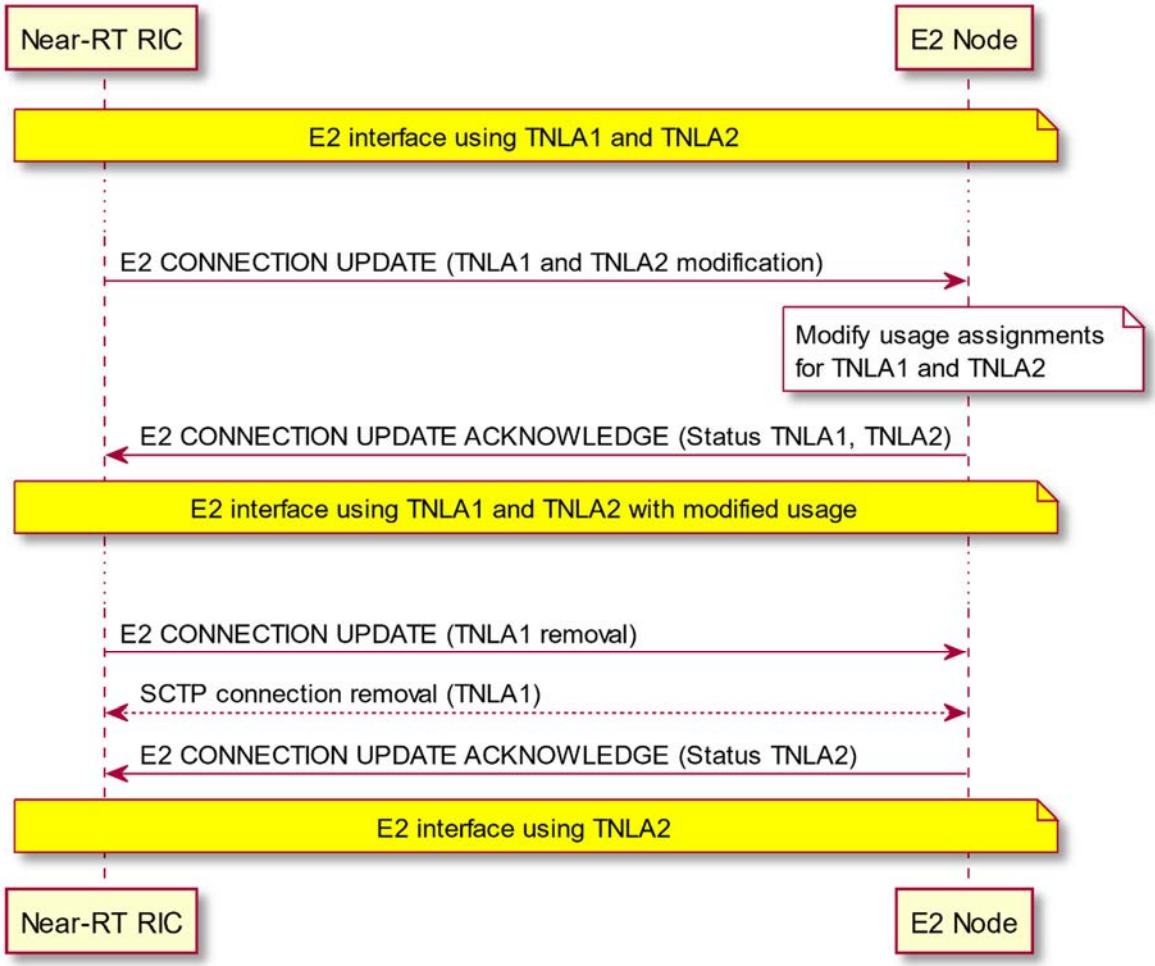


Figure 6.2-2: TNL management examples
(Near-RT RIC initiated TNL Modification and TNL Removal)

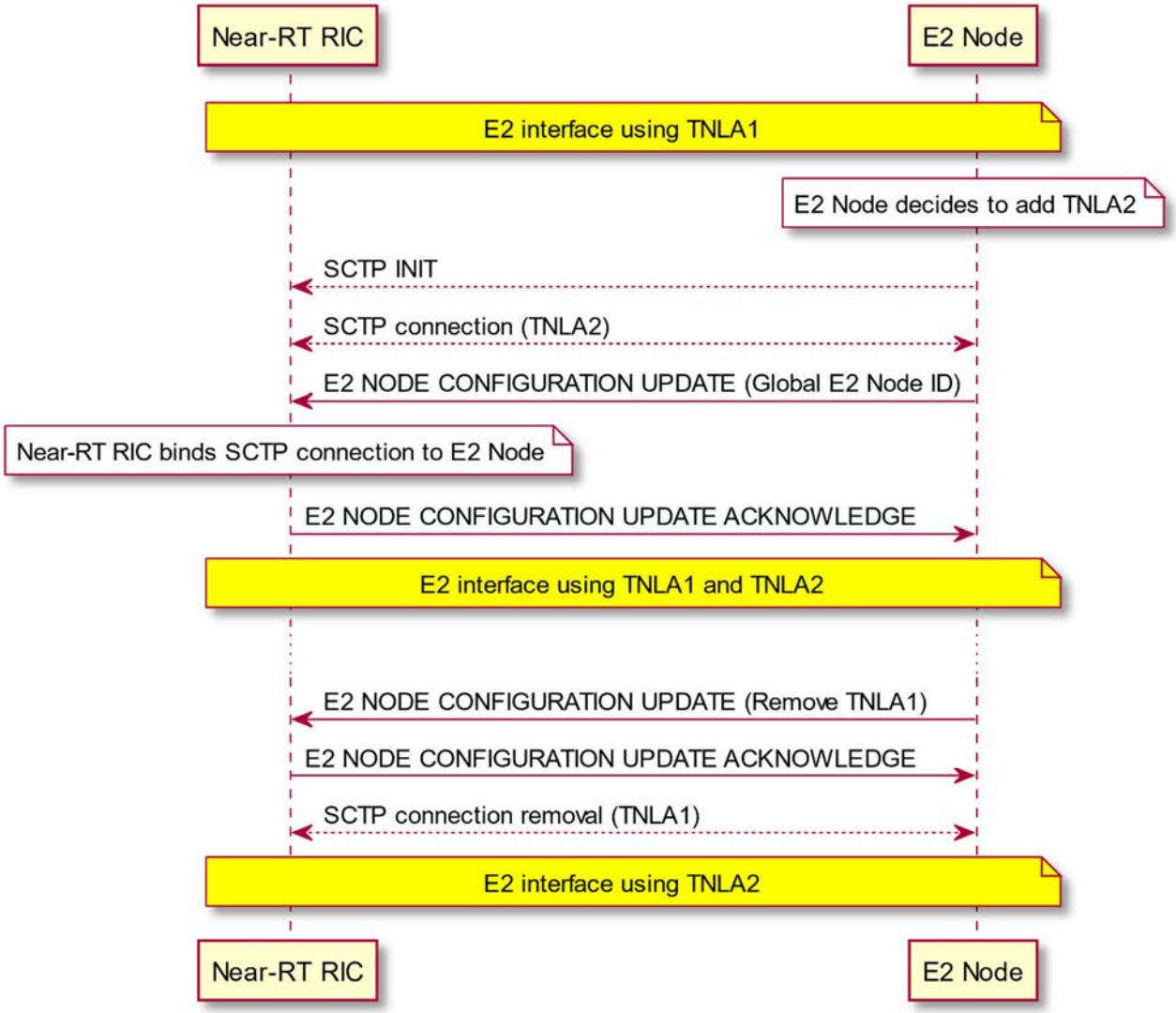


Figure 6.2-3: TNL management examples
(E2 Node initiated TNL Addition and TNL Removal)

7 Security for the E2 interface

7.1 General

The security requirements given in this clause only apply to the E2 interface.

7.2 Requirements for the E2 interfaces

The requirements given below apply to E2 interface defined in the present document:

- E2 interface shall support confidentiality, integrity, replay protection and data origin authentication.

7.3 Security mechanism for the E2 interface

In order to protect the traffic on the E2 interface, IPsec ESP implementation shall be supported according to IETF RFC 4303 [20] as profiled by ETSI TS 133 210 [21]. For IPsec implementation, tunnel mode is mandatory to support while transport mode is optional. The multiple IKE Security Associations (SAs), multiple IPsec SAs and multiple IPsec SAs per IPsec tunnel (e.g. for rekeying) shall be supported.

IKEv2 certificate-based authentication implementation shall be supported according to ETSI TS 133 310 [22]. The certificates shall be supported according to the profile described by ETSI TS 133 310 [22]. IKEv2 shall be supported conforming to the IKEv2 profile described in ETSI TS 133 310 [22].

8 Other E2 interface specifications

8.1 O-RAN E2 interface: E2 Application Protocol (E2AP) (ORAN-WG3.E2AP)

ETSI TS 104 039 [2] specifies the signalling protocol between the Near-RT RIC and the E2 Node over the E2 interface.

8.2 O-RAN E2 interface: E2 Service Model (E2SM) specifications

ETSI TS 104 040 [17] provides the list of the supported RAN Function-specific E2 Service Models supported over the E2 interface and presents a recommended layout for additional E2SM specifications.

Annex A (normative): Deployment considerations

A.1 Deployment use cases

The Near-RT RIC may be connected to range of different E2 Node configurations as described in the list implementation options in clause A.4 of [18]. Examples include:

- Standalone O-CU-CP connected to one or more standalone O-CU-UP and one or more standalone O-DU. Each logical node is considered as an E2 Node that presents an E2 interface to the Near-RT RIC.
- Combined O-CU-CP and O-CU-UP connected to one or more standalone O-DU. The combined O-CU-CP/O-CU-UP may present either a common E2 interface or individual E2 interfaces corresponding to the individual O-RAN components.
- Combined O-CU-CP, O-CU-UP and O-DU. The combined node may present either a common E2 interface or individual E2 interfaces corresponding to the individual O-RAN components.

In all cases the different RAN components may initiate either independent E2 connections to the Near-RT RIC for each logical O-RAN component or may present a shared E2 interface and hence present the combined RAN components as a common E2 Node supporting services appropriate to more than one logical O-RAN component.

In all cases each E2 Node shall present a single E2 interface to the Near-RT RIC and shall announce which E2 Services supports for each logical O-RAN component.

Example deployment use case are presented in Figures A.1-1 and A.1-2.

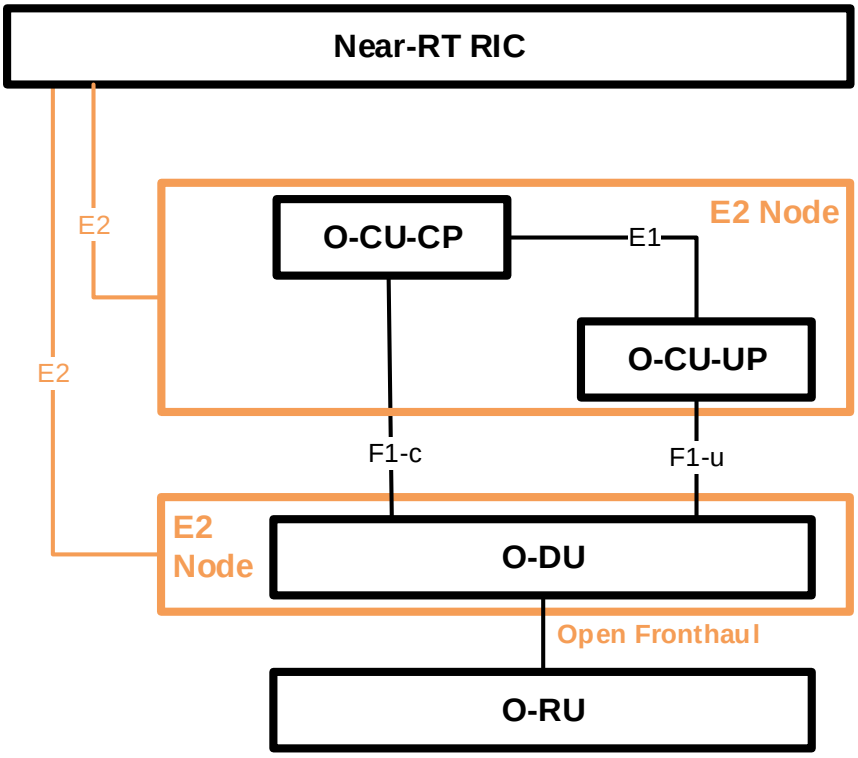


Figure A.1-1: Example deployment use case with single E2 Node supporting both O-CU-CP and O-CU-UP roles

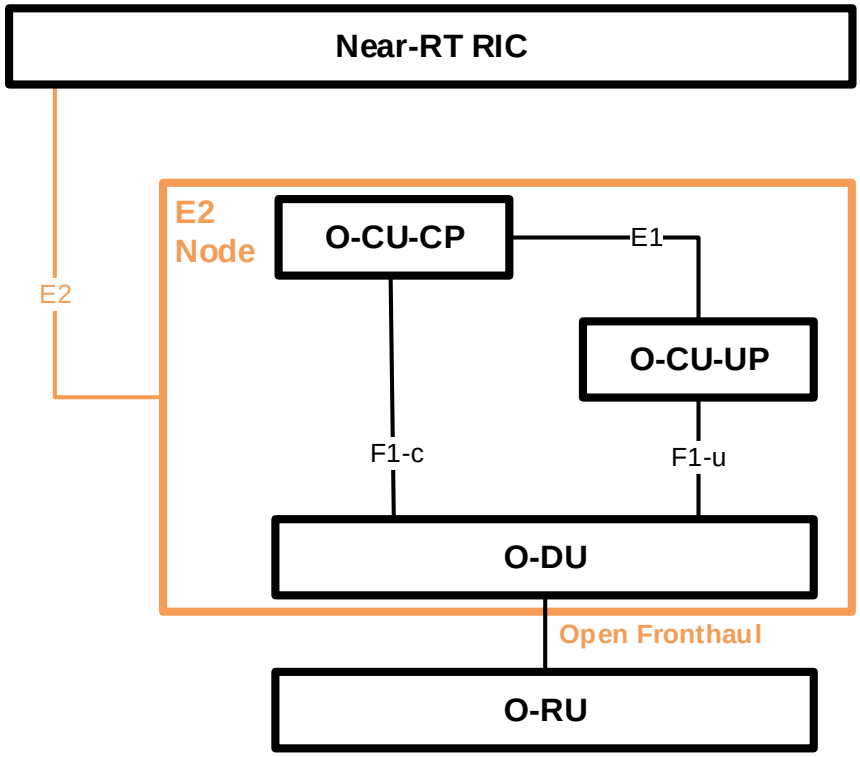


Figure A.1-2: Example deployment use case with single E2 Node supporting O-CU-CP, O-CU-UP and O-DU roles

Annex B (informative): Change history

Date	Version	Information about changes
February 2020	01.00	Initial version
October 2020	01.01	Editorial and functional corrections
October 2021	02.00	New features: RIC Subscription Delete, TNLA Removal. Improvement to security text
March 2022	02.01	New features: E2 Removal. Clarification on handling of multiple TNLAs
July 2022	02.02	Clarification on REPORT and INSERT service handling. Editorial and functional corrections
March 2023	03.00	New features: RIC Subscription Modification, RIC Query. Clarification on Combining RIC Services, Timer handling, RIC Action execution order, use of term RIC Service
June 2023	03.01	Alignment of O-RAN Drafting Rules (ODR) in preparation for ETSI PAS submission
October 2023	04.01	Editorial and functional corrections

History

Document history		
V4.1.0	October 2024	Publication