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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Future networks

Architecture of the IMT-2020 network

Recommendation ITU-T Y.3104

International Telecommunication Union

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Recommendation ITU-T Y.3104

Architecture of the IMT-2020 network

Summary

Recommendation ITU-T Y.3104 specifies the architecture of the IMT-2020 network from a functional perspective. An architecture reference model of the IMT-2020 network and procedures of the IMT-2020 network basic services (Recommendation ITU-T Y.3102) are also specified.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.3104	2018-12-14	13	11.1002/1000/13808

Keywords

IMT-2020 network, architecture, architecture reference model, registration management procedures, connection management procedures, session management procedures, handover procedures

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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1 Scope

This Recommendation specifies an architecture reference model of the international mobile telecommunication 2020 (IMT-2020) network. Following the reference model and the associated reference points (RPs), procedures of the IMT-2020 network basic services [ITU-T Y.3102] are also specified.

NOTE – This Recommendation addresses basic aspects of the architecture of the IMT-2020 network and it can be used as a foundation for further IMT-2020 studies. Detailed and comprehensive aspects [b-3GPP TS 23.501] [b-3GPP TS 23.502] are not included.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.3102] Recommendation ITU-T Y.3102 (2018), *Framework of the IMT-2020 network*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 control plane [b-ITU-T Y.2011]: The set of functions that controls the operation of entities in the stratum or layer under consideration, plus the functions required to support this control.

3.1.2 data plane [b-ITU-T Y.2011]: The set of functions used to transfer data in the stratum or layer under consideration.

3.1.3 IMT-2020 [b-ITU-T Y.3100]: Systems, system components, and related technologies that support to provide far more enhanced capabilities than those described in [b-ITU-R M.1645].

NOTE – [b-ITU-R M.1645] defines the framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000 for the radio access network.

3.1.4 management [b-ITU-T Y.3100]: In the context of IMT-2020, the processes aiming at fulfilment, assurance, and billing of services, network functions, and resources in both physical and virtual infrastructure including compute, storage, and network resources.

3.1.5 network function [b-ITU-T Y.3100]: In the context of IMT-2020, a processing function in a network.

NOTE 1 – Network functions include but are not limited to network node functionalities, e.g., session management, mobility management and transport functions, whose functional behaviour and interfaces are defined.

NOTE 2 – Network functions can be implemented on a dedicated hardware or as virtualized software functions.

NOTE 3 – Network functions are not regarded as resources, but rather any network functions can be instantiated using the resources.

3.1.6 network slice [b-ITU-T Y.3100]: A logical network that provides specific network capabilities and network characteristics.

NOTE 1 – Network slices enable the creation of customized networks to provide flexible solutions for different market scenarios which have diverse requirements, with respect to functionalities, performance and resource allocation.

NOTE 2 – A network slice may have the ability to expose its capabilities.

NOTE 3 – The behaviour of a network slice is realized via network slice instance(s).

3.1.7 network slice instance [b-ITU-T Y.3100]: An instance of network slice, which is created based on a network slice blueprint.

NOTE 1 – A network slice instance is composed of a set of managed run-time network functions, and physical/logical/virtual resources to run these network functions, forming a complete instantiated logical network to meet certain network characteristics required by the service instance(s).

NOTE 2 – A network slice instance may also be shared across multiple service instances provided by the network operator. A network slice instance may be composed of none, one or more sub-network slice instances which may be shared with another network slice instance.

3.1.8 Protocol data unit session [b-ITU-T Y.3100]: In the context of IMT-2020, an association between a user equipment (UE) and a data network that provides a protocol data unit (PDU) connectivity service.

NOTE – The type of the association includes IP type, non-IP type and Ethernet type.

3.1.9 user plane [b-ITU-T Y.2011]: A synonym for data plane.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

Ack	Acknowledgement
AF	Application Function
AN	Access Network
ASF	Authentication Server Function
CEF	Capability Exposure Function
CM	Connection Management
CN	Core Network
CP	Control Plane
HO	Handover
HTTP	Hypertext Transfer Protocol
ID	Identifier
IMT-2020	International Mobile Telecommunication 2020
IP	Internet Protocol
NACF	Network Access Control Function
NF	Network Function
NFR	Network Function Repository

NS Network Slice

NSI Network Slice Instance

NSISP Network Slice Instance Selection Preference

NSSF Network Slice Selection Function

PCF Policy Control Function

PDU Protocol Data Unit

RP Reference Point

RT Route Trace

QoS Quality of Service

RAN Radio Access Network

RM Registration Management

RRC Radio Resource Control

SM Session Management

SMF Session Management Function

UE User Equipment

UP User Plane

UPF User Plane Function

USM Unified Subscription Management

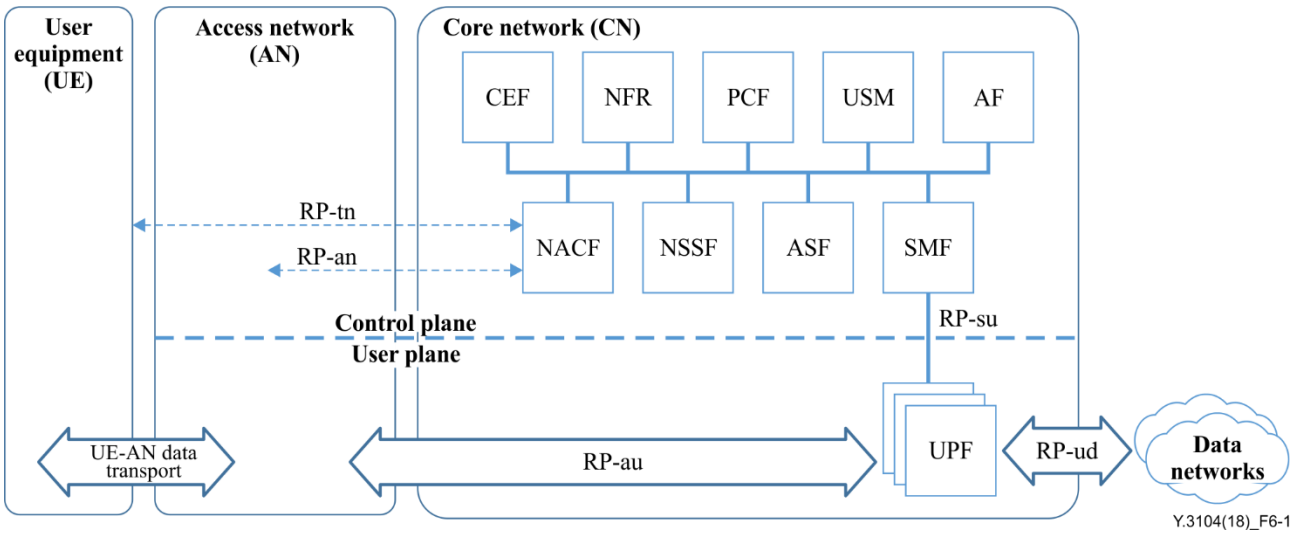
5 Conventions

None.

6 Architecture reference model

Figure 6-1 depicts an architecture reference model of the IMT-2020 network.

The architecture reference model is used to illustrate the interactions between the network functions defined in [ITU-T Y.3102].



(AF: application function; CEF: capability exposure function)

Figure 6-1 – Architecture reference model of the IMT-2020 network

The network functions interact with each other to provide the IMT-2020 network services specified in [ITU-T Y.3102]. Interaction procedures among network functions in order to provide network services are specified in clause 7.

The network functions within the core network (CN) control plane (CP) interact with each other using service interfaces. These service interfaces can be implemented by common protocols such as the hypertext transfer protocol (HTTP) 2.0 [b-IETF RFC 7540]. The details of the service interfaces lie outside the scope of this Recommendation.

User equipment (UE), access network (AN) and user plane (UP) functions are connected over point-to-point RPs. They require specialized signalling and transport interfaces, and related protocols.
The following RPs are defined in the IMT-2020 network architecture reference model:

- RP-tn: reference point between the UE and network access control function (NACF);
- RP-an: reference point between the AN and NACF;
- RP-au: reference point between the AN and user plane function (UPF);
- RP-su: reference point between the session management function (SMF) and UPF;
- RP-ud: reference point between the UPF and data network.

7 Procedures of IMT-2020 network services

Based on the architecture reference model defined in clause 6, this clause describes the procedures to provide each of the basic network services defined in [ITU-T Y.3102]: registration management (RM); connection management (CM); session management (SM); and handover (HO), respectively.

7.1 Registration management procedures

RM procedures are used to register or deregister UE with the IMT-2020 network and to establish the UE context in the network.

The registration and deregistration procedures are specified in clause 7.1.1 and clause 7.1.2, respectively.

7.1.1 Registration procedures

UE needs to register with the network to get authorized to receive network services, to enable mobility tracking and to enable reachability. The registration procedures are used when the UE, which is in

RM DEREGISTERED state, needs to register on the network. Even pieces of UE in RM REGISTERED state also need to use the procedures when:

1) UE, in both CM CONNECTED and CM IDLE states [ITU-T Y.3102], needs to perform registration updates when it moves to a new mobility tracking area outside the registered tracking area:

2) UE performs periodic registration updates due to a predefined time period of inactivity;

3) UE needs to update its capabilities or parameters negotiated in the previous registration procedure.

Clause 7.1.1.1 specifies the general registration procedure that applies to all required registrations in the previous paragraph.

When an NACF receives a Registration Request message and it is an inappropriate NACF to serve UE requirements, the NACF needs to reroute the message to an appropriate NACF. The registration with NACF re-allocation procedure is specified in clause 7.1.1.2.

7.1.1.1 General registration

See Figure 7-1.

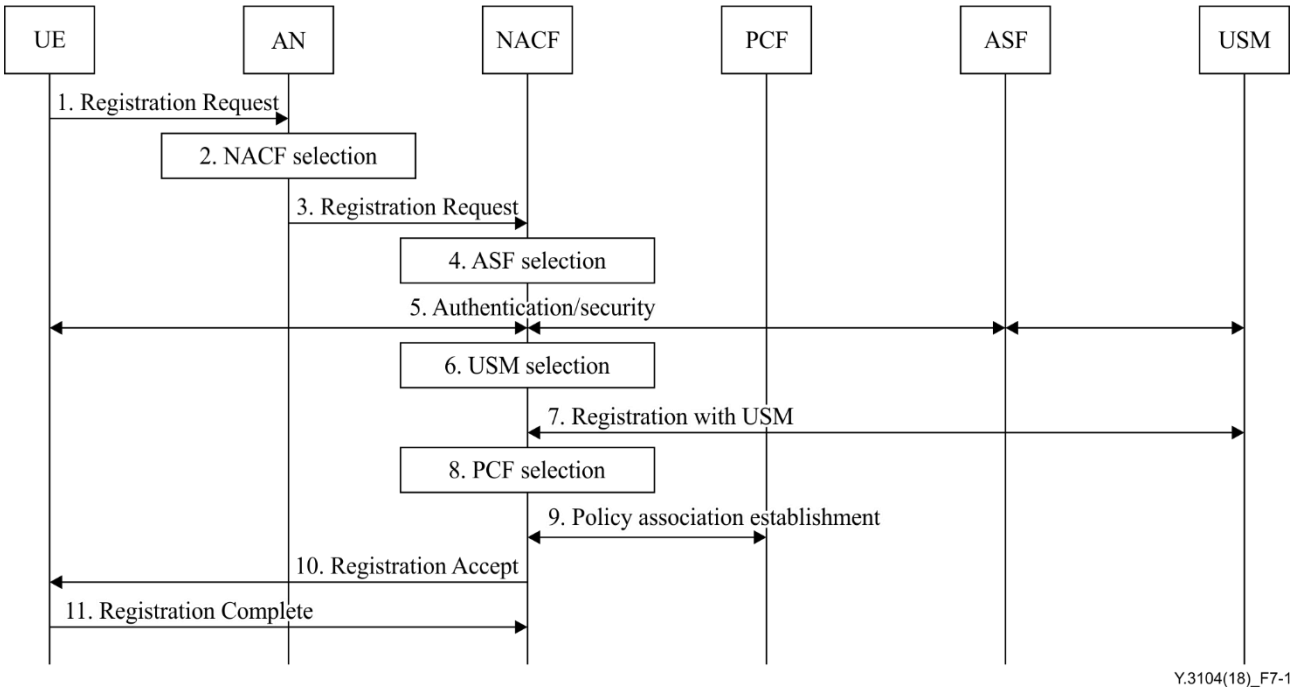


Figure 7-1 – Registration procedure

1) Registration Request AN message (UE to AN)

   UE sends the Registration Request AN message to an AN, including network slice instance selection preference (NSISP) information and the NACF instance identifier (ID), if available from a previous registration procedure. UE can attach to the IMT-2020 common CN simultaneously over different types of AN – 'IMT-2020 RAN' [i.e., new radio access network (RAN) for IMT-2020] and non 'IMT-2020 RAN' (e.g., WiFi, fixed wireline AN). An NACF selected for the first successful registration of UE over an AN can be used for subsequent registrations over other ANs.

2) NACF selection

   If the Registration Request AN message sent from UE does not indicate a valid NACF instance ID (e.g., no NACF instance ID is given or the given ID is not usable for the requested registration), AN selects an NACF based on the requested NSISP information, location of

the NACF, network operator policy, load balancing, etc. When the UE-provided NACF instance ID in the Registration Request AN message is valid, AN selects the NACF that maintains the UE context created on the previous registration(s).

3) Registration Request RP-an message (AN to NACF)

AN sends the message to the selected NACF.

4) ASF selection

The NACF selects an authentication server function (ASF) to initiate UE authentication. The NACF utilizes a network function repository (NFR) function for the selection.

5) Authentication of the UE

The ASF executes authentication of the UE: it discovers a unified subscription management (USM) function to get the UE authentication information; the ASF selects an authentication method and performs UE authentication procedures. After successful authentication, the ASF returns the results to the NACF. The NACF initiates UE-CN signalling security function setup procedures, such as those specified in [b-3GPP TS 33.501]. Upon completion of the signalling security function setup, the NACF provides the security context to the AN (e.g., by using the RAN application protocol [b-3GPP TS 38.413]), which enables an AN to use the security context of the signalling security function setup to protect the messages exchanged with the UE. The AN stores the security context and acknowledges the NACF.

6) USM selection

NACF utilizes the NFR to select a USM for UE and NACF RM context registration.

7) Registration with USM

NACF registers with USM and subscribes to the event notification service in order to be notified when USM deregisters the NACF in the following cases:

– if the NACF has changed since the last registration procedure (e.g., due to UE mobility);
– if the UE-provided subscription identifier, which is permanent and globally unique in the IMT-2020 network, does not refer to a valid context in the NACF;
– if the UE is registered over a non-IMT-2020 RAN access network and initiates another registration procedure on an IMT-2020 RAN access network.

The NACF provides the AN type of the UE to the USM (e.g., IMT-2020 RAN access). The USM stores the associated AN type together with the serving NACF. The NACF creates a mobility management context for the UE after getting the mobility subscription data from the USM.

8) PCF selection

If the NACF has not yet obtained AN and mobility policies for the UE or if those policies in the NACF are no longer valid, the NACF selects a policy control function (PCF).

9) Policy association establishment

NACF performs policy association of the UE with the PCF.

10) Registration Accept RP-tn message (NACF to UE)

The NACF sends a Registration Accept RP-tn message to the UE indicating that the registration request has been accepted. If a globally unique temporary identifier is allocated by NACF, it can be commonly used in both 'IMT-2020 RAN' and non 'IMT-2020 RAN' access networks. The identifier is included in the Registration Accept RP-tn message.

11) Registration Complete RP-tn message (UE to NACF)

If a new globally unique temporary identifier is assigned, the UE sends a Registration Complete RP-tn acknowledgment message to the NACF.

7.1.1.2 Registration with the network access control function re-allocation

When an NACF (i.e., the initial NACF in Figure 7-2) receives a registration request and it is an inappropriate NACF to serve the UE, it reroutes the registration request to another NACF (i.e., the target NACF in Figure 7-2) in the same network slice instance (NSI) or other NSIs. The registration with the NACF re-allocation procedure depicted in Figure 7-2 is used to reroute the Registration Request RP-tn signalling message of the UE to the target NACF during a registration procedure.

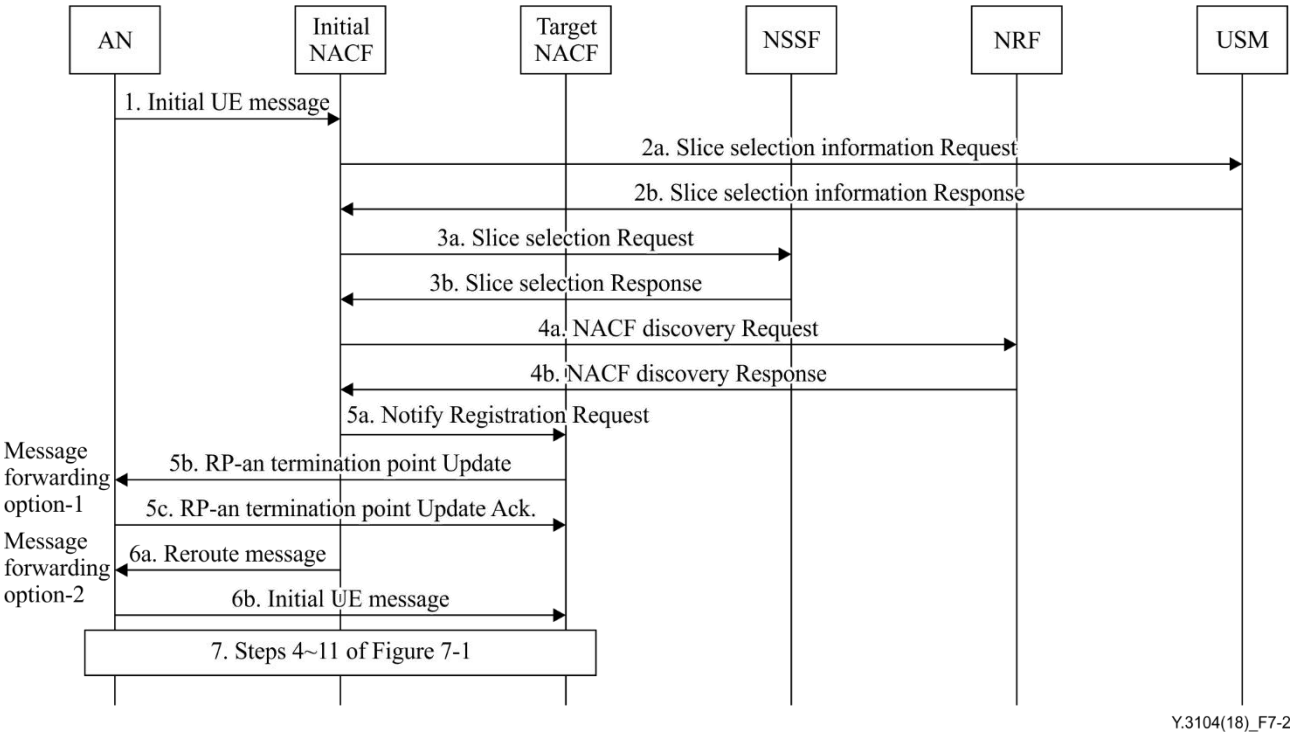


Figure 7-2 – Registration with the network access control function re-allocation procedure

It is assumed that the initial NACF and the target NACF have registered their capabilities in the NFR.

1) Initial Registration Request RP-tn message (UE to initial NACF)

   Step 1 and step 2 of Figure 7-1 have occurred. The AN sends the registration request within the Initial UE message to the initial NACF.

2) Slice selection information Request/Response

   a) Slice selection information Request

      If the initial NACF needs the UE subscription information to decide whether to reroute the registration request and the UE slice selection subscription information is not provided, the NACF requests them from USM.

   b) Slice selection information Response

      USM sends a Response message to the NACF.

3) Slice selection Request/Response

   a) Slice selection Request

      If slice selection is needed, the initial NACF sends a slice selection request to the network slice selection function (NSSF).

   b) Slice selection Response

      The NSSF returns to the NACF the allowed NSISP information and the target NACF set. The NSSF may return the NFR(s) to be used to select network functions (NFs; e.g.,

NACF) within the selected NSI(s). The NFR(s) can be a shared NF across the selected NSI(s).

4) NACF discovery Request/Response

a) NACF discovery Request

If the initial NACF does not locally store the Internet protocol (IP) address of the target NACF and if the initial NACF intends to use direct reroute to the target NACF or reroute via an AN message, then the initial NACF sends the NACF discovery Request to the NFR to find a proper target NACF that has the required capabilities to serve the UE.

b) NACF discovery Response

The NFR replies with the list of potential target NACF(s) and optionally additional selection rules. Based on the information about NACFs and required capabilities, a target NACF is selected by the initial NACF.

If the initial NACF is not able to get a list of NACF(s) by querying the NFR (e.g., the candidate NACF is on another NS instance and the local NFR, which is not a shared function between NS instances, does not provide the requested NACF information, or the query to the appropriate NFR provided by the NSSF is not successful), then the initial NACF forwards the Initial Registration Request message to the target NACF via the AN; the NSISP information and the target NACF set are included in the message to enable the AN to select the target NACF.

5) Registration Request message forwarding option-1 (direct forwarding)

a) Notify Registration Request message

If the initial NACF decides to forward the Registration Request message to the target NACF directly, the initial NACF sends a Registration Request Notify message to the target NACF, carrying the rerouted Registration Request message and the information enabling AN to identify the RP-an termination point.

b) RP-an termination point Update

The target NACF then updates the AN with a new updated RP-an termination point.

c) RP-an termination point Update acknowledgement

AN acknowledges the updated RP-an termination point. step 6 is skipped.

6) Registration Request message forwarding option-2 (via AN)

a) Reroute Registration Request message to the AN

If the initial NACF decides to forward the Registration Request message to the target NACF via the AN, the initial NACF sends a Reroute RP-an message to the AN. The message includes information about the target NACF and the Registration Request.

b) Initial UE message to the target NACF

The AN sends the Initial UE message to the target NACF.

7) Continues with the general registration procedure

After receiving a Registration Request message forwarded according to step 5 or step 6, the target NACF continues with the registration procedure from step 4 to step 11 of Figure 7-1.

7.1.2 Deregistration procedures

Deregistration procedures allow the UE to inform the network that the UE does not want to access the network any longer or the network to inform the UE that the UE does not have access to the network. Upon receipt of a deregistration request from either the UE or network, NACF deletes the UE context and UE subscription information, and notifies the AN and UPFs via the corresponding

SMF. The UPFs terminate the PDU sessions and release the resources allocated to the deregistered UE.

7.1.2.1 UE-initiated deregistration

The UE uses this procedure to deregister from the registered network as shown in Figure 7-3.

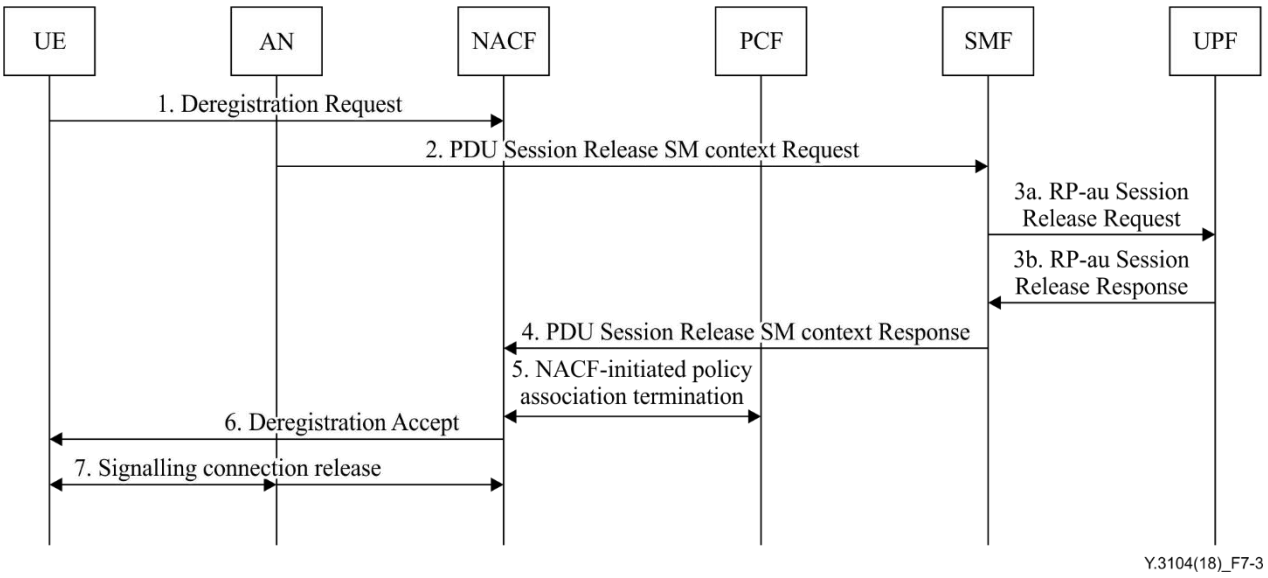


Figure 7-3 – UE-initiated deregistration procedure

1) Deregistration Request (UE to NACF)

   The UE sends a Deregistration Request RP-tn message including the access type to the NACF.

   The access type indicates whether the deregistration procedure applies to 'IMT-2020 RAN' or non 'IMT-2020 RAN' access network, or both if the UE is served by the same NACF over both ANs. The NACF invokes the deregistration procedure for the target AN indicated by the UE.

2) PDU Session Release SM context Request (NACF to SMF)

   If the UE has no established PDU session over the target AN indicated in step 1, then steps 2 to 5 are not executed. For all PDU sessions over the target AN that belong to the UE, they are released by the NACF sending PDU Session Release SM context Request message to the SMF for each PDU session.

3) RP-au session release

   The SMF releases the IP addresses that were allocated to the PDU session and releases the corresponding UP resources:

   a) RP-au Session Release Request

      The SMF sends an RP-au Session Release Request (RP-au session ID) message to the UPF(s) of the PDU session. The UPF(s) drops any remaining packets of the PDU session and releases all tunnel resources and contexts associated with the RP-au session.

   b) RP-au Session Release Response

      The UPF(s) acknowledges the RP-au Session Release Request by an RP-au Session Release Response (including RP-au session ID) message to the SMF.

4) PDU Session Release SM context Response (SMF to NACF)

   The SMF responds with a PDU Session Release SM context Response message to the NACF.

5) NACF-initiated policy association termination

If there is any association with the PCF for this UE, the NACF performs deletion of the association with the PCF.

6) Deregistration Accept (NACF to UE)

The NACF sends Deregistration Accept message to UE.

7) RP-an UE context Release Request (NACF to AN)

If there is RP-an signalling connection, the NACF sends RP-an UE context Release message to AN to release the signalling connection.

7.1.2.2 Network-initiated deregistration

The procedure depicted in Figure 7-4 shows the network-initiated deregistration procedure. The NACF can initiate this procedure for either explicit cause (e.g., by OAM intervention) or implicit cause (e.g., expiration of the implicit deregistration timer). The USM can trigger this procedure for network operator-determined purposes to request the removal of a subscriber RM context and PDU session(s) of the UE.

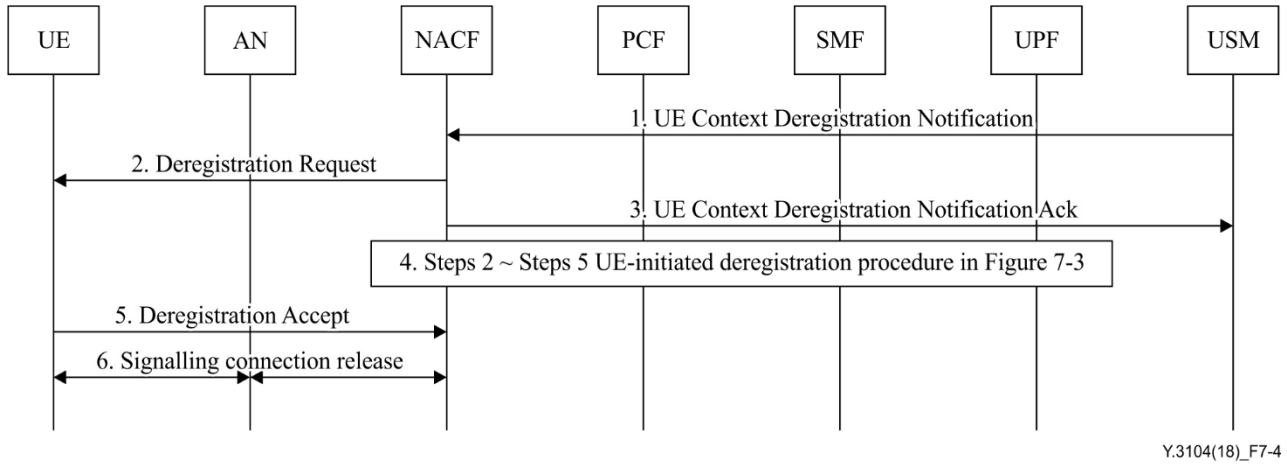


Figure 7-4 – Network-initiated deregistration procedure

1) UE Context Deregistration Notification (USM to NACF)

If the USM wants to request the immediate deletion of a subscriber RM context and PDU sessions, the USM sends a UE Context Deregistration Notification to the registered NACF.

2) Deregistration Request (NACF to UE)

If the NACF receives a UE Context Deregistration Notification in step 1, the NACF executes the deregistration procedure over all ANs on which the UE is registered.

The NACF does not send the Deregistration Request message to the UE for implicit deregistration.

If the UE is in CM CONNECTED state, the NACF may explicitly deregister the UE by sending a Deregistration Request message, including the deregistration type and access type, to the UE. The deregistration type may be set to "re-registration", in which case the UE should re-register at the end of the deregistration procedure. The access type indicates whether the deregistration procedure applies to the 'IMT-2020 RAN' or non 'IMT-2020 RAN' access networks, or both.

3) UE Context Deregistration Notification Ack (NACF to USM)

If the UE receives the Deregistration Request message from the NACF in step 2, the UE sends a Deregistration Accept message to the NACF any time after step 2.

4) Step 2 to step 5 of a UE-initiated deregistration procedure in Figure 7-3

5) Deregistration Accept (UE to NACF)

The NACF sends the Deregistration Accept message to the UE.

6) RP-an UE context Release request (NACF to AN)

If there is RP-an signalling connection, the NACF sends RP-an UE context Release message to AN to release the signalling connection.

7.2 Connection management procedures

CM procedures are used to establish and release a signalling connection between the UE and NACF. Through the established signalling connection, the UE and the network exchange signalling messages for SM, etc.

The establishment of the signalling connection can be triggered either by the UE or the network as specified in clause 7.2.1 or clause 7.2.2, respectively.

The release procedure of a signalling connection can be initiated by the AN or NACF. The UE considers the signalling connection released if it detects the release of the signalling connection between the AN and NACF. The NACF considers the signalling connection released if it detects the deletion of the signalling connection context.

7.2.1 UE-triggered connection request

The UE in CM IDLE state initiates the connection request procedure. After establishment of the signalling connection to the NACF, the UE or the network may send signalling messages for SM, e.g., a PDU Session Establishment Request from the UE to the SMF via the NACF.

The connection request procedure is also used by UE in CM CONNECTED state to request the activation of a UP connection for PDU session(s). When the UE wants to activate the PDU session(s), the UE provides a list of PDU session(s) to be activated.

For any Connection Request, the NACF responds with a Connection Request acceptance message to synchronize the PDU session(s) status between the UE and network. The NACF responds with a reject message to the UE if the request cannot be accepted by the network. The reject message may include an indication or cause code requesting the UE to perform the RM procedure.

The UE-triggered connection request procedure is shown in Figure 7-5.

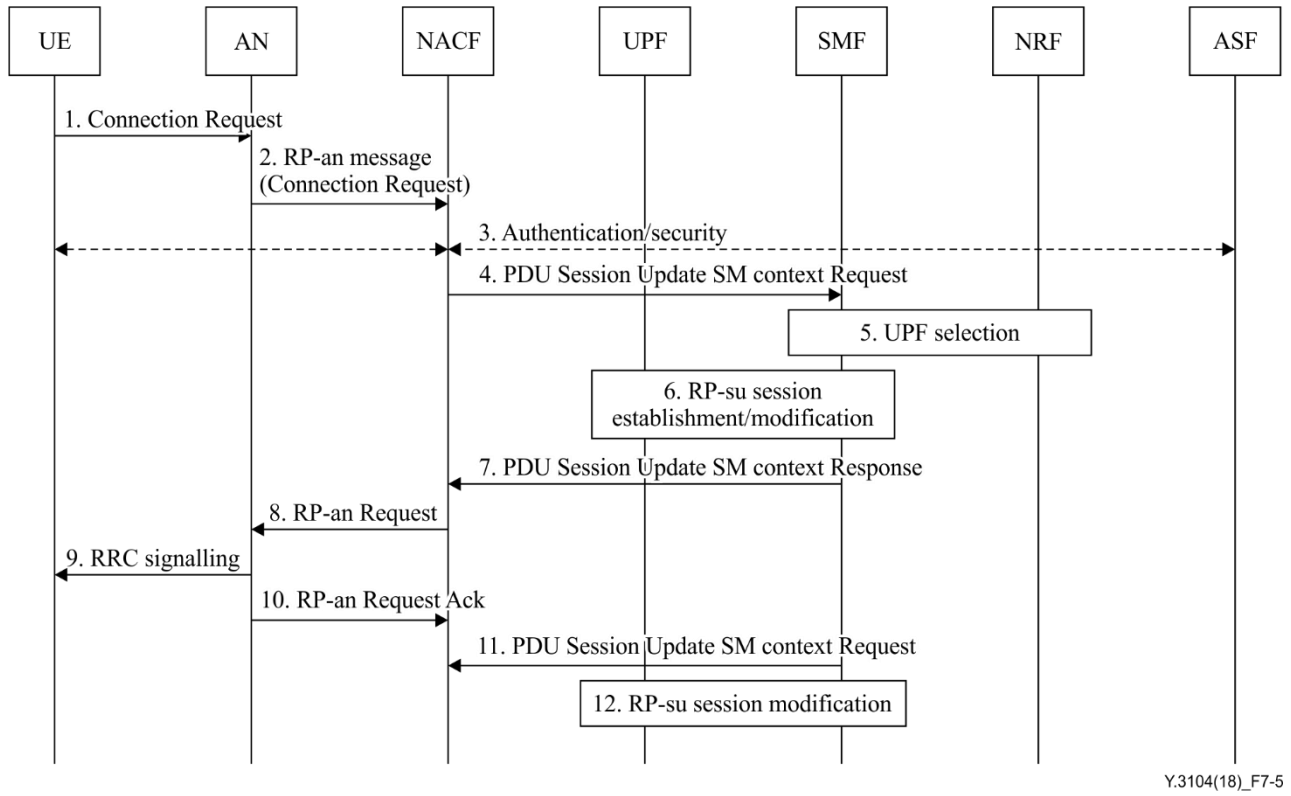


Figure 7-5 – UE-triggered connection request procedure

1) Connection Request AN message (UE to AN)

The UE sends a Connection Request message towards the NACF encapsulated in an AN message requesting the establishment of a radio resource control (RRC) connection to the AN.

If the Connection Request message is triggered for uplink user data by the UE in the CM CONNECTED state, the UE identifies the PDU session(s) for which the UP connections are to be activated.

2) Connection Request RP-an message (AN to NACF)

AN encapsulates the Connection Request message sent from the UE in the RP-an signalling message and sends it to NACF.

If the UE is in the CM IDLE state, AN selects a proper NACF according to the UE identity information which includes the set of NACF IDs.

3) Authentication and security procedure

If the Connection Request is not integrity protected or the integrity protection verification has failed, NACF initiates the authentication and security procedure with the ASF. After a successful authentication and security procedure, a secure signalling connection between the UE and NACF is established.

If the UE in a CM IDLE state triggered the Connection Request only to establish a signalling connection, after its successful establishment, the UE and the network can exchange signalling messages for SM, etc.

4) PDU Session Update SM context Request (NACF to SMF)

If the Connection Request was not sent only for the establishment of a signalling connection, and if the UE provides a list of PDU sessions to be activated in the Connection Request message, NACF requests the SMF(s) associated with the PDU sessions to update their SM context, e.g., establishment of UP resources for the PDU session(s). The PDU Session Update

SM context Request message contains PDU session ID(s), UE location information, access type, etc.

5) UPF selection

Based on the UE location information received from the NACF, the SMF performs the following actions:

– accepts activation of the UP connection of PDU session(s) and continues using the current UPF; or

– accepts the activation of the UP connection of PDU session(s) and selects a new UPF with NFR; or

– rejects the activation of the UP connection of a PDU session and triggers the re-establishment of the PDU session after the connection request procedure.

6) RP-su session establishment and modification

If the SMF selects a new UPF in step 5, in order to relocate the UPF, the SMF establishes RP-su session with the new UPF and modifies the RP-su session with the old UPF.

The new UPF, acting as RP-au terminating point in CN, provides new RP-au tunnel CN interface information to the SMF.

The old UPF forwards buffered downlink data to the new UPF and releases the allocated resources for the PDU session.

7) PDU Session Update SM context Response (SMF to NACF)

For the activated PDU session in step 5, the SMF generates the corresponding SM information that the NACF will encapsulate in an RP-an signalling message. The SM information contains information that the NACF will provide to the AN, e.g., PDU session ID, quality of service (QoS) profile and RP-au tunnel CN interface information.

The SMF sends the SM information to the NACF through a PDU Session Update SM context Response message.

8) RP-an Request (NACF to AN)

The NACF sends RP-an Request signalling message to the AN. The message includes SM information received from SMF(s) and connection request acceptance-related information, e.g., the result of requested PDU session(s) activation. If the result of PDU session(s) activation includes failures, the cause of the failures is also provided.

If there are multiple PDU sessions that involve multiple SMFs, the NACF does not need to wait for responses from all SMFs in step 7 before it sends RP-an SM information to the AN.

9) RRC signalling (AN to UE)

AN may perform RRC connection reconfiguration with the UE depending on the QoS information for the QoS flows of the PDU sessions whose UP connections are activated.

After UP radio resources are set up, uplink data from the UE can now be forwarded to the RAN, which sends the uplink data to the UPF using RP-au tunnel CN interface information provided in step 7.

10) RP-an Request Ack (AN to NACF)

The RP-an Request Ack message may include RP-an SM information, e.g., AN tunnel information. AN may respond to RP-an SM information with separate RP-an Request Ack messages (e.g., RP-an tunnel setup response) if the NACF sends separate RP-an messages in step 8.

11) PDU Session Update SM context Request (NACF to SMF)

If the NACF has received RP-an SM information (one or multiple RP-an messages) in step 10, then the NACF forwards it to the relevant SMF per PDU session ID.

12) RP-su session modification

If the SMF has selected a new UPF for the PDU session in step 5, the SMF provides the AN tunnel information received from the AN in step 10 and forwarded by NACF in step 11, to the new UPF through the RP-su Session Modification signalling message. With the AN tunnel information, the new UPF completes the establishment of the UP connection to UE.

7.2.2 Network-triggered connection request

When the network needs to signal UE (e.g., when SMF needs to set up an RP-au tunnel with UE in CM IDLE state or to activate a UP connection of UE in CM CONNECTED state in order to deliver downlink data), the network can initiate a network-triggered connection request procedure. The network can also perform paging to the UE in CM IDLE state in order to initiate a UE-triggered connection request procedure in the UE.

If the UE is in the CM IDLE state in a non 'IMT-2020 RAN' access network and the UE is simultaneously registered over IMT-2020 RAN and non 'IMT-2020 RAN' access networks, the network initiates a network-triggered connection request procedure over the 'IMT-2020 RAN' access network.

If the UE is in the CM IDLE state in an 'IMT-2020 RAN' access network and in the CM CONNECTED state in a non 'IMT-2020 RAN' access network, the network may initiate a network-triggered connection request procedure for the 'IMT-2020 RAN' access network via the non 'IMT-2020 RAN' access network. See Figure 7-6.

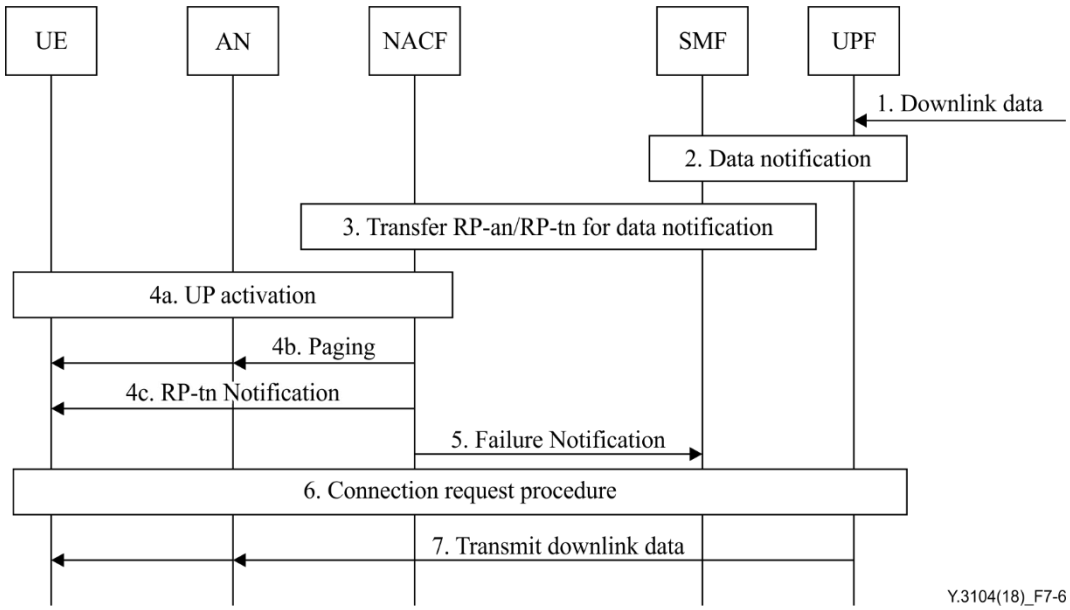


Figure 7-6 – Network-triggered connection request procedure

1) Downlink data

When a UPF receives downlink data for a PDU session and there is no RP-au AN tunnel endpoint information stored in the UPF for the PDU session, the UPF may buffer the downlink data or forward the downlink data to the SMF.

2) Data notification

The UPF sends a Data Notification message that contains PDU session ID-related information to the SMF.

The SMF sends a Data Notification Ack message to the UPF.

If the SMF can buffer the downlink data, UPF may forward the downlink data to the SMF.

3) Transfer Data Notification RP-an/RP-tn message

The SMF requests the NACF, associated with the PDU session ID received in step 2, to transfer a downlink Data Notification RP-an/RP-tn message to the UE.

If the UE is in CM IDLE state and the NACF is able to page the UE, NACF responds to the SMF with "Attempting to reach UE".

If the UE is in CM CONNECTED state at the NACF, NACF responds to the SMF with "Success".

If the NACF determines that UE is not reachable, NACF rejects the request from the SMF.

If the SMF receives a response from the NACF that the UE is not reachable, the SMF may notify the UPF about the UP connection setup failure.

4) UP activation

a) UP activation (CM CONNECTED)

If the UE is in CM CONNECTED state for the PDU session ID received from the SMF in step 3, in order to activate the UP connection for this PDU session (i.e., establish the radio resources and RP-au tunnel), steps 8 to 12 in the UE-triggered connection request procedure are performed as specified in clause 7.2.1.

b) Paging (CM IDLE)

If the UE is in the CM IDLE state in 'IMT-2020 RAN' access network and in the CM CONNECTED state for non 'IMT-2020 RAN' access network, and if the PDU session ID received from the SMF in step 3 has been associated with 'IMT-2020 RAN' access network and NACF decides to notify the UE through 'IMT-2020 RAN' access network, NACF may send a Paging message to the 'IMT-2020 RAN' access network nodes.

If the UE is simultaneously registered over IMT-2020 RAN and non 'IMT-2020 RAN' access networks and the UE is in the CM IDLE state in both ANs, and if the PDU session ID in step 3 is associated with a non 'IMT-2020 RAN' access network, the NACF sends a Paging message to 'IMT-2020 RAN' nodes towards the associated non 'IMT-2020 RAN' access network. Upon receiving the Paging message through the 'IMT-2020 RAN' access network, the paged UE triggers the connection request procedure through the associated non 'IMT-2020 RAN' access network.

If the UE is in RM REGISTERED state and CM IDLE state, and it is reachable in the 'IMT-2020 RAN' access network, the NACF sends a Paging message to AN nodes belonging to the registered area(s) in which the UE is registered, and then the 'IMT-2020 RAN' nodes page the UE, including the non 'IMT-2020 RAN' access network associated with the PDU session in the Paging message.

c) Notification RP-tn

If the UE is simultaneously registered over 'IMT-2020 RAN' and non 'IMT-2020 RAN' access networks, the NACF sends a Notification RP-tn message to UE as follows.

– If the UE is in CM CONNECTED state in 'IMT-2020 RAN' access network and the PDU session ID in step 3 is associated with non 'IMT-2020 RAN' access network, the NACF sends a Notification RP-tn message containing the non-'IMT-2020 RAN' access type to the UE over 'IMT-2020 RAN' access network and sets a notification timer.

– If the UE is in CM CONNECTED state in a non 'IMT-2020 RAN' access network and in CM IDLE state in an 'IMT-2020 RAN' access network, and if the PDU session ID in step 3 is associated with an 'IMT-2020 RAN' access network and the NACF decides to notify the UE through a non 'IMT-2020 RAN' access network, then the NACF sends a Notification RP-tn message containing the 'IMT-2020 RAN' access

type to the UE over the non 'IMT-2020 RAN' access network and sets a notification timer.

5) Failure Notification (NACF to SMF)

If the NACF determines that paging to the UE has failed, the NACF notifies the SMF by sending a Failure Notification message. When a Failure Notification is received, the SMF informs the UPF.

6) Connection request procedure

If the UE is in CM IDLE state in an 'IMT-2020 RAN' access network, upon receipt of a Paging Request for a PDU session associated with the 'IMT-2020 RAN' access network, the UE initiates the UE-triggered connection request procedure specified in clause 7.2.1.

If the UE is in CM IDLE state in both non 'IMT-2020 RAN' and 'IMT-2020 RAN' access networks, upon receipt of a Paging Request for a PDU session associated with the non 'IMT-2020 RAN' access network, and if the requested PDU sessions are allowed for 'IMT-2020 RAN' access network, the PDU sessions can be re-activated over the 'IMT-2020 RAN' access network according to UE policies. The UE initiates the UE-triggered connection request procedure. In this case, the UE Connection Request AN message contains the list of allowed PDU sessions. If there is no PDU session that can be re-activated over the 'IMT-2020 RAN' access network, the UE includes an empty list of allowed PDU sessions.

If the UE is in the CM IDLE state in a non 'IMT-2020 RAN' access network and in CM CONNECTED state in an 'IMT-2020 RAN' access network, upon receipt of a Notification RP-tn message over the 'IMT-2020 RAN' access network containing the non 'IMT-2020 RAN' access type, the UE initiates the UE-triggered connection request procedure with the list of allowed PDU sessions that can be re-activated over the 'IMT-2020 RAN' access network.

When the NACF receives the Connection Request message and the list of allowed PDU sessions does not include the PDU session for which the UE was notified, the NACF notifies the SMF that the UE was reachable, but did not accept reactivation of the PDU session in step 4 of clause 7.2.1.

If the NACF receives a Connection Request message from the UE via a non 'IMT-2020 RAN' access network, the NACF stops the paging procedure and processes the received connection request procedure.

If the UE is in the CM IDLE state in an 'IMT-2020 RAN' access network and in the CM CONNECTED state in a non 'IMT-2020 RAN' access network, upon receipt of a Notification RP-tn message over the non 'IMT-2020 RAN' access network identifying the 'IMT-2020 RAN' access type, the UE initiates the UE-triggered connection request procedure over the 'IMT-2020 RAN' access network when an 'IMT-2020 RAN' access network is available. If the NACF does not receive the Connection Request message before the notification timer expires, the NACF may either page the UE through the 'IMT-2020 RAN' access network or notify the SMF that the UE was not able to re-activate the PDU session.

7) Transmit downlink data

The UPF, which received downlink data in step 1, transmits the buffered downlink data toward the UE via an AN.

7.3 Session management procedures

SM procedures are used to establish, modify and release PDU sessions that support PDU connectivity to enable the exchange of PDUs between UE and a data network. PDU session establishment, modification and release procedures are described in clauses 7.3.1, 7.3.2 and 7.3.3, respectively.

While a PDU session is the connectivity association between the UE and data network in the UP to forward PDUs, an RP-su session is the association between the SMF and UPF in the CP. An RP-su session is used by the SMF to control the functionality of the UPF regarding a PDU session, e.g., to establish a new PDU session or to change the UPF for an established PDU session. The UPF provides PDU session-related information to the SMF through an RP-su session. RP-su SM procedures are specified in clause 7.3.4.

7.3.1 Protocol data unit session establishment

The PDU session establishment procedure is used to establish a new PDU session. See Figure 7-7.

The procedure is also used when UE moves between different IMT-2020 ANs. In this case, to continue the service provided by the existing PDU session, switching of the existing PDU session is required.

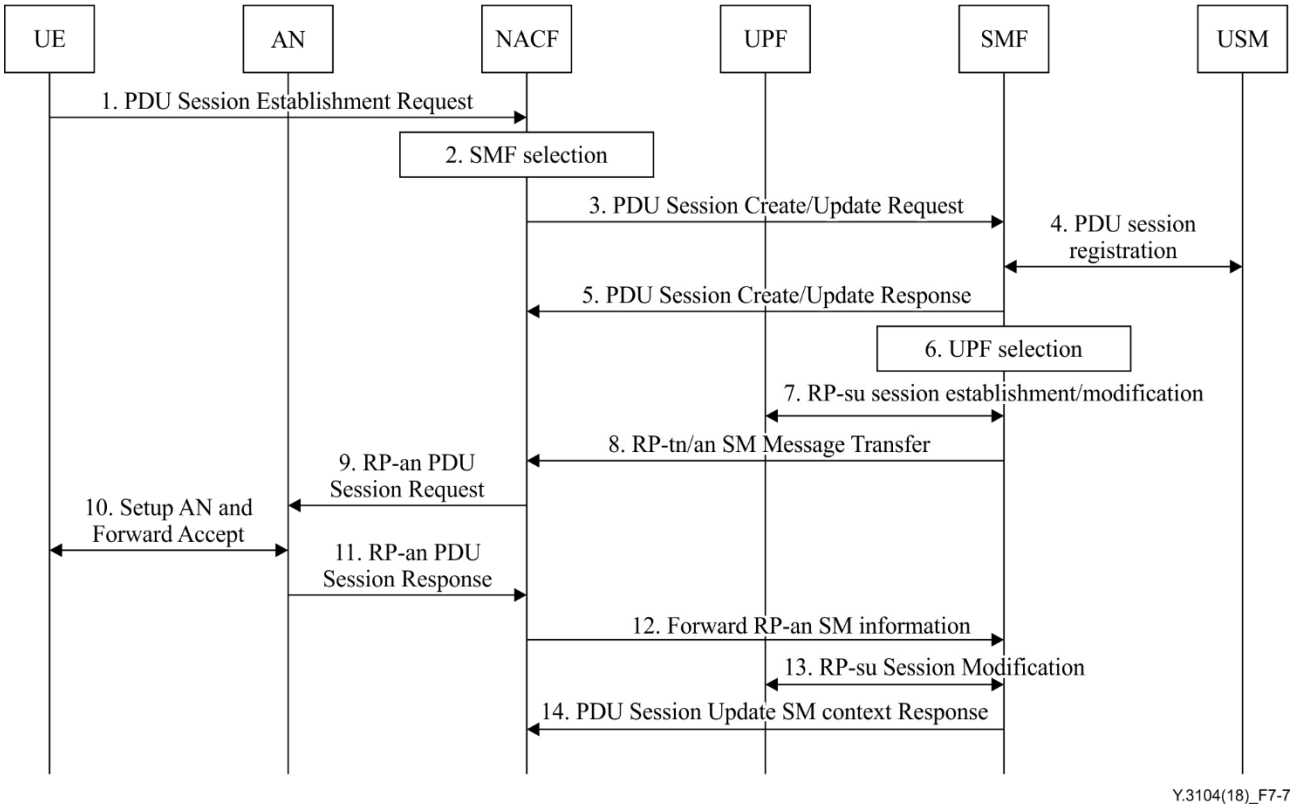


Figure 7-7 – Protocol data unit session establishment procedure

1) PDU Session Establishment Request message (UE to NACF)

   In order to establish a new PDU session, UE generates a new PDU session ID and sends a message containing a PDU Session Establishment Request to the NACF. The message includes the PDU session ID, request type and PDU session type. The request type indicates "initial request" if the PDU session establishment is a request to establish a new PDU session, or indicates "existing PDU session" if the request is for an existing PDU session switching between different IMT-2020 ANs.

   The AN encapsulates the message sent by the UE in an RP-an message and sends it, together with user location information and access type information, to the NACF.

2) SMF selection

   If the request type is "initial request", the NACF selects an SMF considering the target data network, NSI, subscription information retrieved from the USM, access type information, etc.

If the request type is "existing PDU session", the NACF selects the SMF based on the SMF ID received from the USM.

3) PDU Session Create/Update Request (NACF to SMF)

If NACF does not have an association with the SMF for the PDU session ID provided by UE, the NACF sends a PDU Session Create Request message to the SMF, otherwise the NACF sends a PDU Session Update Request message to the SMF.

The NACF forwards the PDU session ID together with the PDU Session Establishment Request message received from the UE.

4) Registration with USM for the PDU session

If the SMF has not yet registered for a PDU session ID, the SMF registers with USM for it.

If the request type in the PDU Session Establishment Request message is "existing PDU session" for switching between different IMT-2020 ANs, the SMF identifies the existing PDU session based on the given PDU session ID. In this case, the SMF does not create a new SM context, but instead updates the SM context and provides it to NACF in the response.

SMF checks the validity of the request, such as whether the request is compliant with the user subscription and with local policies. If the request is determined to be invalid, the SMF does not accept establishment of the PDU session.

5) PDU Session Create/Update Response (SMF to NACF).

If the SMF succeeds in establishing a new PDU session or updating an existing one in step 4, it responds to the NACF by providing SM context information.

When the SMF decides not to accept establishment of a PDU session, the SMF rejects the PDU Session Establishment Request and responds to the NACF with an SM rejection cause. The NACF delivers the result to the UE via an SM RP-tn signalling message. In this case, SMF also indicates to the NACF that the PDU session ID is to be considered as released, and the PDU session establishment procedure is stopped after the SMF has performed deregistration/subscription for the PDU session with the USM.

6) UPF selection

If the request type in the PDU Session Establishment Request is "initial request", SMF selects UPF(s) as needed. For IP type PDU sessions, the SMF allocates an IP address (prefix) for the PDU session.

If the request type is "existing PDU session", SMF maintains the same IP address (prefix) that has already been allocated to the UE.

7) RP-su session establishment/modification

If the request type is "initial request", the SMF initiates the RP-su session establishment procedure with the selected UPF, otherwise it initiates the RP-su session modification procedure. If more than one UPFs are selected for the PDU session, the SMF initiates the procedure with each UPF of the PDU session.

If the request type is "existing PDU session" and the SMF creates an RP-au tunnel, this step is skipped. Otherwise, this step is performed to obtain the RP-au tunnel CN interface information from the UPF.

SMF sends an RP-su Session Establishment/Modification Request signalling message to the UPF. If the RP-au tunnel CN interface information is allocated by the SMF, it is provided to the UPF in this step.

The UPF responds to the SMF by sending an RP-su Session Establishment/Modification Response signalling message. If the RP-au tunnel CN interface information is allocated by the UPF, it is provided to the SMF in this step.

8) SM Message Transfer for RP-tn/an (SMF to NACF)

The SMF requests the NACF to transfer SM information for the requested PDU session to the UE and AN via NACF RP-tn/an signalling. The SM Message Transfer signalling message to NACF contains the PDU session ID allowing the NACF to know which AN towards the UE to use.

The SM information to the AN, forwarded by the NACF to the AN by RP-an signalling, includes RP-au tunnel CN interface information corresponding to the requested PDU session and QoS-related information. If multiple UPFs are used for the PDU session, RP-au tunnel CN interface information contains tunnel information related to the UPF that terminates the RP-au tunnel. The PDU session ID is used by AN signalling with UE to indicate to the UE the association between AN resources and a PDU session for the UE.

The SM information to the UE, forwarded by the NACF to the UE via the AN, includes the PDU Session Establishment Accept message that contains QoS-related information, allocated IP address, data network, NS-related information, etc.

9) RP-an PDU Session Request signalling (NACF to AN)

The NACF sends to the AN an RP-an PDU Session Request signalling message, which contains a PDU session ID and PDU Session Establishment Accept targeted to the UE and RP-an SM information received from the SMF.

10) AN setup and forwarding PDU Session Establishment Accept (AN to UE)

The AN allocates an AN RP-au tunnel for the PDU session.

The AN may also initiate AN specific signalling exchange with the UE, related to the information received from the SMF. For example, in the case of an 'IMT-2020 RAN' access network, an RRC connection reconfiguration may be required with the UE to provide the necessary 'IMT-2020 RAN resources related to the QoS rules for the PDU Session Request.

If the setup of necessary AN resources and AN tunnel allocation is successful, the AN forwards the PDU session ID and PDU Session Establishment Accept message provided in step 9 to the UE.

11) RP-an PDU Session Response signalling (AN to NACF)

The AN sends to the NACF an RP-an PDU Session Response signalling message, which includes RP-an SM information etc. The RP-an SM information contains an AN tunnel address corresponding to the PDU session.

12) Forward RP-an SM information (NACF to SMF)

The NACF forwards the RP-an SM information received from the AN to the SMF through a PDU Session Update SM context Request message.

13) RP-su session modification

The SMF initiates an RP-su session modification procedure with the UPF by sending an RP-su Session Modification Request message. The SMF provides AN tunnel information to the UPF as well as corresponding forwarding rules. If the PDU Session Establishment Request is for the mobility between different IMT-2020 ANs, the downlink data path is switched towards the target AN in this step.

The UPF responds to the SMF with an RP-su Session Modification Response message. If multiple UPFs are used in the PDU session, the UPF terminating the RP-au tunnel performs this procedure.

After this step, the UPF delivers any downlink PDUs to the UE, including buffered PDUs for the PDU session.

14) PDU Session Update SM context Response (SMF to NACF)

The SMF responds to the PDU Session Update SM context Request received from the NACF in step 12. After this step, the NACF forwards to the SMF all events relevant to the PDU session. The SMF may subscribe to the UE mobility event notification from the NACF (e.g., UE location reporting).

7.3.2 Protocol data unit session modification

The PDU session modification procedure is used when a PDU session modification, regarding QoS, is necessary between the UE and IMT-2020 network. The UE or the network can initiate the procedure as shown in Figure 7-8.

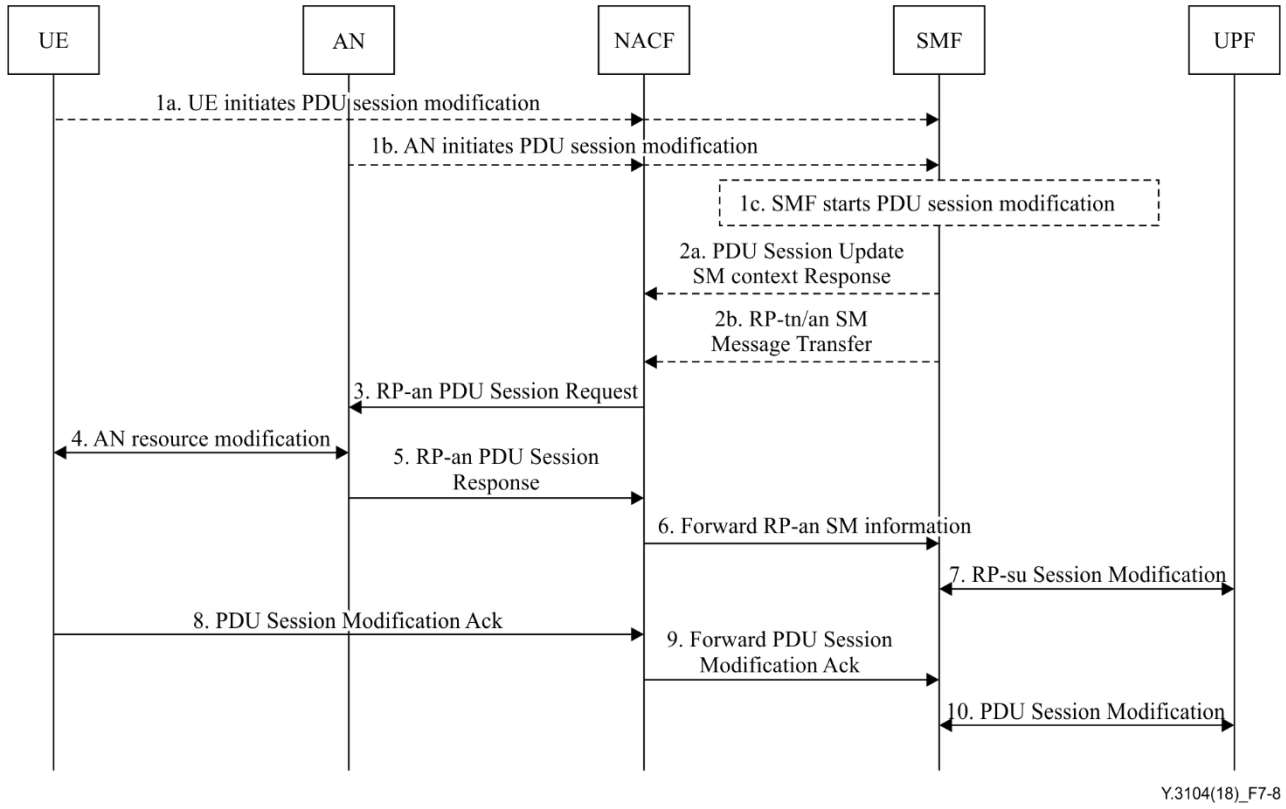


Figure 7-8 – Protocol data unit session modification procedure

1) Initiate PDU session modification

a) UE initiated modification

If the UE needs to modify the QoS of a PDU session, it initiates the PDU session modification procedure by sending a PDU Session Modification Request message containing requested QoS through RP-tn signalling to the NACF. The signalling message is forwarded by the AN to the NACF with user location information.

The NACF requests the SMF to update the SM context for the PDU session with the PDU session ID and PDU Session Modification Request message received from the UE.

b) AN initiated modification

When AN resources for a QoS flow are released, the AN indicates that to the SMF through an RP-an signalling message containing PDU session ID and RP-an SM information, which includes QoS flow identification, user location information and an indication that AN resources for the QoS flow have been released. Then the NACF requests the SMF to update the SM context for the PDU session with RP-an SM information.

When the AN decides that the QoS targets of a flow can no longer be fulfilled or can be fulfilled again, the AN sends to the NACF an RP-an signalling message, containing PDU session ID and RP-an SM information; the NACF then forwards RP-an SM information to SMF.

c) SMF initiated modification

When the PCF notifies the SMF about the modification of policies, USM updates the subscription data of the SMF or the SMF decides to modify the PDU session due to locally configured policy; the SMF starts the PDU session modification procedure.

2) RP-tn/an SM context Response (SMF to NACF)

a) For UE- or AN-initiated modification

The SMF responds to the NACF through a PDU Session Update SM context message containing RP-an SM information and an RP-tn SM signalling message.

RP-an SM information carries information that the NACF is required to provide to the AN. It may include QoS profiles and QoS flow identifiers to notify AN that those QoS flows have been added or modified; or it may include only QoS flow identifiers to notify AN that those QoS flows have been removed.

If PDU session modification was triggered by an AN resource release for QoS flow in step 1b, the RP-an SM information carries an acknowledgement of AN resource release. If PDU session modification was triggered by UE for a PDU session that has no UP resources allocated, RP-an SM information includes information for the allocation of the resources.

An RP-tn SM signalling message carries required information to notify UE that one or more QoS rules have been added, removed or modified. It includes QoS rules, corresponding QoS rule operations and flow-specific QoS parameters.

b) For SMF-initiated modification

The SMF requests the NACF to transfer RP-an SM information and an RP-tn SM signalling message. They contain the same information elements as those used in step 2a.

3) RP-an PDU Session Request (NACF to AN)

The NACF sends to the AN an RP-an PDU Session Request message, which contains the PDU session ID, RP-an SM information and an RP-tn SM signalling message received from the SMF in step 2.

4) AN resource modification with UE

The AN performs AN specific signalling exchange with UE to modify the required resources according to the received RP-an SM information. The RP-tn SM signalling message received from the SMF is also forwarded to UE in this step.

5) RP-an PDU Session Response (AN to NACF)

The AN acknowledges an RP-an PDU Session Request by sending an RP-an PDU Session Response message to the NACF. The message carries RP-an SM information and user location information. The RP-an SM information includes the list of accepted and rejected QoS flow identifiers, AN tunnel endpoint address of RP-au tunnel and PDU session ID.

If an AN tunnel endpoint has no more QoS flow identifiers involved in the PDU session due to the removal of QoS flow identifiers, the corresponding tunnel endpoint is removed from the AN node.

6) Forward RP-an SM information (NACF to SMF)

NACF forwards received RP-an SM information and user location information to SMF.

7) RP-su session Modification

The SMF updates the RP-su session about UPF(s) that are involved in PDU session modification by exchanging an RP-su Session Modification Request/Response message with the UPF(s).

8) PDU Session Modification Ack (UE to NACF)

The UE acknowledges the PDU session modification by sending an RP-tn SM signalling message to the NACF via the AN.

9) Forward RP-tn PDU Session Modification Ack (NACF to SMF)

The NACF forwards the RP-tn PDU Session Modification Ack and user location information received from the AN to the SMF.

10) PDU session modification

In response to the PDU Session Modification Ack and user location information, SMF may initiate the update of UPF(s) that are involved in PDU session modification by sending an RP-su Session Modification Request message to the UPF(s).

7.3.3 Protocol data unit session release

The PDU session release procedure is used to release all resources associated with a PDU session, including IP address(es) (Prefix(es)) allocated for an IP-based PDU session and any UPF resource that was used by the PDU session. The SMF notifies any entity associated with the released PDU session. The UE or the network can initiate the procedure as shown in Figure 7-9.

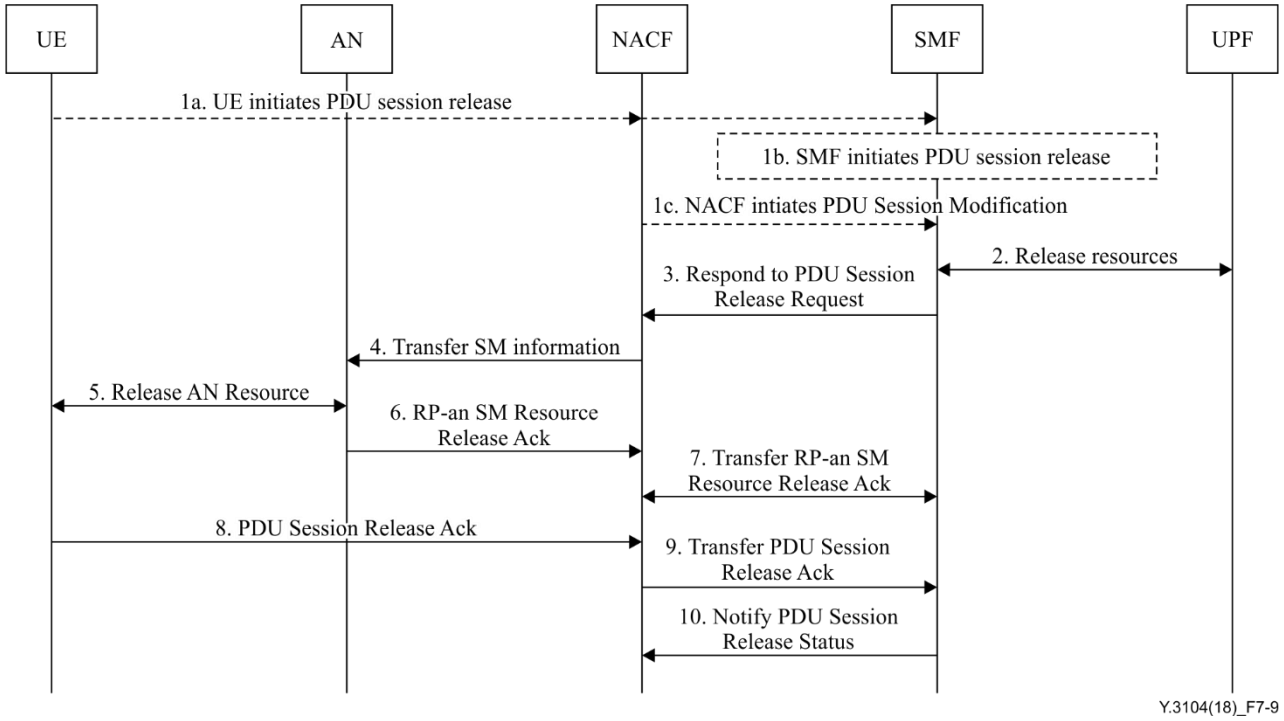


Figure 7-9 – Protocol data unit session release procedure

1) Initiate PDU session release

a) UE-initiated PDU session release

UE can initiate an UE-requested PDU session release procedure by sending an RP-tn signalling message that contains a PDU Session Release Request and PDU session ID.

The message is forwarded by the AN to the NACF with user location information, and then relayed to the SMF corresponding to the PDU session ID by the NACF through a PDU Session Update SM context message.

b) SMF-initiated PDU session release

The SMF may decide to release a PDU session for different reasons, including a PCF request for PDU session release, cancellation of UE authorization by the data network, USM change of subscription information or locally configured policy.

c) NACF-initiated PDU session release

The NACF may request the SMF to release a PDU session in the case of a mismatch of PDU session status between UE and the NACF.

If the SMF receives one of the triggers in step 1a to 1c, the SMF starts the PDU session release procedure.

2) Release resources

The SMF releases IP address(es) (Prefix(es)) that were allocated to the PDU session and also releases corresponding UP resources by exchanging an RP-su Session Request/Response message containing an RP-su session ID to/from the UPF(s). The UPF(s) drop any remaining packets of the PDU session and release all tunnel resources and contexts associated with the RP-su session.

3) Respond to PDU Session Release Request (SMF to NACF)

If the PDU session release is initiated by request from the PCF and if the SMF has been notified by the NACF that the UE is unreachable, the procedure continues in step 10 by the SMF notifying the NACF that the PDU session has been released through a PDU Session SM Context Status Notify message. The rest of step 3 and steps 4 to 9 are skipped.

Otherwise, the SMF creates an RP-tn SM signalling message including required information for UE to release the PDU session, i.e., a PDU session release command.

a) For a UE-initiated PDU session release

The SMF responds to the NACF with an RP-an SM resource release request and an RP-tn SM signalling message containing a PDU session release command.

b) For an SMF-initiated PDU session release

The SMF requests the NACF to transfer an RP-tn/an signalling message with an RP-tn SM signalling message containing a PDU session release command. If the UP connection of the PDU session is active, the SMF also includes an RP-an SM resource release request with a PDU session ID to release AN resources associated with the PDU session.

c) For an NACF-initiated PDU session release

The SMF responds to the NACF with a PDU Session Release SM context Response.

4) Transfer SM info (NACF to AN)

If UE is in the CM IDLE state and an RP-tn signalling message is required to be delivered to UE, the NACF initiates a network-triggered connection request procedure as specified in clause 7.2.2.

If UE is in the CM CONNECTED state, the NACF transfers to the AN the SM information received from the SMF in step 3.

5) Release AN resources

When an AN receives an RP-an SM resource release request to release AN resources associated with the PDU session, it performs an AN specific signalling exchange with UE to release the corresponding AN resources.

During this procedure, the AN forwards an RP-tn SM signalling message containing a PDU session release command received from the NACF in step 4.

6) RP-an SM resource release request Ack (AN to NACF)

If the AN has received an RP-an SM resource release request to release AN resources, the AN sends an RP-an SM Resource Release Ack message with user location information to the NACF.

7) Transfer RP-an SM Resource Release Ack

The NACF transfers an RP-an SM Resource Release Ack and user location information to the SMF, which responds to the NACF by exchanging PDU Session Update SM context messages.

8) PDU session release Ack (UE to NACF)

The UE acknowledges the PDU session release command by sending an RP-tn SM signalling message with a PDU session ID via the AN.

9) Transfer PDU session release Ack (NACF to SMF)

The NACF transfers a PDU session release Ack and user location information to the SMF, which responds to the NACF by exchanging PDU Session Update SM context messages.

10) Notify PDU Session Release Status (SMF to NACF)

If step 3a or 3b was performed, the SMF waits until it has received responses to the RP-tn SM signalling message and RP-an SM Resource Release request that were provided in step 3. When the SMF has confirmed that the PDU session has been released, it then notifies the NACF that the SM context for this PDU session is released. Then the NACF releases the associations between the SMF ID and PDU session ID, etc.

7.3.4 RP-su session management

RP-su SM procedures are used to control the functionality of the UPF. The SMF can establish, modify and release RP-su session context in the UPF.

In order to create the initial RP-su session context for a PDU session at the UPF, the SMF assigns a new RP-su session ID and provides it to the UPF by exchanging RP-su Session Establishment Request/Response messages. The RP-su session ID is stored by both entities and used to identify the RP-su session context during their interaction. The SMF also stores the relationship between the RP-su session ID and PDU session for UE.

Whenever PDU session-related parameters have to be modified, the SMF modifies the RP-su session context of the PDU session at the UPF by exchanging RP-su Session Modification Request/Response messages.

The SMF sends a RP-su Session Release Request message to the UPF to remove the RP-su session context for the PDU session. The UPF identifies the RP-su session context to be removed by the RP-su session ID and removes it. Then, the UPF responds with a RP-su Session Release Response message.

7.4 Handover procedures

HO procedures are used to hand over UE from a source AN node to a target AN node.

If a point-to-point interface between the source AN node and the target AN node exists and if the interface supports the exchange of signalling information and the forwarding of PDUs between them, a target AN node-initiated HO is performed through the interface. In this case, the target AN node requests switching of the RP-an path from the source AN node to the target AN node, notifying the NACF that an AN level HO is in progress.

NOTE – The details of the AN level HO lie outside of scope of this Recommendation.

Otherwise, the source AN node requests the NACF to initiate the HO procedure.

7.4.1 Handover procedure requested by a target access network node

This procedure is used to hand over UE from a source AN node to a target AN node using the point-to-point interface between them when the NACF is not changed during the HO procedure. See Figure 7-10.

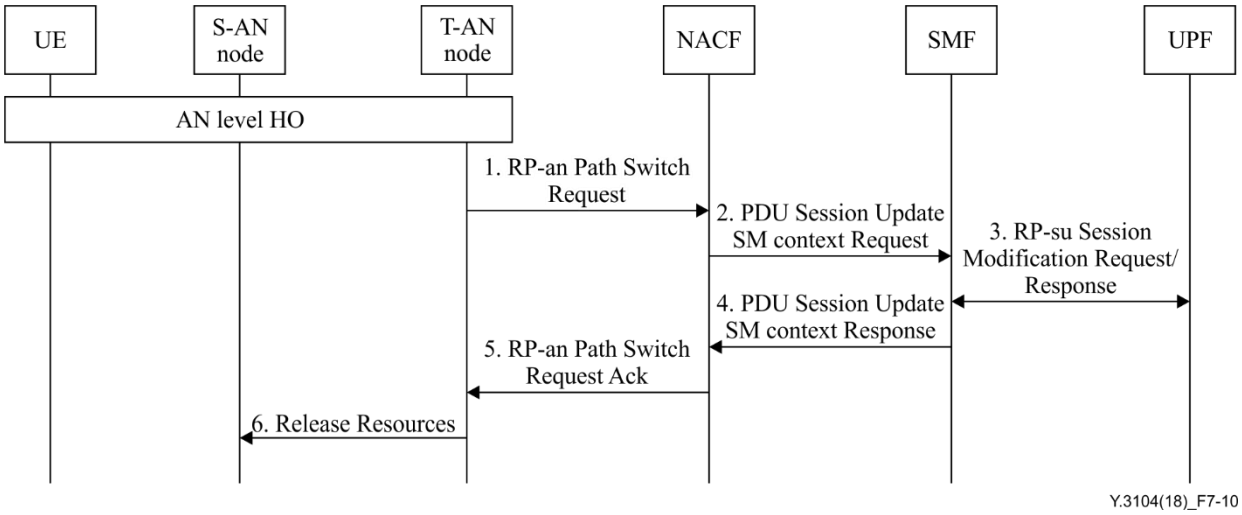


Figure 7-10 – Handover procedure requested by a target access network node

1) RP-an Path Switch Request (target AN node to NACF)

   The target AN node sends an RP-an Path Switch Request message to the NACF to indicate that the UE has moved to a new AN node. The message provides the list of PDU sessions to be switched. If none of the QoS flows of a PDU session are accepted by the target AN node or if the target AN node cannot set up the required UP resources for some PDU sessions, the message is required to include the list of rejected PDU sessions.

   For the PDU sessions to be switched to the target AN node, the message also includes the accepted QoS flows.

2) PDU Session Update SM context Request (NACF to SMF)

   The NACF sends a PDU Session Update SM context Request message to the SMF for PDU sessions in the RP-an Path Switch Request received in step 1.

   For PDU sessions to be switched to the target AN node, the SMF determines whether the existing UPF can continue to serve the UE. If necessary, the SMF may re-allocate the UPF or insert a new intermediate UPF.

   For PDU sessions rejected by the target AN node, the SMF deactivates the UP connections of these PDU sessions.

   If not all QoS flows of a PDU session are accepted by the target AN node, the SMF may initiate a PDU session modification procedure to remove the unaccepted QoS flows from that PDU session after the HO procedure.

3) RP-su Session Modification Request/Response

   For PDU sessions that are modified by the target AN node, the SMF sends an RP-su Session Modification Request message to the UPF.

   After the requested PDU sessions are modified by the UPF, the UPF returns a Response message to the SMF.

4) PDU Session Update SM context Response (SMF to NACF)

The SMF sends a PDU Session Update SM context Response message to the NACF with CN interface information about the RP-au tunnel for the PDU sessions that have been switched successfully.

5) RP-an Path Switch Request Ack (NACF to target AN node)

The NACF aggregates received CN interface information about the RP-au tunnel from all the SMFs and sends it in an RP-an Path Switch Request Ack message to the target AN node. Any information about PDU sessions that have failed to be switched is also included in the message.

6) Release resources (target AN node to source AN node)

The target AN node confirms the success of the HO by sending a Release Resources message to the source AN node.

7.4.2 Handover procedure requested by source access network node

This type of HO procedure is used if there is no point-to-point interface between source and target AN nodes or if this interface does not support the exchange of signalling information and the forwarding of PDUs between them. See Figure 7-11.

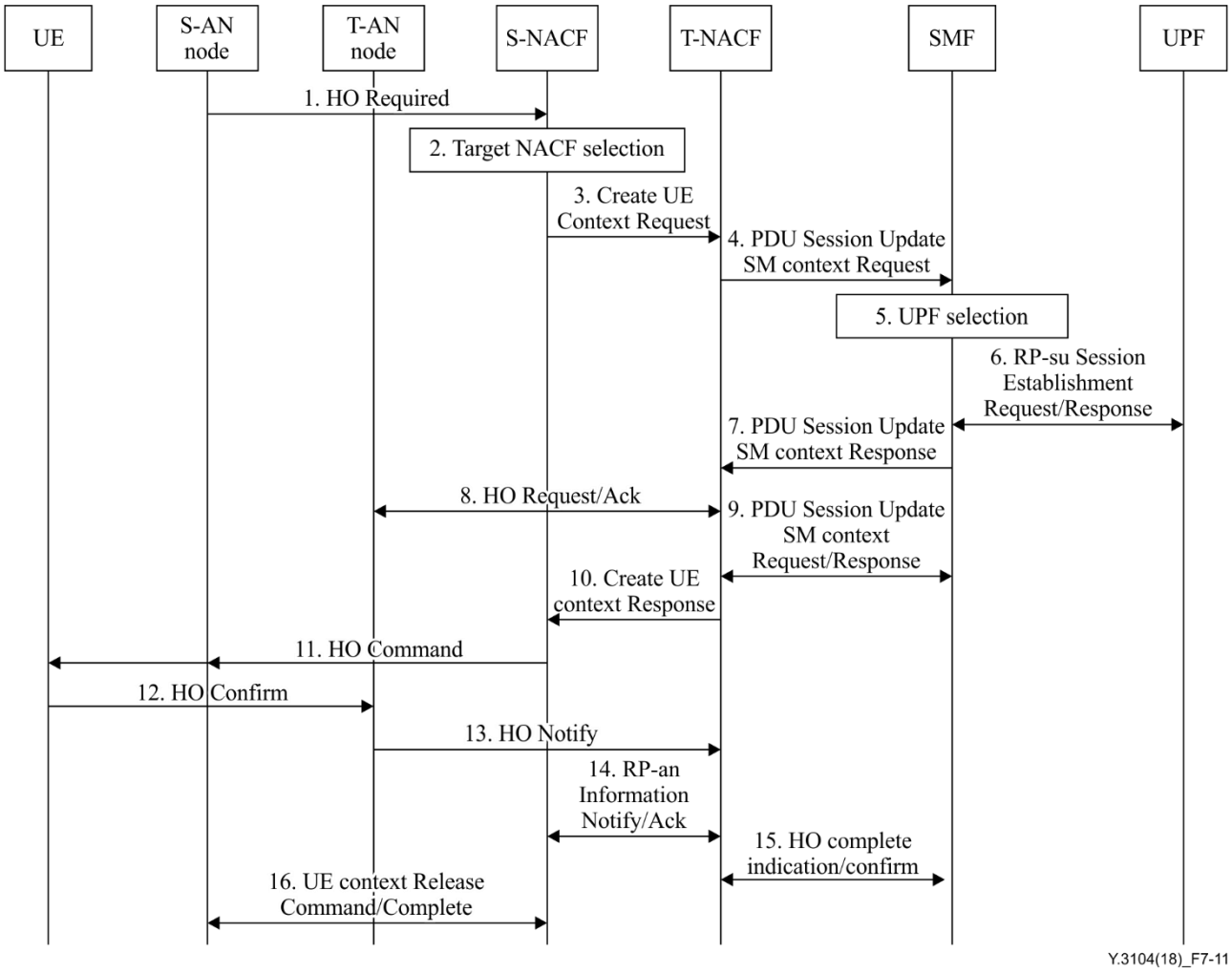


Figure 7-11 – Handover procedure requested by source access network node

1) HO required (source AN node to NACF)

The source AN node sends an HO Required message to the NACF. The message includes the target AN node ID and all PDU sessions of the UE that are handled by the source AN node, indicating that those PDU sessions require HO.

2) Target NACF selection

If the NACF that has received the HO Required message in step 1 can no longer serve the UE, this NACF (i.e., the source NACF) selects a new target NACF.

3) Create UE Context Request (source NACF to target NACF)

When the source NACF cannot serve the UE, the source NACF requests the selected target NACF to create a UE context.

4) PDU Session Update SM context Request (target NACF to SMF)

For each PDU session indicated by the source AN node, the NACF sends a PDU Session Update SM context Request message to the associated SMF(s).

The message includes a PDU session ID for HO and UE location information.

5) UPF selection

If the UE has moved out of the service area of the UPF, the SMF selects a new UPF (i.e., the target UPF).

6) RP-su Session Establishment Request/Response (between SMF and target UPF)

If a new target UPF is selected in step 5, an RP-su session is established between the SMF and the target UPF. CN tunnel information (i.e., RP-au tunnel information) is also allocated in this procedure.

7) PDU Session Update SM context Response (SMF to target NACF)

If the HO for the PDU session is accepted, a PDU Session Update SM context Response message is sent to the NACF, including UP address and CN tunnel information about the UPF, QoS parameters, RP-an SM information and other information for the target AN node.

If the HO for the PDU session is not accepted, the SMF does not include the information in the previous paragraph for unaccepted PDU sessions in the PDU Session Update SM context Response message, in order to avoid establishment of radio resources at the target AN node. Instead, the SMF provides the reason for non-acceptance.

8) HO request/Ack

The target NACF determines the target AN based on the target AN node ID. The NACF sends an HO Request message to the target AN node. The message includes the RP-an SM information received from the SMF in step 7 and the list of unaccepted PDU sessions generated by the NACF. The list includes the PDU sessions unaccepted by the SMF and those unaccepted by the NACF due to no response from the SMF, an un-available NS in the NACF or other reason.

To the HO Request message received from the target NACF, the target AN node responds with an HO Request Ack message. The message includes an RP-an SM response list, target AN node RP-au SM forwarding information list and failed to be setup PDU session list.

The RP-an SM response list is a list, for each received RP-an SM information item, of PDU session IDs and indication of an HO request acceptance for the PDU sessions. The target AN node RP-au SM forwarding information list includes, for each PDU session accepted by the target AN node, the RP-au UP address and tunnel ID of the target AN node. The target AN node creates a list of PDU sessions that failed to be setp , including the reason for failure. It is provided to the source AN node.

9) PDU Session Update SM context Request/Response

For each RP-an SM response received from the target AN node in step 8, the NACF sends it to the SMF associated with the PDU session ID.

The SMF or UPF allocates the RP-au UP address(es) and tunnel ID(s) for data forwarding corresponding to the data forwarding tunnel endpoints established by the target AN node.

Then the SMF responds to the target NACF with a PDU Session Update SM context Response message.

10) Create UE context Response (target NACF to source NACF)

If a new target NACF has been selected in step 2, the target NACF sends a create UE context Response message to the source NACF when all PDU Session Update SM context Response messages are received or the maximum wait time for the Response messages has expired. The message includes the RP-an information necessary for the source NACF to send a HO command to the source AN node.

11) HO command

The source NACF sends an HO Command message with an RP-au SM forwarding information list and list of PDU sessions that failed to be setup. The RP-au SM forwarding information list includes the target AN node SM RP-au forwarding information list. The source AN node decides whether to proceed with the RP-an based HO procedure for the PDU sessions that failed to be setup.

The source AN node sends an HO Command to UE with the target AN node information for the UE.

12) HO confirm (UE to target AN node)

After the UE has successfully synchronized to the target node, it sends an HO Confirm message to the target AN node. With this message, HO is considered to be successful by the UE.

13) HO notify (target AN node to target NACF)

The target AN node notifies the NACF that HO has been successfully performed in the target AN node.

14) RP-an information notify/Ack

The target and source NACF exchange RP-an Information Notify/Ack messages for the HO Notify message received from the target AN node in step 13.

15) HO complete indication/confirm

An HO complete indication is sent for each PDU session to the corresponding SMF to indicate the success of the HO through a PDU Session Update SM context Request message.

If a new target UPF is selected in step 5, the SMF performs the RP-su session modification procedure with the target UPF. The SMF then confirms the receipt of an HO complete by sending a PDU Session Update SM context Response message to the target NACF.

16) UE context Release Command/Complete

The source NACF and source AN node exchange UE context Release Command/Complete messages to release the resources related to the UE.

8 Security considerations

The IMT-2020 network including UE, ANs and CN are subject to security and privacy measures. Sensitive information should be protected as a high priority in order to avoid leaking and unauthorized access. Security and privacy concerns should be aligned with the requirements specified in [b-ITU-T Y.3101] [b-ITU-T Y.2701].

Specific security concerns highlighted in this Recommendation deal with UE authentication during RM procedures, as specified in clause 7.1, and secure signalling connection between AN and CN, as specified in clause 7.2.

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