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Recommendation

# ITU-T Y.3203 (05/2023)

SERIES Y: Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

Future networks

# Fixed, mobile and satellite convergence – Connection management for IMT-2020 networks and beyond

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# Recommendation ITU-T Y.3203

## Fixed, mobile and satellite convergence – Connection management for IMT-2020 networks and beyond


### Summary

Recommendation ITU-T Y.3203 specifies the framework and functions of connection management for fixed, mobile and satellite convergence (FMSC) in IMT-2020 networks and beyond. Recommendation ITU-T Y.3203 specifies connection status management, control plane functions and user plane function maintenance in connection scenarios involving FMSC in networks.



### History *

| Edition | Recommendation | Approval | Study Group | Unique ID |
|---|---|---|---|---|
| 1.0 | ITU-T Y.3203 | 2023-05-14 | 13 | 11.1002/1000/15536 |

### Keywords

Connection management, FMSC, IMT-2020, satellite network.


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## Fixed, mobile and satellite convergence – Connection management for IMT-2020 networks and beyond

### 1 Scope

This Recommendation specifies the framework and functions of connection management (CM) for fixed, mobile and satellite convergence (FMSC) in IMT-2020 networks and beyond. This Recommendation covers the following aspects of CM to support FMSC:

- scenarios;
- requirements;
- functional architecture, control plane (CP) and user plane (UP) functions description;
- typical information flows;
- security considerations.

### 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.3101] Recommendation ITU-T Y.3101 (2018), *Requirements of the IMT-2020 network*.

[ITU-T Y.3104] Recommendation ITU-T Y.3104 (2018), *Architecture of the IMT-2020 network*.

### 3 Definitions

#### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 fixed, mobile and satellite convergence** [b-ITU-T Y.3200]: The capabilities that provide services and applications to end users regardless of the fixed, mobile or satellite access technologies being used independently of the users' location.

**3.1.2 connection** [b-ITU-T Y.2028]: A connection is an association established for the transfer of data between two or more peer-(*N*)-entities. This association binds the peer-(*N*)-entities together with the (*N* − 1)-entities in the next lower layer.

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

#### 3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

**3.2.1 connection management**: Management of the establishment and release of a signalling connection.

NOTE – Paraphrased from [b-ITU-T Y.3102].

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

| | |
|---|---|
| AF | Application Function |
| AN | Access Network |
| ASF | Authentication Server Function |
| CEF | Capability Exposure Function |
| CM | Connection Management |
| CN | Core Network |
| CP | Control Plane |
| CU | Central Unit |
| DN | Data Network |
| DU | Distributed Unit |
| FMSC | Fixed, Mobile and Satellite Convergence |
| gNB | next generation Node B |
| ID | Identifier |
| IMT-2020 | International Mobile Telecommunications-2020 |
| ISL | Inter-Satellite Link |
| IWF | Interworking Function |
| NACF | Network Access Control Function |
| NAS | Non-Access Stratum |
| NFR | Network Function Registry |
| NGSO | Non-Geostationary Satellite Orbit |
| NSSF | Network Slice Selection Function |
| PCF | Policy Control Function |
| PDU | Protocol Data Unit |
| PN | Primary Node |
| QFI | Quality of service Flow Identifier |
| QoS | Quality of Service |
| RRC | Radio Resource Control |
| SM | Session Management |
| SMF | Session Management Function |
| SN | Secondary Node |
| SRI | Satellite Radio Interface |
| UE | User Equipment |
| UP | User Plane |

UPF User Plane Function

USM Unified Subscription Management

## 5 Conventions

In this Recommendation:

The phrase "is required" indicates a requirement that must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

The phrase "is recommended" indicates a requirement that is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The phrase "can optionally" indicates an optional requirement that is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option, and the feature can be optionally enabled by the network operator or service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

## 6 Scenarios of connection management for FMSC

In IMT-2020 networks and beyond, FMSC offers capabilities that provide services and applications to end users regardless of the fixed, mobile or satellite access technologies being used. Both users and operators can benefit from FMSC in networks in terms of connection reliability, network efficiency and service continuity.

In connection scenarios, some control functions or user plane functions (UPFs) can be deployed on the satellite, e.g., access control is mostly located at a satellite base station, gateway or hub level in satellite systems. When non-geostationary satellite orbit (NGSO) satellites move, the interface between user equipment (UE) and core network (CN) is changed. Various requirements must be considered carefully, such as minimizing access network (AN) technology dependency, multi-AN coordination, service continuity and quality of service (QoS) guarantee.

CM scenarios for FMSC in IMT-2020 networks and beyond are shown in Figure 6-1 and Figure 6-2, which illustrate that UE can connect a CN via multiple kinds of access. UE has multiple kinds of access, such as that which is fixed, mobile or satellite. The converged CN has connections to all ANs; it also connects to the data network (DN). In the CP, CM maintains the signalling connection between UE and the CN. In the UP, CM maintains the UP connection between UE and the DN. Satellite radio interface (SRI) is on the feeder link between the satellite gateway and the satellite. In the transparent case, a satellite gateway connects directly to one or several satellites via an SRI. In the regenerative case, a satellite gateway can directly connect to one or several satellites via an SRI, or indirectly connect to one or several satellites via intersatellite links (ISLs).

As the relay node, a transparent satellite corresponds to an analogue radio frequency repeater, as shown in Figure 6-1. UE can connect to the converged CN via the common signalling interface. The user data is transported between the UE and the converged CN, as usual, but via the satellite gateway.

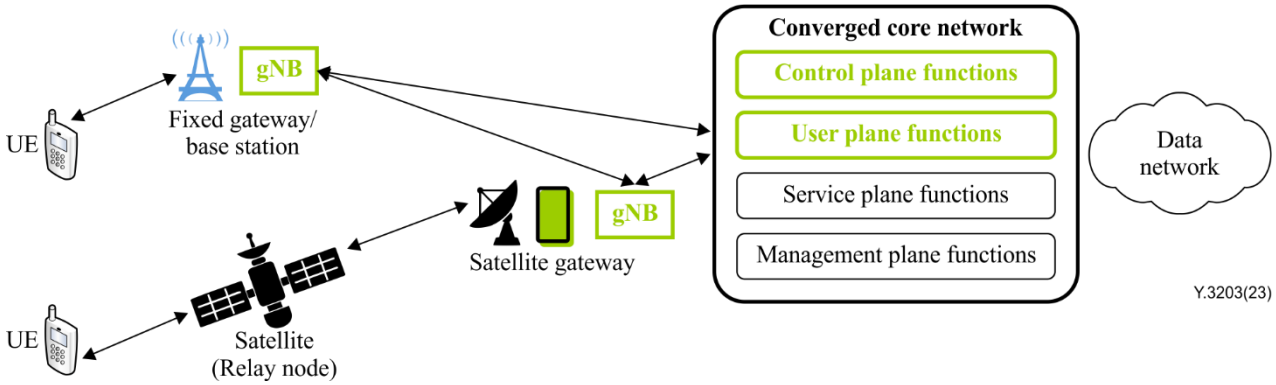


**Figure 6-1 – Connection scenarios for FMSC in IMT-2020 networks and beyond – Transparent satellite**

In the case of connection scenarios involving a transparent satellite, the next generation node B (gNB) is located on the ground, all CP and UP interfaces toward terrestrial AN nodes are terminated on the ground.

The gNB can be deployed on a satellite, as shown in Figure 6-2. It is effectively equivalent to having base station functions on board the satellite. When a gNB is on board a satellite, the regenerative satellite may embark on additional traffic routing functions that are out of the relay node scope. The satellite includes all or part of a gNB to generate or receive a satellite friendly AN signal to or from pieces of UE. An ISL is a transport link between satellites. Served by a gNB on board a satellite, UE can access the converged CN via ISL. A central unit (CU) is a logical node that includes gNB functions (e.g., transfer of user data, connection setup and release, and load balancing) except those functions allocated exclusively to the distributed unit (DU), which is a logical node that includes, depending on the functional split option, a subset of the gNB functions. When the CU is changed, the DU can initiate the connection with the next CU.

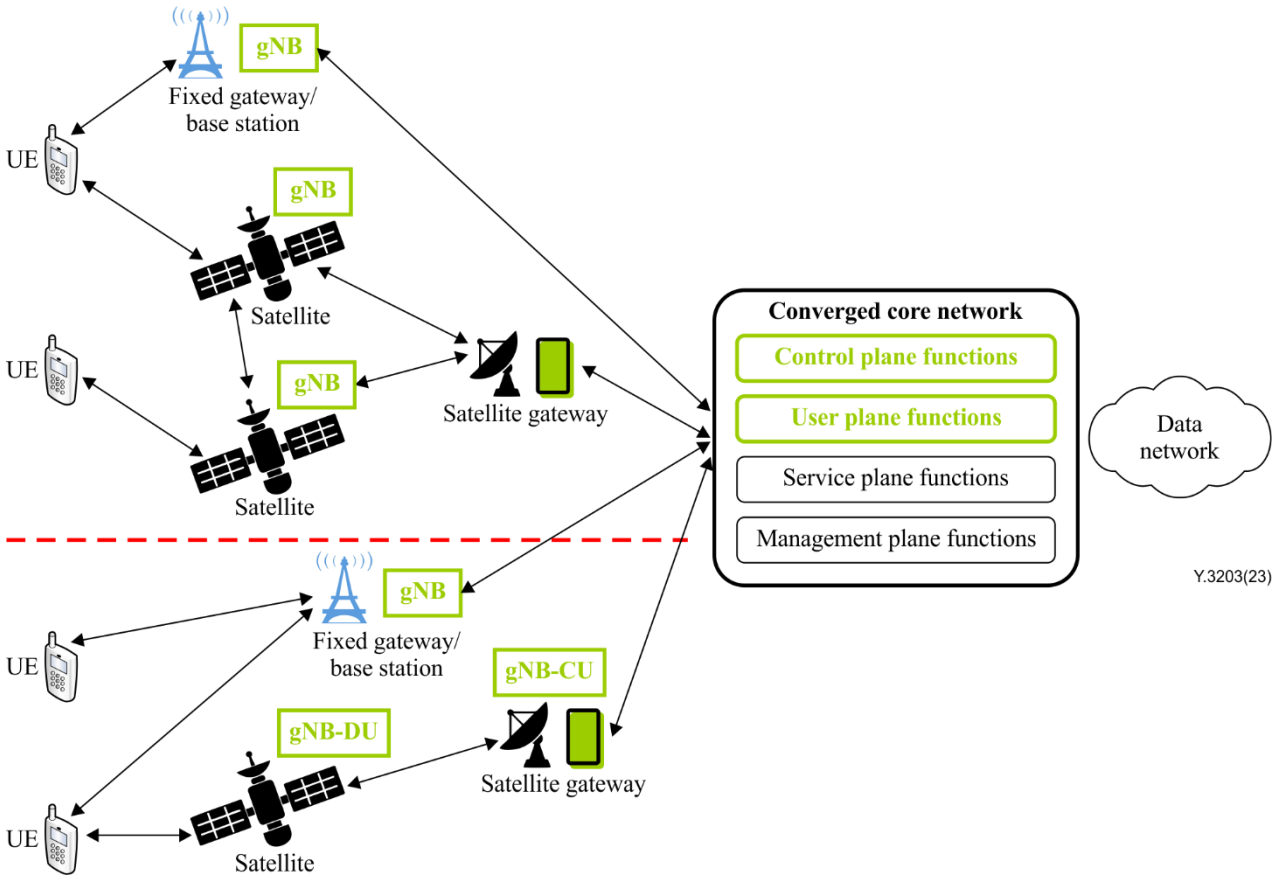


**Figure 6-2 – Connection scenarios for FMSC in IMT-2020 networks and beyond – Regenerative satellite**

If connection scenarios involve a regenerative satellite with gNB-CU on the ground and a gNB-DU on board, all CP interfaces with terrestrial AN nodes are terminated on the ground. When a UE accesses a CN via fixed, mobile or satellite, the UE may establish the UP connection for data transmission. CM should maintain UP connection when NGSO satellites move and ensure the reliability of connection. UE can connect to a CN via fixed, mobile or satellite access technologies, multiple UP connections can be established between different ANs for reliable communication.

If connection scenarios involve a regenerative satellite with on board gNB, setting up and maintaining interfaces towards terrestrial base stations over the feeder link would require all the corresponding traffic (CP and UP), which is relevant to the satellite-hosted gNB, to be transported over the SRI. Due to the movement of satellites, when UE moves out of the coverage of one satellite AN and into that of another, CM needs to migrate the connection to ensure connection continuity.

## 7 Requirements of connection management for FMSC

The FMSC in IMT-2020 networks and beyond is required to support unified CM for access via fixed, mobile and satellite. The requirements of CM for fixed, mobile and satellite converged networks of IMT-2020 and beyond follow.

In connection scenarios involving regenerative satellites and transparent satellites, CM needs to support marking the connection status between the UE and CN, CM also needs to support determination of the procedure based on the connection status. For example, UE and the network access control function (NACF) may optimize power efficiency and signalling efficiency of the UE when in IDLE state.

In connection scenarios involving a regenerative satellite, due to their rapid movement, NGSO satellite handover becomes more frequent. CM should consider not changing connection status during handover for connection continuity.

Therefore, CM is required to support connection status handling functions.

Connection status is used to reflect the non-access signalling connection of UE with the converged network, including UE status of IDLE and CONNECTED. The connection status could be changed for reasons including UE inactivity, UE having uplink data, network having downlink data sent to UE, unspecified failure of an AN or converged network or inter-system redirection. For UE in IDLE status, there will be no connection between UE, AN and converged network; at the same time, there is no connection between the UP and CP of the converged network for this UE. This status changes to CONNECTED when UE or the converged network triggers the uplink or downlink data transmission procedure.

- CM is required to support marking the connection status between UE and the converged network, with which UE and CN can determine the procedure based on the connection status.
- CM is required to support efficient utilization of network resources, if UE has no access signalling connection to the converged network in IDLE mode.
- CM is required to provide service continuity and session continuity for multiple accesses of a fixed, mobile and satellite converged network.
- The converged network is required to adjust the procedure, for supporting the continuity of protocol data unit (PDU) session establishing or service provision for UE. In order to provide continuity for the service or session, a converged network is required to use a handover procedure through the interface of access nodes in the same or different ANs, during UE movement between different tracking areas or systems.
- In the converged network, NGSO satellites move rapidly with respect to the ground, which causes frequent handover between them. CM is required to support rapid movement of NGSO satellites with respect to the ground.

NOTE 1 –Transfer of the connection status by the ISL between NGSO satellites or between an NGSO satellite and converged network is required. The connection status between UE and the converged network should not be changed during NGSO satellite handover.

In connection scenarios involving regenerative and transparent satellites, CM needs to support the establishment and release of a signalling connection between UE and CN. The signalling connection is used to enable signalling exchange between UE and CN. UE has access to the converged CN via the fixed, mobile and satellite AN-based signalling interface. For ANs that do not natively support a common signalling interface, an interworking function (IWF) needs to be provided at the AN/CN interface.

In connection scenarios involving regenerative satellites, due to their movement, when UE moves out of coverage of one satellite AN and moves into the coverage of another, CM needs to migrate the connection to ensure continuity of connection.

Therefore, CM is required to support CP functions.

- CM is required to support the establishment, release and migration of a signalling connection between UE and CP functions including NACF in IMT-2020.

NOTE 2 – The signalling connection enables non-access signalling exchange between UE and a converged network. It comprises both the AN signalling connection between UE and the AN, and the connection for this UE between the AN and the NACF in IMT-2020.

In connection scenarios involving regenerative satellites, when UE accesses a CN via fixed, mobile or satellite access, it may establish an UP connection for data transmission. To ensure the service, CM should maintain the UP connection when NGSO satellites move and ensure the reliability of connection. In connection scenarios involving dual connectivity, to guarantee reliable and low-latency communication, CM can determine whether multi-connection should be established to ensure a completely redundant UP path; multiple UP connections can be established between different ANs for reliable communication. Connection information flows can transfer between different ANs.

Therefore, CM is required to support UPFs.

- CM is required to support the activation, reactivation and deactivation of a UP connection.
- CM is required to support the management of a secondary UP connection, including its addition, modification and release.
- CM is required to support the transfer of connection information flows between different ANs and satellites.

# 8 Functional architecture and function description of connection management for FMSC

## 8.1 Architecture of connection management for FMSC

In connection scenarios involving regenerative satellites and transparent satellites, CM needs to support the marking of connection status and determination of the procedure based on it. For example, UE and the NACF may optimize UE efficiency ofpower and signalling when in the IDLE state. CM needs to support the establishment, migration and release of the signalling connection between UE and the CN. CM should also manage a UP connection. In connection scenarios involving dual connectivity, CM can determine whether multi-connection should be established to guarantee reliable and low-latency communication.

Therefore, in connection scenarios involving transparent and regenerative satellites, CM should support connection status management, CP functions and UPFs. Figure 8-1 shows the architecture of CM for FMSC in IMT-2020 networks and beyond.

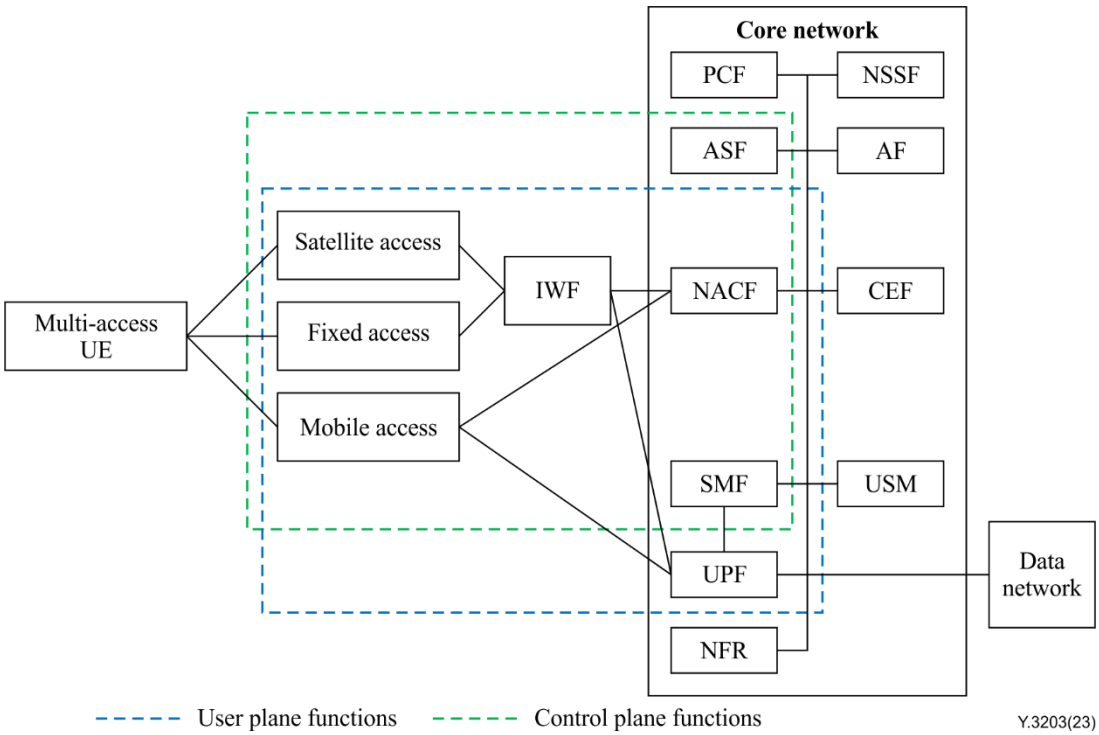


**Figure 8-1 – Architecture of CM for FMSC in IMT-2020 networks and beyond**

As shown in Figure 8-1, in connection scenarios involving transparent satellites and regenerative satellites, functions of CM mainly consist of connection status management, CP functions and UPFs. Entities relevant to CP functions include AN (fixed, mobile or satellite AN), session management function (SMF), NACF and authentication server function (ASF). Entities relevant to UPFs include AN (fixed, mobile or satellite AN), NACF, SMF and UPF. When UE connects to a CN via fixed or satellite access, an IWF is required. An IWF is a gateway provided at the AN/CN interface so that network functions deployed in the CN can still use a common signalling interface. It also supports relay uplink and downlink CP signalling between UE and NACF, and relay uplink and downlink user side data packets between UE and UPF. At the same time, an IWF can have the selection capability of an NACF.

An SMF controls the UP for that connectivity (e.g., selection or reselection of UP network functions and user path). The SMF determines that the UP connection of the PDU session can be deactivated. An ASF performs authentication between UE and the network. When a registered UE requests network services to the network, an NACF provides functionalities to establish and release signalling connections between UE and the CN.

In order to support CM in multi-access scenarios for FMSC in IMT-2020 networks and beyond, an NACF in the converged network possesses the following enhanced functions.

- An NACF in the converged network is required to discriminate different access type of fixed, mobile and satellite, when UE connects to a specific AN.
- An NACF in the converged network is required to store the context of UE after it finishes a successful registration procedure.
- An NACF in the converged network is required to transmit the UE security context between different ANs, in order to reduce the authentication signalling overhead during UE moves between different ANs.
- An NACF in the converged network is required to provide a connection status management mechanism to avoid frequent location updates when UE connects to the converged network through NGSO satellites, which have the characteristic of rapid movement relative to the ground.

- An NACF in the converged network is required to support session and service continuity by avoiding the conflict of session created in different ANs.

CM is required to support multi-access scenarios for FMSC in IMT-2020 networks and beyond. UE has access to all the fixed, mobile and satellite networks, and moves among different ANs. Apart from fixed and mobile ANs, the satellite AN including a satellite gateway is introduced to assist the converged CN in realizing CM. The converged CN has connections to all ANs previously mentioned; it also connects to the DN.

CM should include the following functions:

- function of connection status handling;
- function of procedure trigger based on connection status;
- function of connection information transfer between different ANs, including the connection information transfer through ISLs in an NGSO satellite network;
- functions of CP;
- UPFs.

Functions of CM includes connection status management, CP functions and UPFs. Connection status management includes connection status handling and procedure trigger based on connection status. CP functions include signalling CM on CP. UPFs include the activation, reactivation and deactivation of a UP connection and management of a secondary UP connection.

## 8.2 Function of connection status management for FMSC

Two CM states are used to reflect the signalling connection between UE and NACF.

- IDLE

UE has no signalling connection established with the NACF when it is in IDLE state. There are no connections for AN signalling, NACF and UPF for UE in the IDLE state.

- CONNECTED

UE has a non-access stratum (NAS) signalling connection with the NACF when it is in CONNECTED state. The NACF should keep a UE CM in CONNECTED state until it de-registers from the IMT-2020 networks.

UE shall enter CONNECTED state whenever a signalling connection is established between UE and the AN. The transmission of an Initial message (Registration Request, Service Request or Deregistration Request) initiates the transition from IDLE to CONNECTED state.

The NACF shall enter a CONNECTED state for UE whenever a connection is established for this UE between the AN and the NACF. The receipt of an Initial AN/CN message initiates the transition of NACF from IDLE to CONNECTED state.

If in IDLE and REGISTERED states, unless otherwise specified in mobility restrictions, the UE shall:

- perform a Service Request procedure when the UE has uplink signalling or user data to be sent or respond to paging by performing a Service Request procedure – specific conditions apply for LAN.

When the UE states in the NACF are IDLE and REGISTERED, the NACF shall:

- perform a network triggered Service Request procedure when it has signalling or mobile-terminated data to be sent to this UE, by sending a Paging Request to this UE, if UE is not prevented from responding.

UE and the NACF may optimize the efficiency of power and signalling of the UE when in IDLE state.

When UE is in CONNECTED state in NACF, UE shall:

- change to IDLE state whenever the AN signalling connection is released.

When the UE state in the NACF is CONNECTED, the NACF shall:

- change UE CM state to IDLE whenever the NACF signalling connection and the UP connection for this UE are released upon completion of the AN Release procedure.

## 8.3 Functions of connection management on control plane for FMSC

In the CP, CM is used to manage signalling connection, which is used to enable signalling exchange between UE and the CN. It comprises both the AN signalling connection between UE and the AN, and the connection for this UE between the AN and the NACF. Through the established signalling connection, UE and the network exchange signalling messages for session management (SM), etc. CM has the functions of establishment, release and migration of a signalling connection between UE and the NACF.

The establishment of the signalling connection is triggered by UE. The network can perform paging to UE in the CM IDLE state in order to initiate a UE-triggered connection request procedure in the UE. The release of a signalling connection can be initiated by the AN or NACF. 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. The migration procedure can be requested by a target or current AN. The migration procedure requested by a target AN is used to migrate UE from a current to a target AN using the point-to-point interface between them when the NACF is not changed. The migration procedure requested by the current AN is used if there is no point-to-point interface between the current and target AN or if this interface does not support the exchange of signalling information.

In connection scenarios involving regenerative satellites and transparent satellites, CM needs to support the establishment and release of the signalling connection between UE and CN. Because of their movement, when UE moves out of the coverage of one satellite AN and moves into the coverage of another, CM needs to migrate the connection to ensure continuity of connection. CM also needs to migrate the connection when UE moves out of the coverage of one fixed or mobile AN and moves into the coverage of another. UE may also move out of the coverage of a fixed or mobile AN and into the coverage of a new satellite AN, which can be transparent or regenerative.

## 8.4 Functions of connection management on user plane for FMSC

In connection scenarios involving regenerative or transparent satellites, when UE accesses a CN via fixed, mobile or satellite access, it may establish the UP connection for data transmission. To ensure the service, CM should manage an UP connection. CM can establish multiple UP connections between different ANs for reliable communication. In the UP, functions of CM include activation, reactivation and deactivation of UP connection and managing secondary UP connection.

UE can activate a UP connection of an existing PDU session. UE can request the independent activation of the UP connection of existing PDU sessions. The network may reactivate the UP connection of a PDU session. The deactivation of the UP connection of an existing PDU session causes the corresponding data radio bearer and AN/CN data transport to be deactivated. The UP connection of different PDU sessions can be deactivated independently. If a PDU session is always-on, the SMF should not deactivate its UP connection due to inactivity.

In connection scenarios involving dual connectivity, the secondary UP connection addition procedure is initiated by the primary node (PN) and is used to establish a UE context at the secondary node (SN) in order to provide resources from the SN to UE. The secondary UP connection modification procedure may be initiated either by the PN or the SN. The secondary UP connection release procedure may be initiated either by the PN or SN and is used to initiate the release of the UE context and relevant resources at the SN.

# 9 Information flows of connection management for FMSC

This clause describes detailed CM information flows, including those of CP functions and UPFs. CM procedures are based on the characteristic of FMSC in IMT-2020 networks and beyond, and CM in [ITU-T Y.3104].

## 9.1 Information flows of connection management on control plane for FMSC

The connection procedures of CP functions include those for establishment, release and migration. Detailed information flows of these procedures are described in clauses 9.1.1 to 9.1.3.

### 9.1.1 Information flows of connection establishment

The establishment of the connection is initiated by UE using the connection request procedure. After establishment of the signalling connection to the NACF, UE or the network may send signalling messages. The UE triggered connection establishment procedure is illustrated as Figure 9-1.

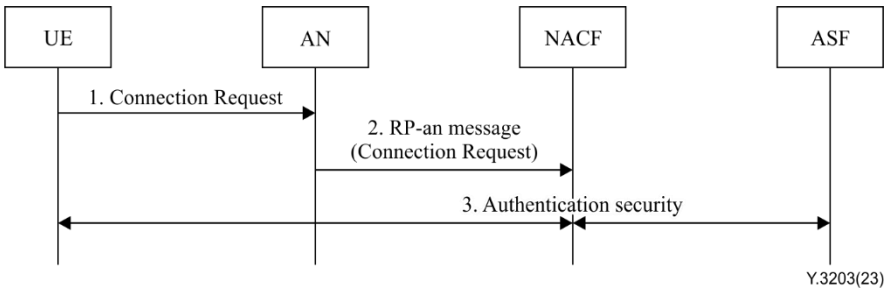


**Figure 9-1 – UE triggered connection establishment procedure**

1 Connection Request

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.

2 Reference Point between AN and NACF (RP-an) message (Connection Request)

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

If the UE is in the CM IDLE state, the AN selects an appropriate NACF according to the UE identity information that includes the set of NACF identifiers (IDs).

3 Authentication security

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. Then UE and the network can exchange signalling messages.

This procedure is triggered and is used by the network when it needs to signal to UE, e.g., from an NACF, or UP connection activation for a PDU session to deliver mobile terminating user data. The network-triggered connection establishment procedure is illustrated as Figure 9-2.

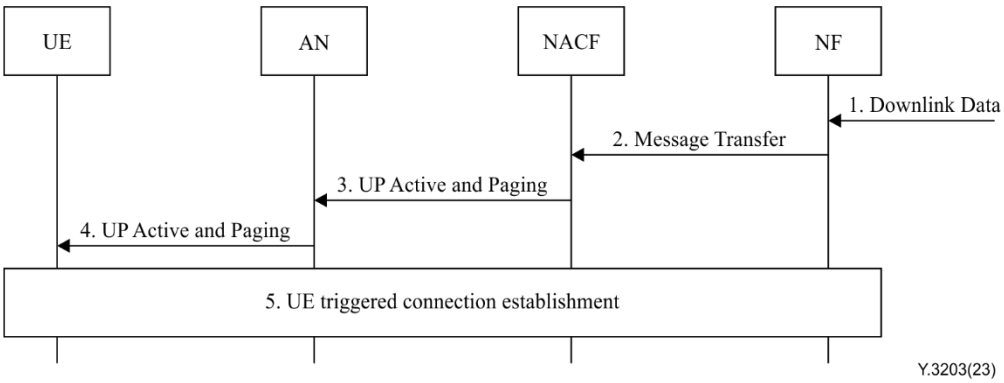


**Figure 9-2 – Network triggered connection establishment procedure**

1 Downlink data

When there is downlink data to UE for a PDU session and there is no AN Tunnel Info stored, network forwards the downlink data.

2 Message transfer

An NACF receives request message(s) from network functions, which leads to signalling towards UE/AN, such as network-initiated deregistration, PDU session modification, when UE is in an IDLE state.

3–4 UP active and paging

UP is activated to establish its tunnel. When UE is in an RM-REGISTERED state and IDLE, the NACF sends a Paging message to AN, belonging to the Registration Area(s) in which the UE is registered. Then the AN node pages the UE.

5 UE triggered connection establishment

The UE shall initiate the UE Triggered Service Request procedure when it is in IDLE state. The procedure is shown in Figure 9-1.

### 9.1.2 Information flow of connection release

The release procedure of a signalling connection can be initiated by the AN or NACF. Both AN- and NACF-initiated connection release procedures are shown in Figure 9-3. 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.

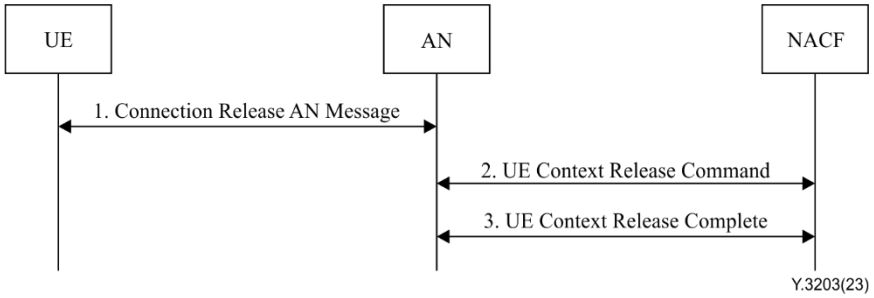


**Figure 9-3 – Connection release procedure**

1 Connection Release AN Message

When AN sends an RP-an UE Context Release Request message to the NACF, it performs a specific AN signalling exchange with the UE to release the connection between the AN and the UE.

2 UE Context Release Command

If the NACF receives the RP-an UE Context Release Request message, the NACF sends an RP-an UE Context Release Command to the AN.

3 UE Context Release Complete

The AN confirms the RP-an Release by returning an RP-an UE Context Release Complete message to the NACF. The RP-an signalling connection between the NACF and the AN for that UE is released.

### 9.1.3 Information flows of connection migration

In the FMSC scenario, a connection migration decision is made based on the following parts: NGSO satellite information, including ephemeris, speed and angle; fixed or mobile AN information, including location and elevation; and UE information, including service type and quality of service (QoS). Connection migration exists in the following ways: migration between satellite access and fixed or mobile access, migration between satellite access and satellite access, or migration between fixed or mobile access and fixed or mobile access.

When the satellite acts as a relay node, connection migration is completed on the ground. When gNB is deployed on the satellite, the connection migration between the satellite and the fixed or mobile AN is completed by the negotiation between them, and the connection migration between satellite is completed by the negotiation between the satellites deploying gNB.

The connection migration procedure can be requested by a target or current AN. If a point-to-point interface between the current AN and the target AN exists and if the interface supports the exchange of signalling information and the forwarding of PDUs between them, a connection migration procedure initiated by the target AN is performed as shown in Figure 9-4.

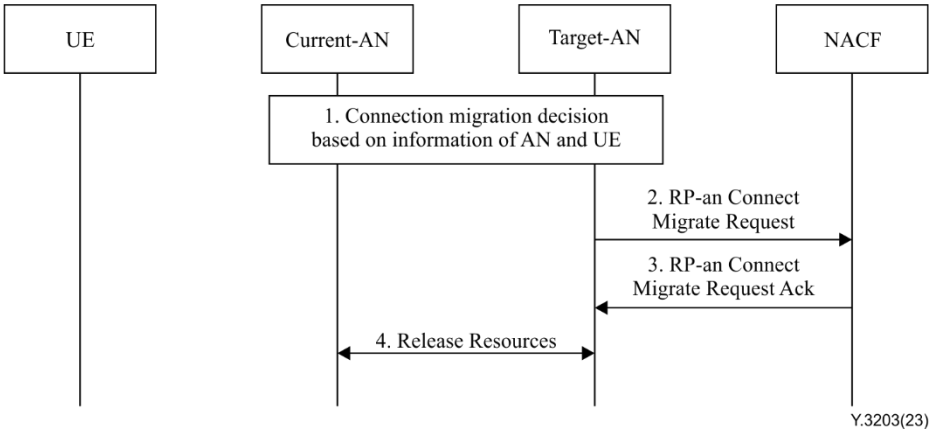


**Figure 9-4 – Connection migration procedure – requested by target AN**

1 A connection migration decision is made based on NGSO satellite access, fixed or mobile access and UE information.

2 RP-an Connection Migrate Request

The target AN sends an RP-an Connection Migrate Request message to the NACF to indicate that the UE has moved to a target AN. UE moved to a target AN may be caused by the moving of UE or the moving of satellite.

3 RP-an Connection Migrate Request Ack

The NACF sends an RP-an Connection Migrate Request Ack message to the target AN.

4 Release Resources

The target AN confirms migration success by exchanging Release Resources messages with the current AN.

If there is no point-to-point interface between current and target AN or if this interface does not support the exchange of signalling information and the forwarding of PDUs between them, a current AN-initiated migration procedure is performed as shown in Figure 9-5.

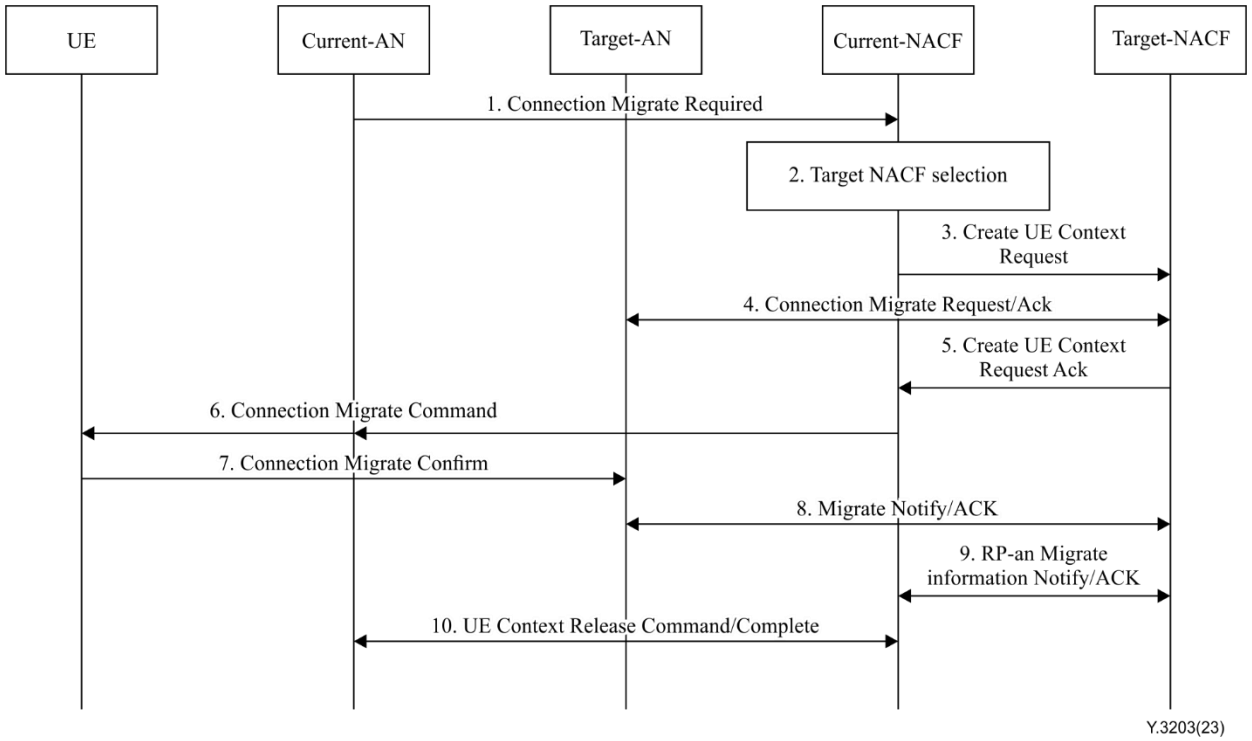


**Figure 9-5 – Connection migration procedure – Requested by current AN**

1 Connection Migrate Required

The current AN sends a Migrate Required message to the NACF. The message includes the target AN ID.

2 Target NACF selection

If the NACF that has received the Migrate Required message in step 1 can no longer serve the UE, this NACF selects a new target NACF.

3 Create UE Context Request

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

4 Connection Migrate Request/Ack

The target NACF determines the target AN based on the target AN ID. The NACF sends a Migrate Request message to the target AN. On receipt of the Migrate Request message from the target NACF, the target AN responds with a Migrate Request Ack message.

5 Create UE Context Request Ack

If a target NACF has been selected, it sends a create UE Context Request Ack message to the current NACF. The message includes the RP-an information necessary for the current NACF to send a Migrate Command to the current AN.

6 Connection Migrate Command

The current NACF sends a Migrate Command message. The current AN sends a Migrate Command to UE with the target AN information for the UE.

7 Connection Migrate Confirm

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

8 Migrate Notify/Ack

The target AN and the target NACF exchange Migrate Notify/Ack messages when Migrate has been successfully performed in the target AN.

9 RP-an Information Notify/Ack

The target and current NACF exchange RP-an Information Notify/Ack messages for the Migrate Notify message received from the target AN.

10 UE Context Release Command/Complete

The current NACF and current AN exchange UE Context Release Command/Complete messages to release the resources related to the UE.

## 9.2 Information flows of connection management on user plane for FMSC

The UP performs primary and secondary UP connection procedures. The procedures of the UP are based on the characteristic of FMSC in IMT-2020 networks and beyond and CM in [ITU-T Y.3104]. An AN can be of the fixed, mobile or satellite types. The UPF may belong to a land- or satellite-based CN. Detailed information flows of these procedures are described in clauses 9.2.1 to 9.2.3.

### 9.2.1 Information flows of primary user plane connection

The procedures include activating and deactivating primary UP connection. Detailed information flows of these procedures are described in clauses 9.2.1.1 and 9.2.1.2.

#### 9.2.1.1 Information flow of activating primary user plane connection

The primary UP connection activation procedure is illustrated as Figure 9-6. An AN can be of the fixed, mobile or satellite types.

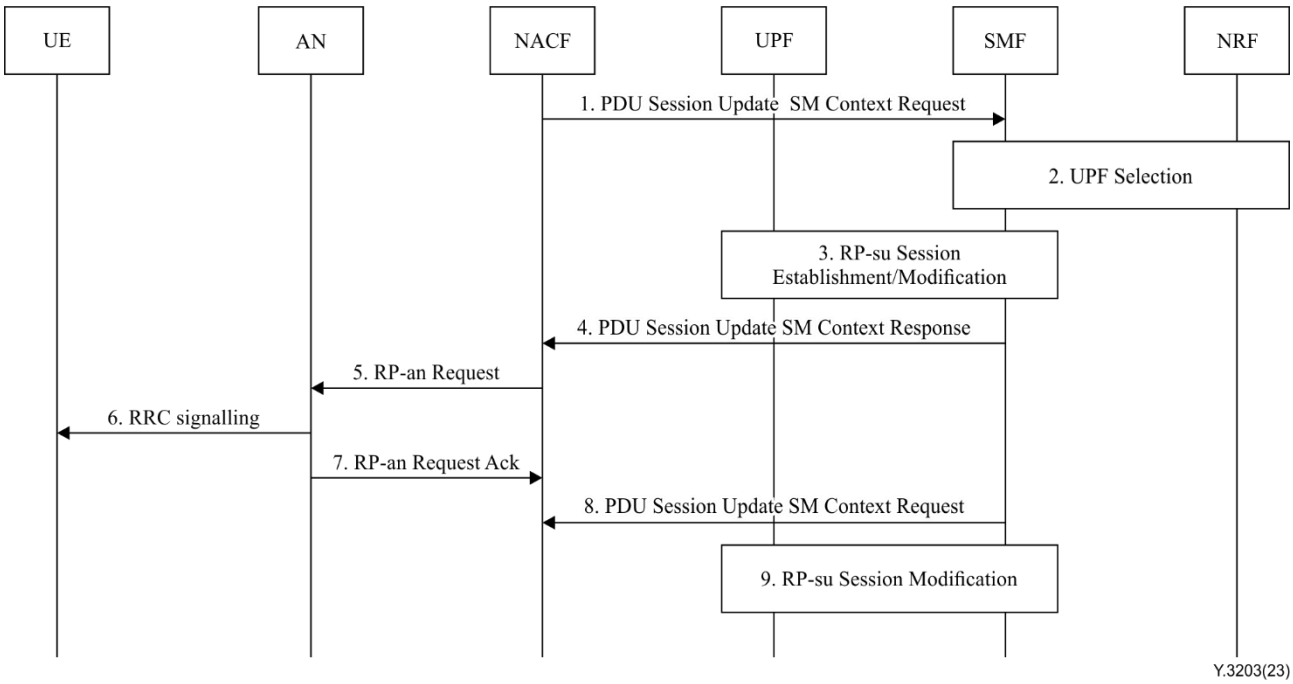


**Figure 9-6 – Activation of primary user plane connection**

1 When UE has established a CP connection through the procedures specified in clause 9.1.1, if the Connection Request also needs to establish a UP connection and UE provides a list of PDUs to be activated, 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).

2 The SMF makes decisions on; accepting or rejecting the activation of the UP connection; and using the current or selecting a new UPF. The current UPF can be based on land or satellite. When appropriate, the SMF needs to make a decision on a UPF that is based on land or satellite. If appropriate, the SMF needs to select a land-based UPF based on UE location information. If appropriate the SMF needs to select a satellite-based UPF based on UE location information and satellite ephemeris.

3 In order to relocate the UPF it selects, the SMF establishes a Reference point between the SMF and UPF (RP-su) session with the new UPF and modifies the RP-su session with the old UPF.

4 For the activated PDU session, the SMF generates the corresponding SM information and sends it to the NACF through a PDU Session Update SM Context Response message.

5 The NACF sends an RP-an Request Signalling message to the AN.

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

7 The RP-an Request Ack message may include RP-an SM information.

8 If the NACF has received RP-an SM information, then the NACF forwards it to the relevant SMF per PDU session ID.

9 If the SMF has selected a new UPF for the PDU session, the SMF provides the AN tunnel information received from the AN to the new UPF through an RP-su Session Modification signalling message. With the AN tunnel information, the new UPF completes the establishment of the UP connection to UE.

### 9.2.1.2 Information flow of deactivating primary user plane connection

The deactivation of the UP connection of an existing PDU session causes the corresponding data radio bearer and Reference Point between AN and UPF (RP-au) tunnel to be deactivated. The UP connection of different PDU sessions can be deactivated independently when a UE is in CM-CONNECTED state. The UP connection deactivation procedure is illustrated in Figure 9-7.

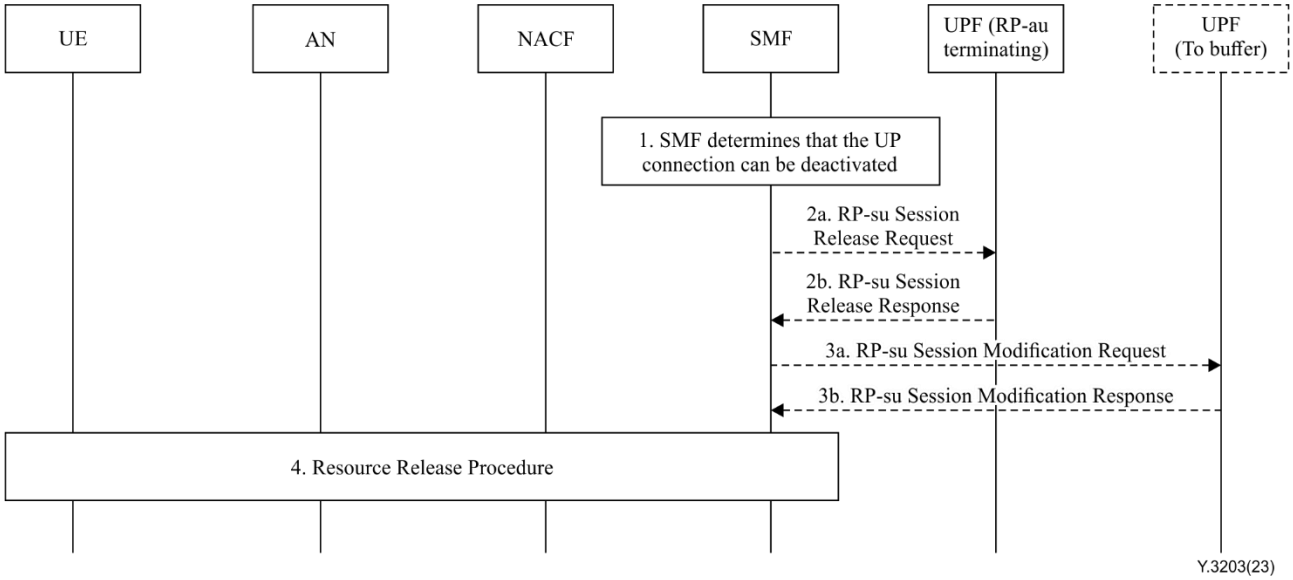


**Figure 9-7 – Deactivation of primary user plane connection**

1 The SMF determines that the UP connection can be deactivated.

2 The SMF may initiate an RP-su Session Release procedure to release the intermediate UPF of an RP-au terminating point. If there are multiple intermediate UPFs, this step can be performed for each UPFs to be released. The SMF needs to initiate a RP-su Session Modification procedure to the UPF connecting to the released UPF. The selection of the released UPF needs to consider the mobility of UE and the satellite.

3 If the UPF of an RP-au terminating point is released in step 2, the SMF initiates an RP-su Session Modification procedure towards the UPF (PDU session anchor or another intermediate UPF) connecting to the released UPF. If the UPF of RP-au terminating point is not released, the SMF initiates an RP-su Session Modification procedure indicating the need to remove AN Tunnel Info for RP-au of the corresponding PDU session.

4 The SMF invokes the Nnacf_Communication MessageTransfer service operation to release the AN resources associated with the PDU session. The NACF sends the RP-an PDU session resource release command via an RP-an to the AN. The AN may issue an AN specific signalling exchange with UE to release the AN resources. When a UP connection for a PDU session is released, the access stratum (AS) layer in the UE indicates it to the NAS layer. The AN acknowledges the RP-au PDU session resource release command. The NACF invokes the Nsmf_PDUSession_UpdateSMContext service operation to acknowledge the Nnacf service received.

## 9.2.2 Information flows of secondary user plane connection

In FMSC scenario, both PN and SN may be a fixed, mobile or satellite AN. When both PN and SN are a fixed or mobile AN, the procedures of secondary UP connection are completed on the ground. When PN and SN belong to fixed or mobile, and satellite AN, respectively, the procedures of secondary UP connection are completed by negotiation between the satellite and the fixed or mobile

AN. Furthermore, when both PN and SN are satellite ANs, the procedures of secondary UP connection may be completed by negotiation between the satellites.

The procedures of secondary UP connection include those for addition and release. Detailed information flows of these procedures are described in clauses 9.2.2.1 to 9.2.2.3.

### 9.2.2.1 Information flow of adding secondary user plane connection

The secondary UP connection addition procedure is initiated by the PN and is used to establish a UE context at the SN in order to provide resources from the SN to UE. The secondary UP connection addition procedure is illustrated in Figure 9-8. Both PN and SN can be fixed, mobile or satellite ANs.

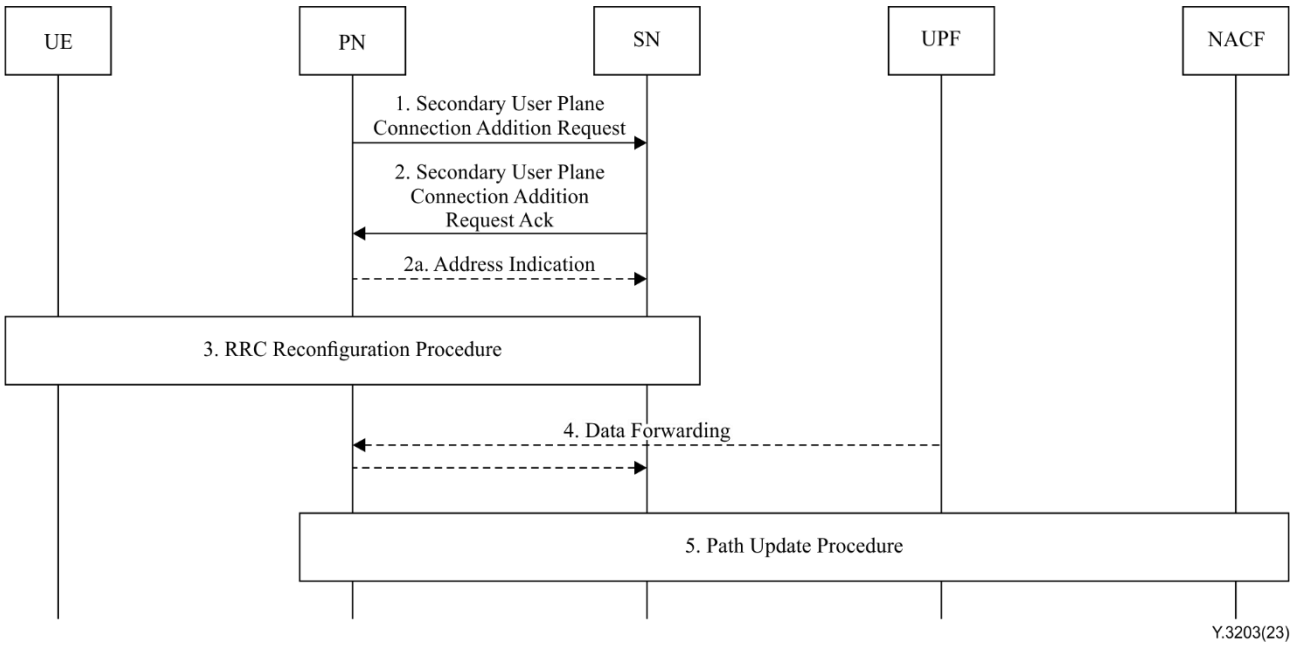


**Figure 9-8 – Addition of secondary user plane connection**

1 The PN chooses an SN and the best-suited access of the fixed, mobile or satellite types. When appropriate, the PN chooses satellite access based on satellite ephemeris. The PN decides to request the target SN to allocate resources for one or more specific PDU sessions or QoS flows, indicating QoS flow characteristics.

2 The SN sends an Addition Request Ack to the PN.

2a The PN provides address information to the SN in an Address Indication message.

3 The PN sends the PN RRC Reconfiguration message to UE including the SN RRC Configuration Message. UE applies the new configuration and replies to the PN with PN RRC Reconfiguration Complete message, including an SN RRC Response message for SN, if needed. The PN informs the SN that UE has completed the reconfiguration procedure successfully via an SN Reconfiguration Complete message, including the SN RRC Response message, if received from UE. UE performs the Random Access procedure. The successful Random Access procedure is not required for a successful completion of the RRC Connection Reconfiguration procedure. When the RRC full configuration is not used, the PN sends the SN Status Transfer.

4 For SN terminated bearers or QoS flows moved from the PN, dependent on the characteristics of the respective bearer or QoS flow, the PN may take actions to minimize service interruption. When both PN and SN are satellite-based networks, data may be transferred by ISL.

5 If applicable, the update of the UP path is performed via a PDU session path update procedure.

#### 9.2.2.2 Information flow of releasing secondary user plane connection

The secondary UP connection release procedure may be initiated either by the PN or by the SN and is used to initiate the release of the UE context at the SN. The recipient node of this request can reject it, e.g., if an SN change procedure is triggered by the SN. It does not necessarily need to involve signalling towards the UE. The secondary UP connection release procedure is illustrated in Figure 9-9.

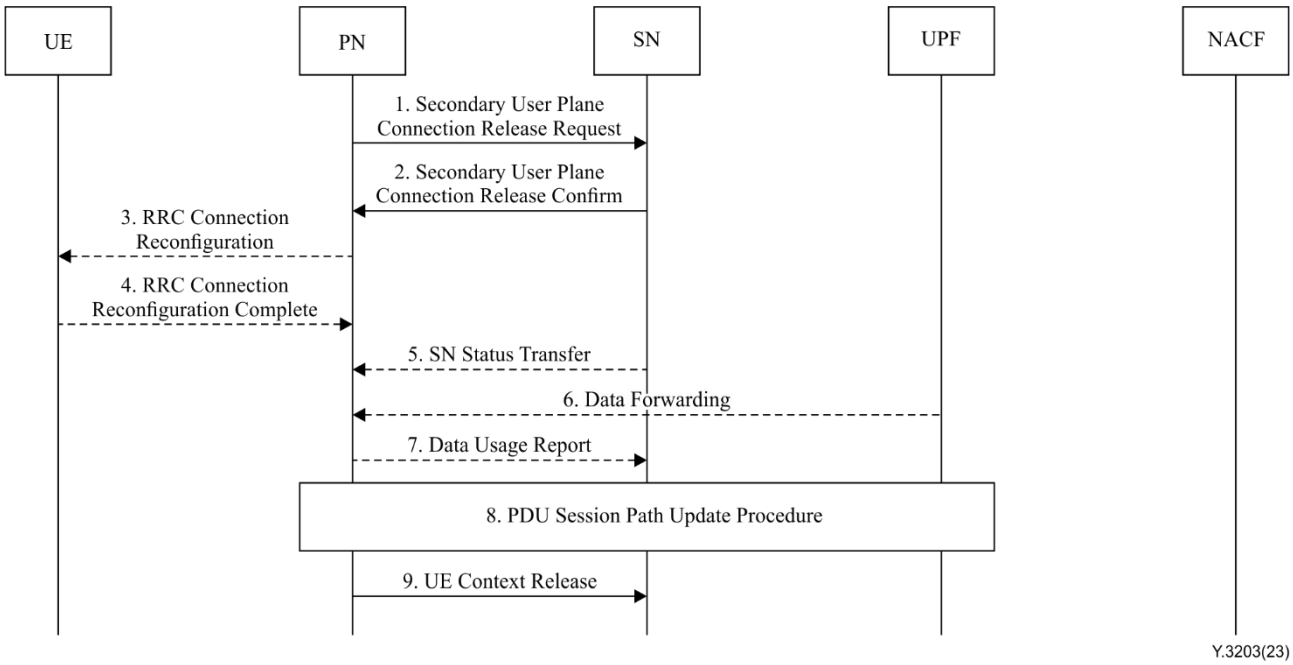


**Figure 9-9 – Release of secondary user plane connection**

1 The SN or PN initiates the procedure by sending the secondary UP connection Release Required message.

2 The SN confirms secondary UP connection release by sending the secondary UP Connection Release Request Confirm message.

3–4 If required, the PN indicates in the PN RRC Reconfiguration message to UE that UE shall release the configuration. If UE is unable to comply with (part of) the configuration included in the PN RRC reconfiguration message, it performs the reconfiguration failure procedure.

5 The SN sends the SN Status Transfer.

6 Data forwarding from the SN to the PN may start. When both PN and SN are satellite-based networks, data may be transferred by ISL.

7 The SN sends the Data Usage Report message to the PN and includes the data volumes delivered to and received from the UE.

8 If applicable, the PDU session path update procedure is initiated.

9 Upon receipt of the UE Context Release message, the SN releases associated to the UE context. Any ongoing data forwarding may continue.

#### 9.2.2.3 Information flows of modifying secondary user plane connection

The secondary UP connection modification procedure may be initiated either by the PN or SN. The secondary UP connection modification procedure can be used to modify, establish or release bearer contexts, to transfer bearer contexts to and from the SN or to modify other properties of the UE context within the same SN. It may also be used to transfer an RRC message from the SN to the UE via the PN and the response from the UE via PN to the SN.

The secondary UP connection modification procedure initiated by PN is illustrated in Figure 9-10. Both PN and SN can be fixed, mobile and satellite AN nodes.

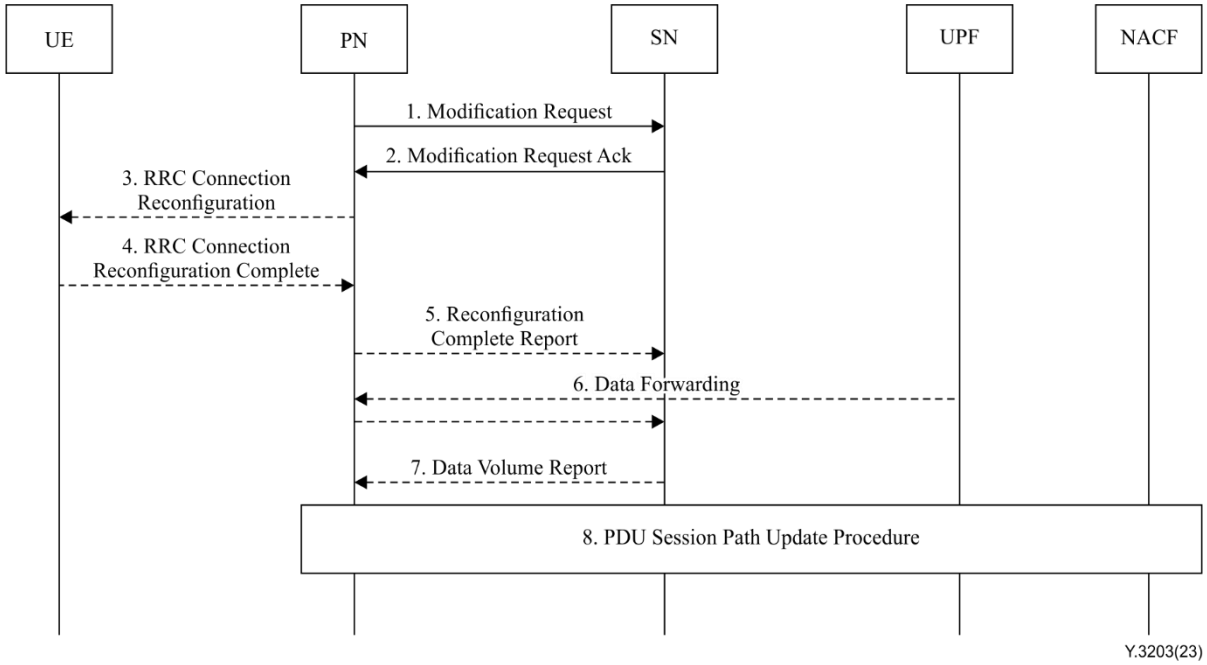


**Figure 9-10 – Modification of secondary user plane connection – PN initiated**

1 Modification Request

The PN sends a Modification Request message to the SN. The Modification Request message may contain information related to the context of the bearer or other UE and data forwarding address information (if applicable).

2 Modification Request Ack

The SN responds to the PN with the Modification Request Ack message, which may contain radio resource configuration information and data forwarding address information (if applicable).

3–4 RRC reconfiguration procedure

The PN initiates the RRC connection reconfiguration procedure, including a Radio Resource Configuration message. The UE applies the new configuration and replies to the PN with a RRC Connection Reconfiguration Complete message. If UE is unable to comply with (part of) the configuration included in the RRC Connection Reconfiguration message, it performs the reconfiguration failure procedure.

5 Reconfiguration Complete Report

Upon successful completion of the reconfiguration, the success of the procedure is indicated in a Reconfiguration Complete Report message.

6 Data Forwarding

If applicable, data is forwarded between the PN and SN. The data is forwarded from the UPF to PN, which then sends the data to the SN.

7 Data Volume Report

The SN sends the Data Volume Report message to the PN and includes the data volumes delivered to and received from the UE.

NOTE 1 – The order in which the SN sends the Data Volume Report message and performs data forwarding with PN is not specified. The SN may send the report when the transmission of the related bearer is stopped.

8 PDU session path update procedure

If applicable, a PDU session path update procedure is performed.

The secondary UP connection modification procedure initiated by SN is illustrated in Figure 9-11.

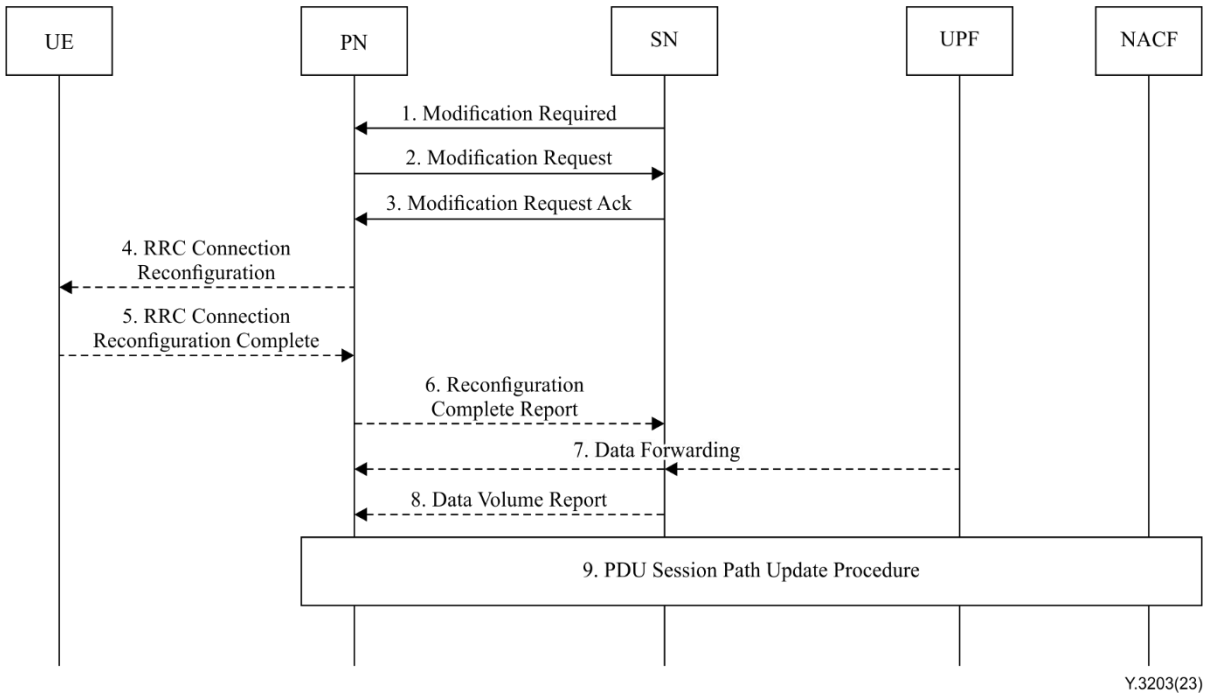


**Figure 9-11 – Modification of secondary user plane connection – SN initiated**

1 Modification Required

The SN sends the Modification Required message to the PN. The Modification Required message may contain information related to the context of the bearer or other UE.

2 Modification Request

The PN sends the Modification Request message to SN.

3 Modification Request Ack

The SN responds to the PN with the Modification Request Ack message.

4–5 RRC reconfiguration procedure

The PN initiates the RRC connection reconfiguration procedure, including a Radio Resource Configuration message. The UE applies the new configuration and replies to PN with a RRC Connection Reconfiguration Complete message. After the reconfiguration finishes successfully, the Success of the Reconfiguration Procedure message is sent to the SN. If UE is unable to comply with

(part of) the configuration included in the RRC Connection Reconfiguration message, it performs the reconfiguration failure procedure.

6 Reconfiguration Complete Report

Upon successful completion of the reconfiguration, the success of the procedure is indicated in a Reconfiguration Complete Report message.

7 Data Forwarding

If applicable, data is forwarded between the PN and SN. The data is forwarded from the UPF to the SN, which then sends the data to the PN.

8 Data Volume Report

The SN sends the Data Volume Report message to the PN and includes the data volumes delivered to and received from the UE.

NOTE 2 – The order in which the SN sends the Data Volume Report message and performs data forwarding with PN is not specified. The SN may send the report when the transmission of the related bearer is stopped.

9 PDU session path update procedure

If applicable, a PDU session path update procedure is performed.

### 9.2.3 Information flow of connection information transfer based on dual connectivity

This procedure is used to transfer QoS flows to and from the SN. During this procedure, the SMF and UPF are never re-allocated. The presence of Internet protocol connectivity between the UPF and the PN, as well as between the UPF and the SN is assumed. If QoS flows for multiple PDU sessions need to be transferred to or from the SN, the procedure shown in the Figure 9-12 is repeated for each PDU Session. Both PN and SN can be fixed, mobile or satellite ANs. When both PN and SN are satellite ANs, connection information is transferred by the ISL between satellites.

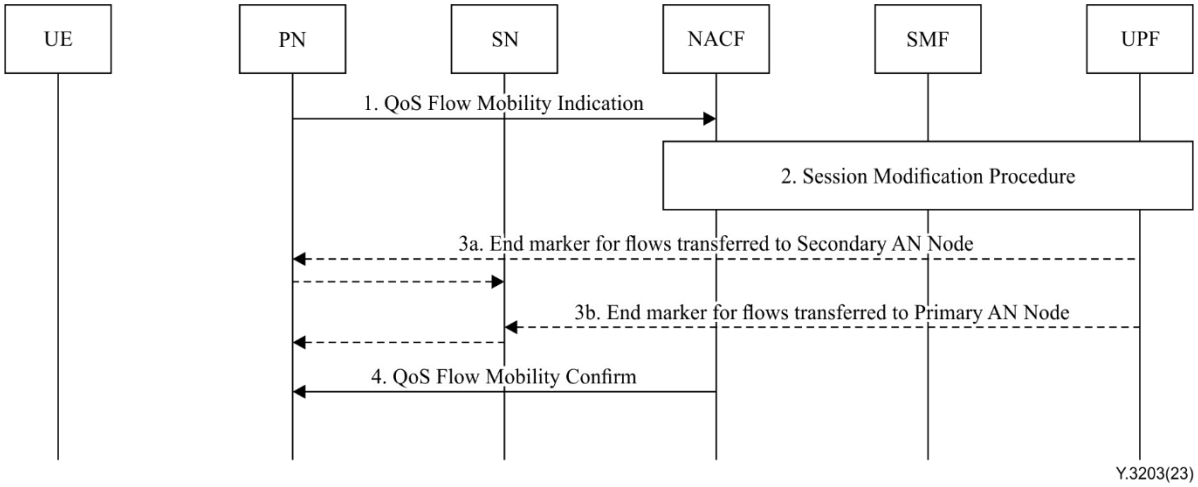


**Figure 9-12 – QoS flow transfer procedure**

1 QoS flow mobility indication

The PN sends an AN/CN QoS flow mobility indication message to the NACF, including PDU session ID, quality of service flow identifier (QFI), AN Tunnel Info. AN Tunnel Info includes the new AN tunnel endpoint for the QFI(s) for which the AN tunnel information shall be modified.

2 Session Modification Procedure

The NACF relays the AN/CN QoS Flow Mobility Indication message to the SMF associated with the PDU session ID received in the previous message. The SMF sends an RP-su Session Modification Request message to the UPF. The UPF returns an RP-su Session Modification Response message to the SMF after requested QFIs are switched. The SMF sends a QoS Flow Mobility Confirm to the NACF for QFIs of the PDU session that have been switched successfully. If none of the requested QFIs have been switched successfully, the SMF shall send an AN/CN QoS Flow Mobility Failure message.

3 End Marker for Flows Transferred to Secondary AN Node and Primary AN Node

In order to assist the reordering function in the PN or SN, for each affected RP-au tunnel, the UPF sends one or more "end marker" packets on the old tunnel immediately after switching the tunnel for the QFI. The UPF starts sending downlink packets to the Target AN.

4 QoS Flow Mobility Confirm

The NACF relays QoS Flow Mobility Confirm message to the PN.

## 10 Security considerations

- Provision of CM to the UE through an AN, which is authorized by the converged network to provide services to this UE, is required. This AN authorization applies to all types of ANs, including fixed, mobile and satellite.
- The converged network is required to support unauthenticated access for emergency services, according to regulatory requirements in some regions.
- The converged network and different ANs allow the use of encryption and integrity protection algorithms for application signalling and non-access signalling protection by security keys. The network interfaces are required to support the transmission of security keys.
- It is required to support ciphering CM signalling by UE, ANs, and converged network.
- Support for security mechanisms to protect non-access signalling and data transmission between UE and NACF is required. This protection involves both integrity and confidentiality protection.
- Security functions are necessary to support UE that is simultaneously connected to more than one access node in the same or different ANs. The first access node can generate a security key for the second access node, and share it over the access node interface.

In addition, security and privacy considerations should be aligned with the requirements specified in [ITU-T Y.3101] and [b-ITU-T Y.2701].

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[b-ITU-T Y.2028] Recommendation ITU-T Y.2028 (2015), *Intelligent access selection in multi-connection*.

[b-ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1*.

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

[b-ITU-T Y.3200] Recommendation ITU-T Y.3200 (2022), *Fixed, mobile and satellite convergence – Requirements for IMT-2020 networks and beyond*.

[b-ITU-R M.1645] Recommendation ITU-R M.1645 (2003), *Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000*.

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Published in Switzerland
Geneva, 2023