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Technical Specification

3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; GPRS enhancements for E-UTRAN access (Release 8)



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Foreword

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

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

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- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document defines the stage 2 service description for the Evolved 3GPP Packet Switched Domain - also known as the Evolved Packet System (EPS) in this document. The Evolved 3GPP Packet Switched Domain provides IP connectivity using the Evolved Universal Terrestrial Radio Access Network (E-UTRAN).

The specification covers both roaming and non-roaming scenarios and covers all aspects, including mobility between E-UTRAN and pre-E-UTRAN 3GPP radio access technologies, policy control and charging, and authentication.

The Radio Access Network functionality is documented only to the extent necessary to describe the overall system. 3GPP TS 36.300 [5] contains the overall description of the Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN).

ITU-T Recommendation I.130 [3] describes a three-stage method for characterisation of telecommunication services, and ITU-T Recommendation Q.65 [4] defines stage 2 of the method.

TS 23.402 [2] is a companion specification to this specification.

2 References

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

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

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 23.402: "Architecture enhancements for non-3GPP accesses".
- [3] ITU-T Recommendation I.130: "Method for the characterization of telecommunication services supported by an ISDN and network capabilities of an ISDN".
- [4] ITU-T Recommendation Q.65: "The unified functional methodology for the characterization of services and network capabilities".
- [5] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Overall description; Stage 2".
- [6] 3GPP TS 23.203: "Policy and charging control architecture".
- [7] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".
- [8] 3GPP TS 43.129: "Packet-switched handover for GERAN A/Gb mode; Stage 2".
- [9] 3GPP TS 23.003: "Numbering, addressing and identification".
- [10] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station in idle mode".
- [11] 3GPP TS 43.022: "Functions related to MS in idle mode and group receive mode".
- [12] 3GPP TS 25.304: "UE procedures in idle mode and procedures for cell re-selection in connected mode".
- [13] 3GPP TS 26.346: "MBMS Protocols and codecs".

- [14] 3GPP TS 29.060: "GPRS Tunnelling Protocol (GTP) across the Gn and Gp interface".
- [15] 3GPP TS 43.051: "GERAN Overall description - stage 2".
- [16] 3GPP TS 25.401: "UTRAN overall description".
- [17] IETF RFC 1034 (1987): "Domain names – concepts and facilities" (STD 13).

3 Definitions and abbreviations

3.1 Definitions

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

MME Pool Area: An MME Pool Area is defined as an area within which a UE may be served without need to change the serving MME. An MME Pool Area is served by one or more MMEs ("pool of MMEs") in parallel. MME Pool Areas are a collection of complete Tracking Areas. MME Pool Areas may overlap each other.

UPE Pool Area: A UPE Pool Area is defined as an area within which a UE may be served without need to change the serving UPE. A UPE Pool Area is served by one or more UPEs ("pool of UPEs") in parallel. UPE Pool Areas are a collection of complete Tracking Areas. UPE Pool Areas may overlap each other.

Editor's Note: The need for a definition for UPE Pool Area requires review given the absence of the UPE in the architecture.

3.2 Abbreviations

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

AMBR	Aggregate Maximum Bit Rate
DL TFT	DownLink Traffic Flow Template
EPC	Evolved Packet Core
EPS	Evolved Packet System
GW	Gateway
L2 PDB	Layer 2 Packet Delay Budget
L2 PLR	Layer 2 Packet Loss Rate
MBSFN	MBMS over Single Frequency Networks
MME	Mobility Management Entity
P-GW	PDN Gateway
S-GW	Serving Gateway
S-TMSI	S-Temporary Mobile Subscriber Identity
SDF	Service Data Flow
TAC	Tracking Area Code
TAI	Tracking Area Identity
TAU	Tracking Area Update
UL TFT	UpLink Traffic Flow Template

4 Architecture Model and Concepts

4.1 General Concepts

<This section explains high-level architecture of EPC/E-UTRAN. E.g. it would indicate that the architecture supports S1 flex. >

Simultaneous exchange of IP traffic to multiple PDNs is supported in the EPS, when the network policies and user subscription allow it. For UEs in which applications are not aware of multiple PDN access and the presence of multiple IP addresses, overlapping address spaces are not supported.

4.2 Architecture Reference Model

4.2.1 Non-Roaming Architecture

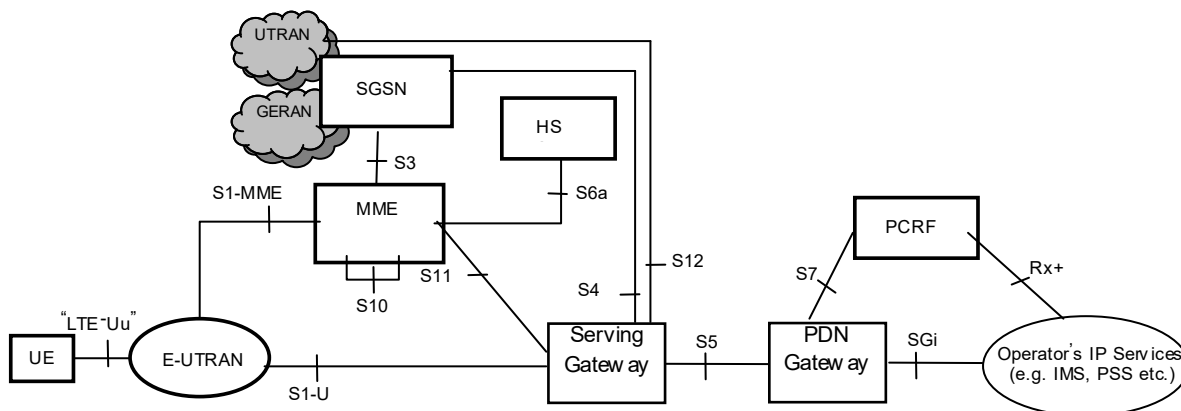


Figure 4.2.1-1: Non-Roaming Architecture for 3GPP Accesses

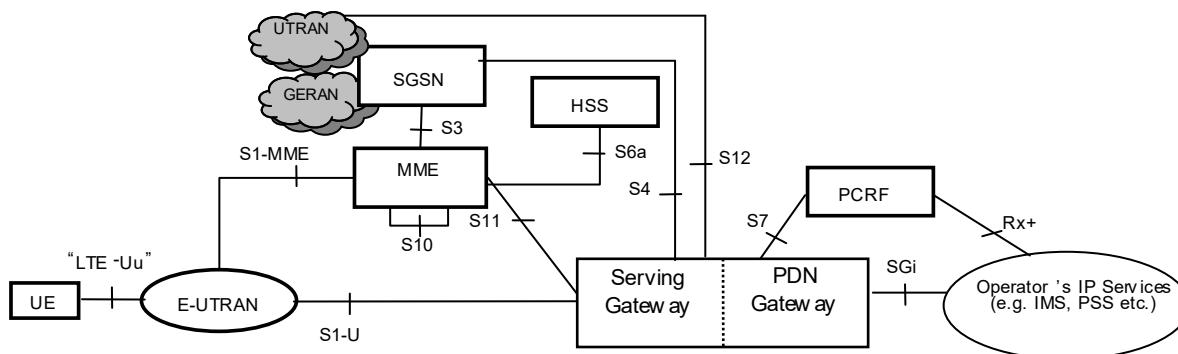


Figure 4.2.1-2: Non-Roaming Architecture for 3GPP Accesses . Single gateway configuration option

Editor's Note: Need to find new name for "LTE-Uu".

NOTE 1: Also in this configuration option, S5 can be used between non collocated Serving Gateway and PDN Gateway.

NOTE 2: Additional interfaces for 2G/3G access are shown in TS 23.060 [7].

4.2.2 Roaming Architecture

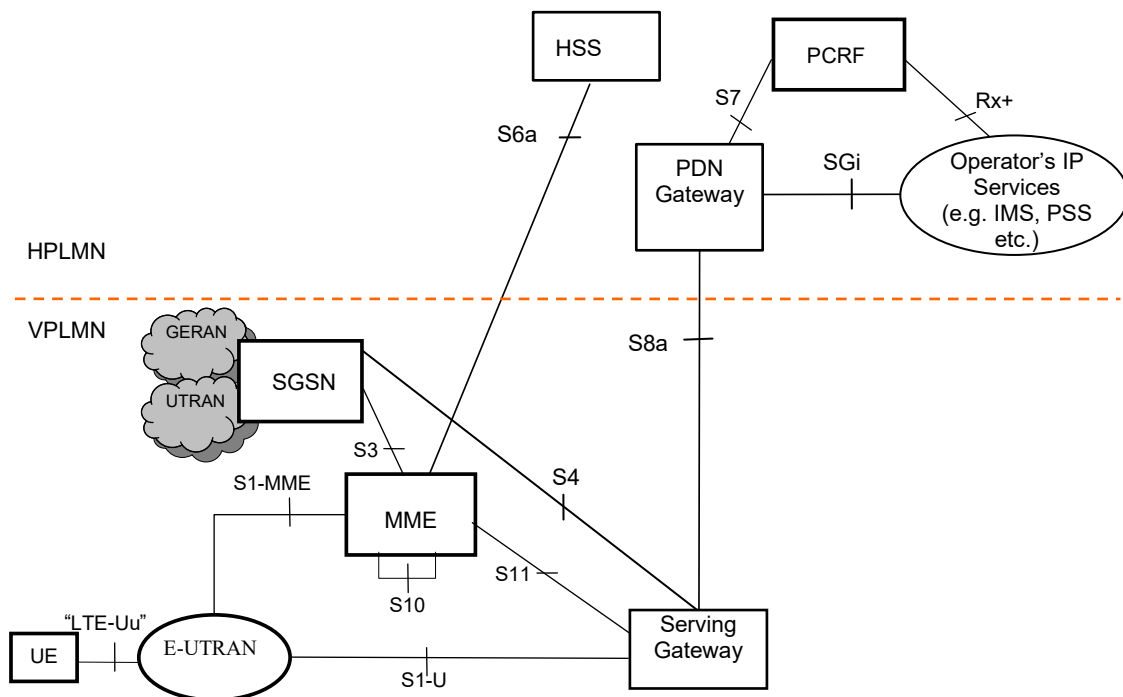


Figure 4.2.2-1: Roaming Architecture for 3GPP Accesses, Home Routed traffic

Editor's Note: Impact from Direct Tunnel architecture need to be included in the architecture diagrams.

NOTE: Additional interfaces/reference points for 2G/3G accesses are documented in TS 23.060 [7].

Editor's Note: The Roaming architecture for the Visited Services scenario and bearer traffic local breakout for the Home Services scenario needs to be included in this specification.

The figures 4.2.2-2 and 4.2.2-3 represent the Roaming with local breakout case with Application Function (AF) in the Home Network and in the Visited Network respectively. The concurrent use of AF's in the home network and AF's in the visited network is not excluded.

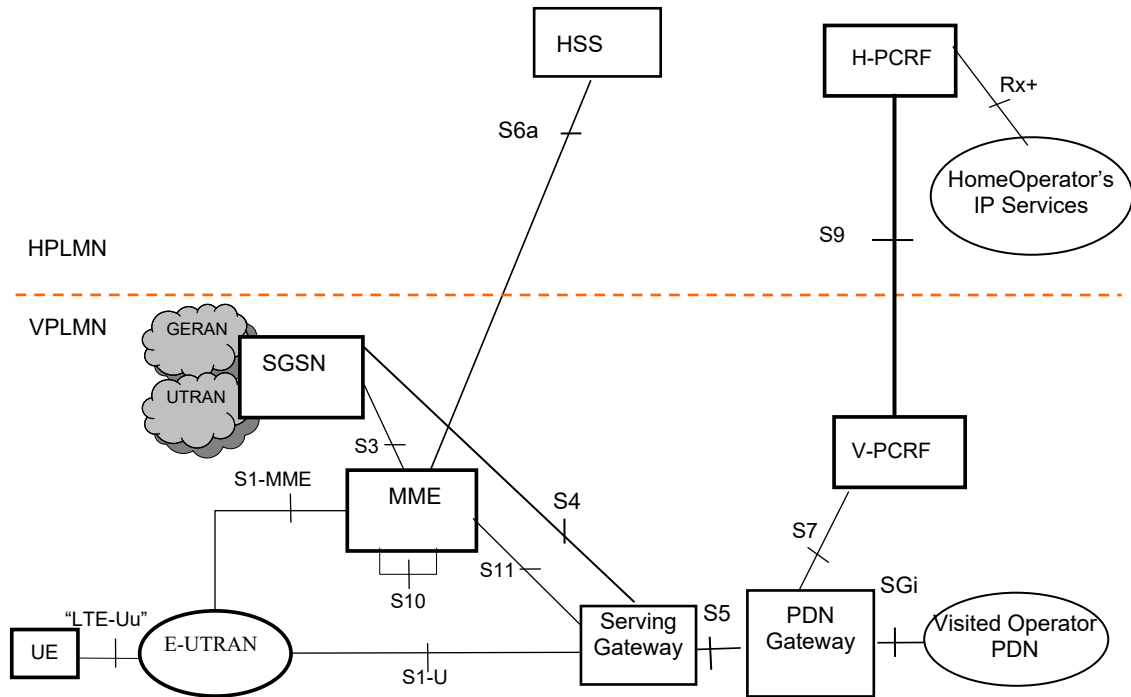


Figure 4.2.2-2. Roaming Architecture for Local Breakout. (with Home operator's Application Functions only)

Editor's note: Applicability for IMS when using Local Breakout with IMS in the HPLMN is FFS.

Editor's note: The Home operator's services providing service information over Rx+ directly to the V-PCRF is FFS.

Editor's note: The requirements for the H-PCRF remain to be defined.

Editor's Note: Impact from Direct Tunnel architecture need to be included in the architecture diagrams.

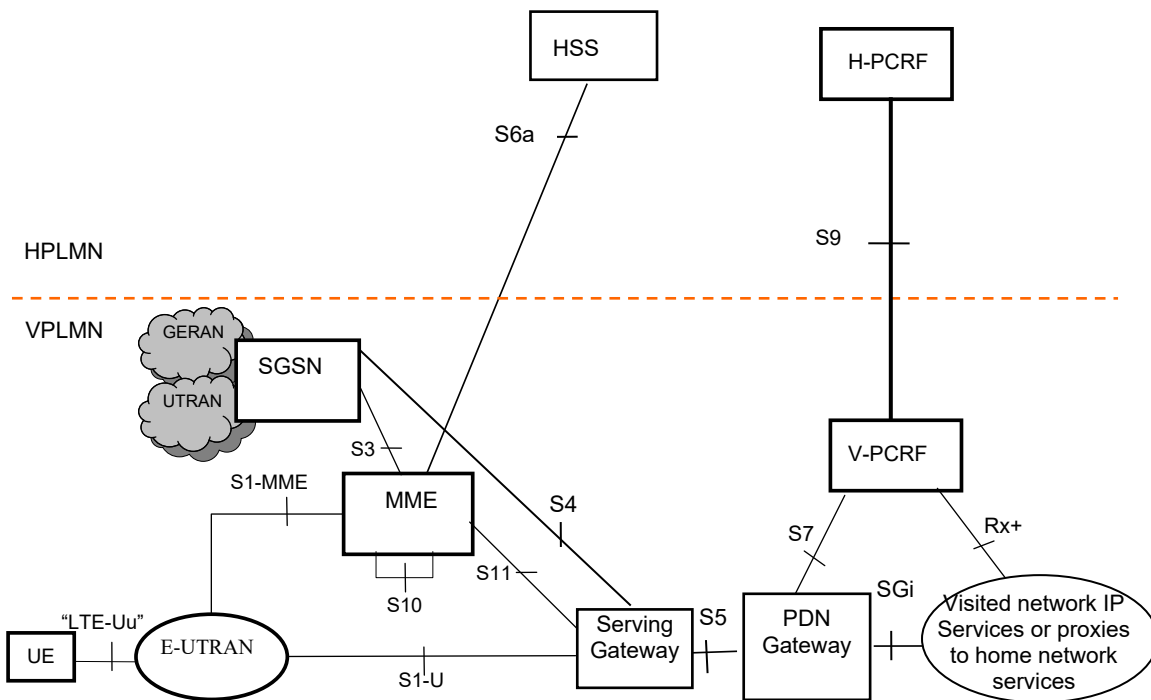


Figure 4.2.2-3. Roaming Architecture for Local Breakout, with visited operator's Application Functions only

Editor's note: The requirements for the H-PCRF and S9 remain to be identified.

Editor's Note: Impact from Direct Tunnel architecture need to be included in the architecture diagrams.

4.2.3 MBMS architecture

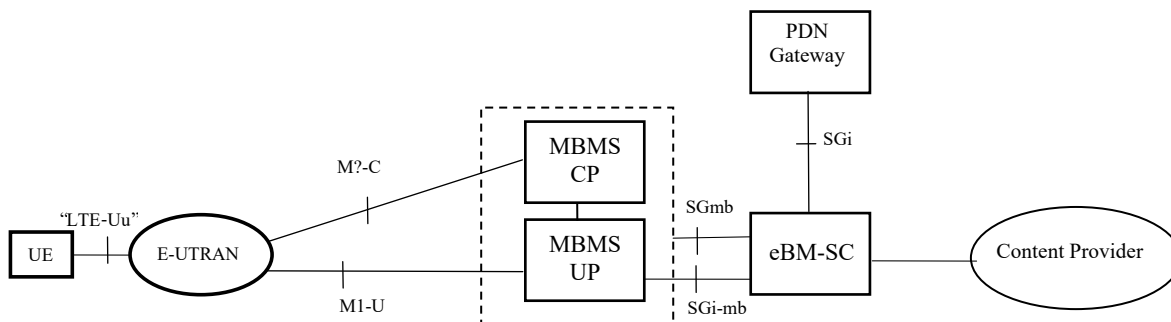


Figure 4.2.3-1. MBMS Architecture for 3GPP Accesses

Editor's Note: MCE and related interfaces are not show in the figures. The node in E-UTRAN where M?-C is terminated is FFS by RAN WGs.

Editor's Note: It is FFS if the CP and UP functions of the MBMS entity are separated and connected with a reference point in between or if it is one entity handling both MBMS CP and UP functions.

NOTE: The eBM-SC uses both MBMS Bearers (over SGmb/SGi-mb) and EPS Bearers (over SGi)

4.3 High Level Functions

<This section explains the high level functions (eg charging, encryption) used in EPS>

4.3.1 General

The following list gives the logical functions performed within this system. Several functional groupings (meta functions) are defined and each encompasses a number of individual functions:

- Network Access Control Functions.
- Packet Routeing and Transfer Functions.
- Mobility Management Functions.
- Radio Resource Management Functions.
- Network Management Functions.

4.3.2 Network access control functions

4.3.2.1 General

Network access is the means by which a user is connected to the evolved packet core system.

4.3.2.2 Network/Access network selection

It is the means by which a UE selects a PLMN/Access network from which to gain IP connectivity. The network/access network selection procedure varies for different access technologies. For 3GPP access networks, the network selection principles are described in 3GPP TS 23.122 [10]. For 3GPP access networks, the access network selection procedures are described in 3GPP TS 36.300 [5], 3GPP TS 43.022 [11] and 3GPP TS 25.304 [12].

Architectural impacts stemming from support for network/access network selection procedures for non-3GPP access and between 3GPP access and non-3GPP accesses are described in 3GPP TS 23.402 [2].

4.3.2.3 Authentication and Authorisation Function

This function performs the identification and authentication of the service requester, and the validation of the service request type to ensure that the user is authorised to use the particular network services. The authentication function is performed in association with the Mobility Management functions.

4.3.2.4 Admission Control Function

<Text needs to be provided>

4.3.2.5 Policy and Charging Enforcement Function

This includes all the functionality of PCEF as defined by 3GPP TS 23.203 [6]. The PCEF encompasses service data flow detection, policy enforcement and flow based charging functionalities as defined in 3GPP TS 23.203 [6].

4.3.2.6 Lawful Interception

<Text needs to be provided>

4.3.3 Packet routing and transfer functions

4.3.3.1 General

A route is an ordered list of nodes used for the transfer of packets within and between the PLMN(s). Each route consists of the originating node, zero or more relay nodes and the destination node. Routing is the process of determining and using, in accordance with a set of rules, the route for transmission of a message within and between the PLMN(s).

The EPS is an IP network and uses the standard routing and transport mechanism of underlying IP network.

Editor's note: The above text does not appear to be relevant to a functional description.

4.3.3.2 IP Header Compression function

The compression function optimises use of radio capacity by IP header compression mechanisms.

4.3.3.3 Ciphering function

The ciphering function preserves the confidentiality of user data and signalling across the radio channels.

4.3.3.4 Integrity Protection function

<Text needs to be provided>

4.3.3.5 Packet Screening Function

The packet screening function provides the network with the capability to check that the UE is using the exact IPv4-Address/IPv6-Prefix/Full-IPv6-Address that was assigned to the UE.

4.3.4 Mobility Management Functions

4.3.4.1 General

The mobility management functions are used to keep track of the current location of a UE.

4.3.4.2 Idle mode UE Tracking and Reachability Management

<Text needs to be provided>

4.3.4.3 Inter-eNB Mobility Anchor Function

<Text needs to be provided>

4.3.4.4 Inter-3GPP Mobility Anchor Function

<Text needs to be provided>

4.3.5 Radio Resource Management functions

Radio resource management functions are concerned with the allocation and maintenance of radio communication paths, and are performed by the radio access network. Refer to 3GPP TS 36.300 [5] for further information on E-UTRAN.

4.3.6 Network management functions

Network management functions provide mechanisms to support O&M functions related to the Evolved System.

The Network management architecture and functions for the evolved packet core system are described in 3GPP TS [ss.xyz\[qq\]](#)

4.3.7 Selection functions

4.3.7.1 PDN GW Selection Function (3GPP accesses)

The PDN GW selection function allocates a PDN GW that shall provide the PDN connectivity for the for 3GPP access. The selection uses subscriber information provided by the HSS and possibly additional criteria. The HSS provides:

- an IP address of a PDN GW and an APN, or
- an APN and an indication whether the allocation of a PDN GW from the visited PLMN is allowed or a PDN GW from the home PLMN shall be allocated.

Editor's note: It is FFS what additional criteria beyond the subscriber information can be used for PDN GW selection.

Editor's note: It is FFS whether the UE can provide additional input information (e.g. the desired APN) for the PDN GW selection function.

If the HSS provides an IP address of a PDN GW, no further PDN GW selection functionality is performed. Note that the provision of an IP address of a PDN GW as part of the subscriber information allows also for a PDN GW allocation by HSS.

If the HSS provides an APN of a PDN GW and the subscription allows for allocation of a PDN GW from the visited PLMN, the PDN GW selection function derives a PDN GW address from the visited PLMN. If a visited PDN GW address cannot be derived, or if the subscription does not allow for allocation of a PDN GW from the visited PLMN, then the APN is used to derive a PDN GW address from the HPLMN. The PDN GW address is derived from the APN and additional information by using the Domain Name Service function as specified in Annex A of 3GPP TS 23.060 [7]. If the Domain Name Service function provides a list of PDN GW addresses, one PDN GW address is selected from this list. If the selected PDN GW cannot be used, e.g. due to an error, then another PDN GW is selected from the list.

If the UE provides an APN this APN is used to derive a PDN GW address like specified for an HSS provided APN if the subscription allows for this APN.

During attach an IP address of the assigned PDN GW may be provided to the UE for use with host based mobility as defined in 3GPP TS 23.402 [2].

Editor's note: It is FFS whether host-based mobility requires additional information and/or mechanisms.

4.3.7.2 Serving GW Selection Function

4.3.7.2.1 Selection at Initial Attach

The Serving GW selection function selects an available Serving GW for serving a UE. The selection bases on network topology, i.e. the selected Serving GW serves the UE's location and in case of overlapping Serving GW service areas, the selection may prefer Serving GWs with service areas that reduce the probability of changing the Serving GW. Other criteria for Serving GW selection may be load balancing between Serving GWs.

If combined Serving and PDN GWs are configured in the network the Serving GW Selection Function preferably derives a Serving GW that is also a PDN GW for the UE.

The Domain Name Service function may be used to resolve a DNS string into a list of possible Serving GW addresses which serve the UE's location. The details of the selection are implementation specific.

4.3.7.2.2 Selection at Handover

Editor's note: this section describes the serving GW selection in case of handover

4.3.7.3 MME Selection Function

The MME selection function selects an available MME for serving a UE. The selection bases on network topology, i.e. the selected MME serves the UE's location and in case of overlapping MME service areas, the selection may prefer MMEs with service areas that reduce the probability of changing the MME. Other criteria for MME selection may be load balancing between MMEs.

4.3.7.4 SGSN Selection Function

The SGSN selection function selects an available SGSN for serving a UE. The selection bases on network topology, i.e. the selected SGSN serves the UE's location and in case of overlapping SGSN service areas, the selection may prefer SGSNs with service areas that reduce the probability of changing the SGSN. Other criteria for SGSN selection may be load balancing between SGSNs.

4.3.8 Domain Name Service Function

The Domain Name Service function resolves logical PDN GW names to PDN GW addresses. This function is standard Internet functionality according to RFC 1034 [17], which allows resolution of any name to an IP address (or addresses) for PDN GWs and other nodes within the EPS.

4.4 Network Elements

4.4.1 E-UTRAN

E-UTRAN is described in more detail in 3GPP TS 36.300 [5].

In addition to the E-UTRAN functions described in 3GPP TS 36.300 [5], E-UTRAN functions include:

- Header compression and user plane ciphering
- MME selection when no routing to an MME can be determined from the information provided by the UE

4.4.2 MME

MME functions include:

- NAS signalling
- NAS signalling security
- Inter CN node signalling for mobility between 3GPP access networks (terminating S3)
- Idle mode UE Tracking and Reachability (including control and execution of paging retransmission)
- PDN GW and Serving GW selection
- MME selection for handovers with MME change
- SGSN selection for handovers to 2G or 3G 3GPP access networks
- Roaming (S6a towards home HSS)
- Authentication
- Bearer management functions including dedicated bearer establishment.

NOTE: The Serving GW and the MME may be implemented in one physical node or separated physical nodes.

4.4.3 Gateway

4.4.3.1 General

Two logical Gateways exist:

- Serving GW (S-GW)
- PDN GW (P-GW)

Functional split of PDN GW and Serving GW shall be the same regardless of the use of IETF or GTP based protocols between them.

NOTE: The PDN GW and the Serving GW may be implemented in one physical node or separated physical nodes.

4.4.3.2 Serving GW

The Serving GW is the gateway which terminates the interface towards E-UTRAN.

For each UE associated with the EPS, at a given point of time, there is a single Serving GW.

Serving GW functions include:

- the local Mobility Anchor point for inter-eNodeB handover
- Mobility anchoring for inter-3GPP mobility (terminating S4 and relaying the traffic between 2G/3G system and PDN GW)
- E-UTRAN idle mode downlink packet buffering and initiation of network triggered service request procedure
- Lawful Interception
- Packet routing and forwarding

4.4.3.3 PDN GW

The PDN GW is the gateway which terminates the SGi interface towards the PDN.

If a UE is accessing multiple PDNs, there may be more than one PDN GW for that UE.

PDN GW functions include:

- Policy enforcement
- Per-user based packet filtering (by e.g. deep packet inspection)
- Charging support
- Lawful Interception
- UE IP address allocation
- Packet screening

4.4.4 SGSN

In addition to the functions described in 3GPP TS 23.060 [7], SGSN functions include:

- Inter EPC node signalling for mobility between 2G/3G and E-UTRAN 3GPP access networks
- PDN and Serving GW selection
- MME selection for handovers to E-UTRAN 3GPP access network

4.4.5 GERAN

GERAN is described in more detail in 3GPP TS 43.051 [15].

4.4.6 UTRAN

UTRAN is described in more detail in 3GPP TS 25.401 [16].

4.4.7 MBMS

Editor's Note: It is FFS how these functions are allocated to functional entity/entities.

4.4.7.1 MBMS CP function

One or more MBMS CP function entities are used in a PLMN.

MBMS CP functions include:

- Session control of MBMS bearers to the E-UTRAN access

NOTE: When a UE leaves or enters MBMS bearer coverage, the service continuity is handled by the Service Layer (in UE and network).

4.4.7.2 MBMS UP function

One or more MBMS UP function entities are used in a PLMN.

MBMS UP functions include:

- It provides an interface for entities using MBMS bearers through the SGi-mb (user plane) reference point
- IP multicast distribution to eNodeBs (M1-U reference point)
- Content synchronization for MBSFN (MBMS over Single Frequency Networks)

NOTE: In case of mobility in or out from an MBMS service area, the service continuity is handled by the Service Layer (in UE and network).

4.4.7.3 eBM-SC

The eBM-SC is a functional entity which provides the functions on MBMS service layer. It may serve as an entry point for content provider MBMS transmissions, used to authorise and initiate MBMS bearers within the PLMN and can be used to schedule and deliver MBMS transmissions. The eBM-SC is further described in 3GPP TS 26.346 [13].

4.5 Reference Points

Editor's Note: Once the architecture diagrams are stable in this specification and in TS 23.402, the reference point names need to be updated to remove either the letters or only keep a number series, e.g. S6a replaced with S_n where there is only either a digit or a letter.

S1-MME: Reference point for the control plane protocol between E-UTRAN and MME.

S1-U: Reference point between E-UTRAN and Serving GW for the per bearer user plane tunneling and inter eNodeB path switching during handover.

S3: It enables user and bearer information exchange for inter 3GPP access network mobility in idle and/or active state. It is based on Gn reference point as defined between SGSNs.

Editor's Note: User data forwarding for inter 3GPP access network mobility in active state (FFS).

S4: It provides related control and mobility support between GPRS Core and the 3GPP Anchor function of Serving GW and is based on Gn reference point as defined between SGSN and GGSN. In addition, if Direct Tunnel is not established, it provides the user plane tunnelling.

S5: It provides user plane tunneling and tunnel management between Serving GW and PDN GW. It is used for Serving GW relocation due to UE mobility and if the Serving GW needs to connect to a non-collocated PDN GW for the required PDN connectivity.

S6a: It enables transfer of subscription and authentication data for authenticating/authorizing user access to the evolved system (AAA interface) between MME and HSS.

S7: It provides transfer of (QoS) policy and charging rules from PCRF to Policy and Charging Enforcement Function (PCEF) in the PDN GW. The interface is based on the Gx interface.

S8a: Inter-PLMN reference point providing user and control plane between the Serving GW in the VPLMN and the PDN GW in the HPLMN. It is based on Gp reference point as defined between SGSN and GGSN. S8a is the inter PLMN variant of S5.

S9: It provides transfer of (QoS) policy and charging control information between the Home PCRF and the Visited PCRF in order to support local breakout function.

Editor's note: The detailed requirements for the S9 reference point are FFS.

S10: Reference point between MMEs for MME relocation and MME to MME information transfer.

S11: Reference point between MME and Serving GW

S12: Reference point between UTRAN and Serving GW for user plane tunneling when Direct Tunnel is established. It is based on the Iu-u/Gn-u reference point using the GTP-U protocol as defined between SGSN and UTRAN or respectively between SGSN and GGSN.

SGi: It is the reference point between the PDN GW and the packet data network. Packet data network may be an operator external public or private packet data network or an intra operator packet data network, e.g. for provision of IMS services. This reference point corresponds to Gi for 3GPP accesses.

Rx+ The Rx reference point resides between the AF and the PCRF in the 3GPP TS 23.203 [6]. It is FFS if there will be any significant functional modifications to current Rx reference point to warrant defining it to be Rx+.

Editor's note: It is FFS if the Rx+ is significantly different from the Rel-7 Rx reference point to warrant defining it to be Rx+.

SGi-mb: It is the reference point between eBM-SC and MBMS UP function for MBMS data delivery.

SGmb: It is the reference point for the control plane between eBM-SC and EPC (MBMS-CP or MBMS-UP).

M1-U: It is the reference point between MBMS UP and E-UTRAN for MBMS data delivery.

M?-C: It is the reference point between MBMS CP and E-UTRAN for session control.

Protocol assumption:

- The S1-U is based on GTP-U protocol.
- The S3 is based on GTP protocol.
- The S4 is based on GTP protocol.
- The S5 is based on GTP protocol. IETF variant of S5 is described in 3GPP TS 23.402 [2].
- The S8a is based on GTP protocol. IETF variant of S8a (S8b) is described in 3GPP TS 23.402 [2]

NOTE: Redundancy support on reference points S5 and S8a should be taken into account.

- The M1-U is based on IP Multicast transport.

4.6 Overall QoS Concept

4.6.1 The EPS Bearer

4.6.1.1 The EPS Bearer in general

Editor's Note: This sub-section may need to be revised following further progress with respect to PCC/QoS architecture for IETF-based interfaces of the EPS.

An EPS bearer is a logical aggregate of one or more Service Data Flows (SDFs), defined in 3GPP TS 23.203[6], running between a UE and a PDN GW. An EPS bearer is the level of granularity for *bearer level QoS control* in the EPC/E-UTRAN. That is, SDFs mapped to the same EPS bearer receive the same bearer level packet forwarding treatment (e.g. scheduling policy, queue management policy, rate shaping policy, RLC configuration, etc.). Providing different bearer level QoS to two SDFs thus requires that a separate EPS bearer is established for each SDF.

NOTE: In addition but independent to *bearer level QoS control*, the PCC framework allows an optional enforcement of *service level QoS control* on the granularity of SDFs independent of the binding of SDFs to EPS bearers.

An UpLink Traffic Flow Template (UL TFT) is a set of uplink packet filters. A DownLink Traffic Flow Template (DL TFT) is a set of downlink packet filters.

Editor's Note: Need to clarify the definitions of UL TFT and DL TFT and their relation to the terms 'TFT' and 'service data flow template' as defined in 3GPP TS 23.060 and 3GPP TS 23.203, respectively.

One EPS bearer is established when the UE connects to a PDN, and that remains established throughout the lifetime of the PDN connection to provide the UE with always-on IP connectivity to that PDN. That bearer is referred to as the *default bearer*. Any additional EPS bearer that is established to the same PDN is referred to as a *dedicated bearer*.

Every EPS bearer is associated with an UL TFT in the UE and a DL TFT in the PCEF.

NOTE: The evaluation precedence order of the filters associated with the default bearer, in relation to those associated with the dedicated bearers, is up to operator configuration. However, if the default bearer is intended to be used for all traffic that doesn't match any of the filters associated to dedicated bearers and/or it is associated with a "match all" filter, then operators should assure that the filters associated with the default bearer are assigned the lowest evaluation precedence order of all filters within that IP-CAN session. Any other configuration would effectively exclude the dedicated bearers associated with filters of lower precedence order from being used, and should therefore be considered a mis-configuration in this particular context.

The initial bearer level QoS parameter values of the default bearer are assigned by the network, based on subscription data (in case of E-UTRAN the MME sets those initial values based on subscription data retrieved from HSS). The PCEF may change those values based in interaction with the PCRF or based on local configuration.

NOTE: In case of 3GPP access: if PCC is enabled the MME should not verify bearer level QoS parameter values received on the S11 reference point against any subscription data stored in HSS. This is independent of whether a bearer is a default or a dedicated bearer.

The distinction between default and dedicated bearers should be transparent to the access network (e.g. E-UTRAN).

An EPS bearer is referred to as a *GBR bearer* if dedicated network resources related to a Guaranteed Bit Rate (GBR) value that is associated with the EPS bearer are permanently allocated (e.g. by an admission control function in the eNodeB) at bearer establishment/modification. Otherwise, an EPS bearer is referred to as a *Non-GBR bearer*.

NOTE: Admission control can be performed at establishment / modification of a Non-GBR bearer even though a Non-GBR bearer is not associated with a GBR value.

A dedicated bearer can either be a GBR or a Non-GBR bearer. A default bearer shall be a Non-GBR bearer.

NOTE: A default bearer remains permanently established to provide the UE with always-on IP connectivity to a certain PDN. That motivates the restriction of a default bearer to bearer type Non-GBR.

4.6.1.2 The EPS Bearer with GTP-based S5/S8

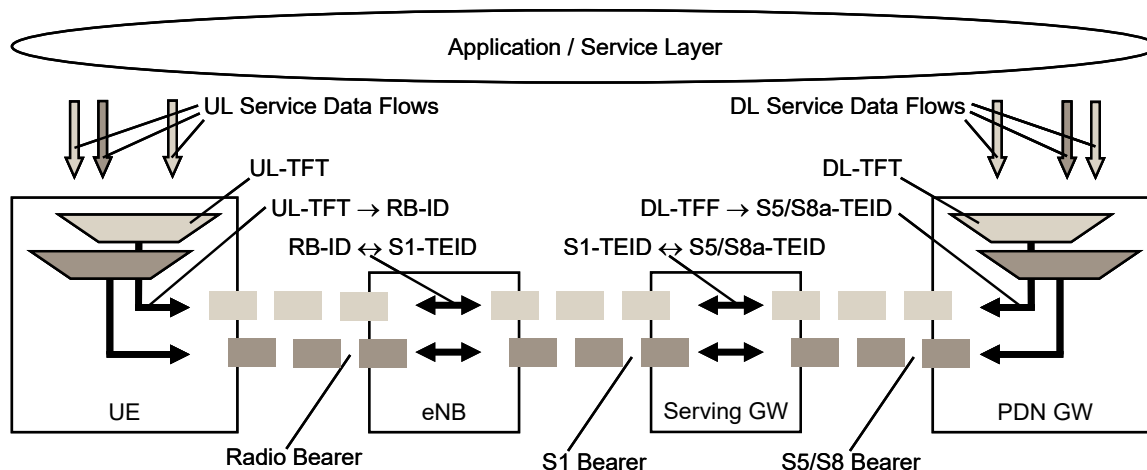


Figure 4.6.1-1: Two Unicast EPS bearers (GTP-u Based S5/S8)

An EPS bearer is realized by the following elements:

- An UL TFT in the UE binds an SDF to an EPS bearer in the uplink direction. Multiple SDFs can be multiplexed onto the same EPS bearer by including multiple uplink packet filters in the UL TFT.
- A DL TFT in the PDN GW binds an SDF to an EPS bearer in the downlink direction. Multiple SDFs can be multiplexed onto the same EPS bearer by including multiple downlink packet filters in the DL TFT.
- A radio bearer (defined in 3GPP TS 36.300 [5]) transports the packets of an EPS bearer between a UE and an eNodeB. There is a one-to-one mapping between an EPS bearer and a radio bearer.
- An S1 bearer transports the packets of an EPS bearer between an eNodeB and a Serving GW.
- An S5/S8 bearer transports the packets of an EPS bearer between a Serving GW and a PDN GW.
- A UE stores a mapping between an uplink packet filter and a radio to create the binding between an SDF and a radio bearer in the uplink.
- A PDN GW stores a mapping between a downlink packet filter and an S5/S8a bearer to create the binding between an SDF and an S5/S8a bearer in the downlink.

- An eNodeB stores a one-to-one mapping between a radio bearer and an S1 to create the binding between a radio bearer and an S1 bearer in both the uplink and downlink.
- A Serving GW stores a one-to-one mapping between an S1 bearer and an S5/S8a bearer to create the binding between an S1 bearer and an S5/S8a bearer in both the uplink and downlink.

4.6.1.3 The EPS Bearer with IETF-based S5/S8

<to be written>

4.6.2 Bearer level QoS parameters

Each EPS bearer (GBR and Non-GBR) is associated with the following bearer level QoS parameters:

- Label.
- Allocation and Retention Priority (ARP).

A **Label** is a scalar that is used as a reference to access node-specific parameters that control bearer level packet forwarding treatment (e.g. scheduling weights, admission thresholds, queue management thresholds, link layer protocol configuration, etc.), and that have been pre-configured by the operator owning the access node (e.g. eNodeB). A one-to-one mapping of standardized Label values to standardized Label Characteristics (see clause 4.6.3) **will be captured in a 3GPP specification.**

Editor's Note: Need to add this to the "3GPP specification" and create formal reference.

NOTE 1: On the radio interface and on S1, each PDU (e.g. RLC PDU or GTP-u PDU) is indirectly associated with one Label via the bearer identifier carried in the PDU header. The same applies to the S5 and S8 interfaces if they are based on GTP-u.

The primary purpose of **ARP** is to decide whether a bearer establishment / modification request can be accepted or needs to be rejected in case of resource limitations (typically available radio capacity in case of GBR bearers). In addition, the ARP can be used (e.g. by the eNodeB) to decide which bearer(s) to drop during exceptional resource limitations (e.g. at handover). Once successfully established, a bearer's ARP shall not have any impact on the bearer level packet forwarding treatment (e.g. scheduling and rate control). Such packet forwarding treatment should be solely determined by the other bearer level QoS parameters: Label, GBR, MBR, and AMBR.

NOTE 2: The ARP should be understood as "Priority of Allocation and Retention"; not as "Allocation, Retention, and Priority". **A more precise definition of ARP, e.g. the encoding of 'retention', is left FFS.**

Each GBR bearer is additionally associated with the following bearer level QoS parameters:

- Guaranteed Bit Rate (GBR).
- Maximum Bit Rate (MBR).

The **GBR** denotes the bit rate that can be expected to be provided by a GBR bearer. The **MBR** limits the bit rate that can be expected to be provided by a GBR bearer (e.g. excess traffic may get discarded by a rate shaping function). The MBR may be greater than or equal to GBR for a particular GBR bearer.

Editor's note: Whether a Non-GBR bearer may also be associated with an MBR is FFS.

Editor's note: Rate-adaptation schemes are FFS.

Each PDN connection (i.e. IP address) is associated with the following IP-CAN session level QoS parameter:

- Aggregate Maximum Bit Rate (AMBR).

Multiple EPS bearers of the same PDN connection can share the same **AMBR**. That is, each of those EPS bearers could potentially utilize the entire AMBR, e.g. when the other EPS bearers do not carry any traffic. The AMBR limits the aggregate bit rate that can be expected to be provided by the EPS bearers sharing the AMBR (e.g. excess traffic may get discarded by a rate shaping function). AMBR applies to all Non-GBR bearers belonging to the same PDN connection. GBR bearers are outside the scope of AMBR.

All the AMBRs for different PDN accesses of a UE are transmitted to the MME from the HSS once the UE has attached to the network.

Editor's note: Further details related to the scope and the signalling of AMBR are FFS.

The GBR and MBR denote bit rates of traffic per bearer while AMBR denotes a bit rate of traffic per group of bearers. Each of those three bearer level QoS parameters has an uplink and a downlink component. On S1_MME the values of the GBR, MBR, and AMBR refer to the bit stream excluding the GTP-u header overhead on S1_U.

Editor's note: A more precise definition of GBR, MBR, and AMBR, e.g. whether those parameters only denote a bit rate or additionally also a token bucket size, is left FFS.

4.6.3 Standardized Label Characteristics

A Label Characteristic describes the bearer level packet forwarding treatment that is expected from an access node (e.g. eNodeB). A standardized Label Characteristic comprises the following elements:

- 1 Bearer Type (GBR or Non-GBR),
- 2 L2 Packet Delay Budget, and
- 3 L2 Packet Loss Rate.

A Label Characteristic is not signaled on any interface.

The **Bearer Type** determines if dedicated network resources related to a Guaranteed Bit Rate (GBR) value that is associated with an EPS bearer are permanently allocated (e.g. by an admission control function in the access node) at bearer establishment/modification (see clause 4.6.1).

The **L2 Packet Delay Budget (L2 PDB)** denotes the time that a link layer SDU (e.g., an IP packet) may reside within the link layer between an access node and a UE. The link layer may include a queue management function. For a certain Label Characteristic the value of the L2 PDB is the same in uplink and downlink. The purpose of the L2 PDB is to support the configuration of scheduling and link layer functions (e.g. the setting of scheduling priority weights and HARQ target operating points).

NOTE: For Non-GBR bearers, the L2 PDB denotes a "soft upper bound" in the sense that an "expired" link layer SDU, i.e. a link layer SDU that has exceeded the L2 PDB, does not need to be discarded (e.g. by RLC in E-UTRAN). The discarding (dropping) of packets is expected to be controlled by a queue management function, e.g. based on pre-configured dropping thresholds.

Sources running on a Non-GBR bearer should be prepared to experience congestion related packet drops and/or per packet delays that may exceed a given L2 PDB. This may for example occur during traffic load peaks or when the UE becomes coverage limited. See Annex B for details.

Sources running on a GBR bearer and sending at a rate smaller than or equal to GBR can in general assume that congestion related packet drops will not occur, and that per packet delays will not exceed a given L2 PDB. Exceptions (e.g. transient link outages) can always occur in a radio access system. The fraction of traffic sent on a GBR bearer at a rate greater than GBR may be treated like traffic on a Non-GBR bearer.

Editor's note: The handling of codecs such as AMR on GBR bearers with MBR>GBR needs to be studied further.

The **L2 Packet Loss Rate (L2 PLR)** determines the rate of SDUs (e.g. IP packets) that have been processed by the sender of a link layer ARQ protocol (e.g. RLC in E-UTRAN) but that are not successfully delivered by the corresponding receiver to the upper layer (e.g. PDCP in E-UTRAN). Thus, the L2 PLR denotes a rate of non congestion related packet losses. The purpose of the L2 PLR is to allow for appropriate link layer protocol configurations (e.g. RLC and HARQ in E-UTRAN). For a certain Label Characteristic the value of the L2 PLR is the same in uplink and downlink.

4.6.4 Interworking with PCC

- The EPS applies the PCC framework as defined in 3GPP TS 23.203 [6] for QoS policy control. The QoS parameters are conveyed in PCC rules (one PCC rule per SDF) over the S7 reference point. The SDF QoS parameters consist of a QoS Class Identifier (QCI) and authorised Guaranteed and Maximum Bit Rate values for

uplink and downlink. The QCI is a scalar that represents the QoS characteristics that the EPS is expected to provide for the SDF.

- The set of standardized QCIs and their characteristics that the PCRF in an EPS can select from is provided in Annex B table B.1. It is expected that the PCRF selects a QCI in such a way that the IP-CAN receiving it can support it.
- For E-UTRAN and for the same UE/PDN connection: SDFs associated with different QCIs shall not be mapped to the same EPS bearer.
- For E-UTRAN the value of the Label of an EPS bearer is identical to the value of the QCI of the SDF(s) mapped to that EPS bearer.

Editor's note: It is FFS whether the PCRF may select a different QCI due to a handover to a different RAT type.

Editor's note: It is FFS if the QCI table B.1 will be moved to the Rel-8 version of TS 23.203.

Editor's note: In case of UMTS access to the EPC, the standardized QCIs in table B.1 will be mapped to UMTS QoS characteristics. It is FFS how to update TS 23.203 Table A.3 for Rel-8 to align it with the standardized QCIs.

Editor's note: It is FFS whether ARP should be used to map SDFs with specific QCIs to EPS bearers and whether ARP should be introduced into the PCC rules to make this possible.

5 Functional Description and Information Flows

Editor's note: The principles of option B for MME separation (see annex H of 23.882) shall be used.

5.1 Control and User Planes

<This section specifies the protocol stacks on the control and user planes for each of the interfaces.>

5.2 Identities

< This section gives a high level overview of the identities used in EPC/E-UTRAN and their usage. The exact definitions will be in 23.003.>

5.2.1 EPS bearer identity

An EPS bearer identity uniquely identifies an EPS bearer for one UE accessing via E-UTRAN.

Editor's Note: One of use cases of this EPS bearer identity is in the dedicated bearer modification without QoS update procedure. In this procedure the MME needs to transfer the EPS bearer identity in NAS signalling to the UE to bind the updated TFT with related EPS bearer.

Editor's Note: The allocation of EPS bearer identity is FFS. The relationship between the NSAPI/RAB ID used in UMTS and EPS bearer identity is FFS.

5.2.2 S-TMSI

The MME shall allocate an S-Temporary Mobile Subscriber Identity (S-TMSI) to a user in order to support the subscriber identity confidentiality.

For paging, The S-TMSI identifies both the user and the serving MME.

For NAS signalling, the S-TMSI, sometimes in combination with the TAI identifies the UE. **It is FFS if and when the TAI is also needed to identify the UE.**

Within the S-TMSI, one field contains the identifier of the MME (e.g. MME colour code or NRI or others to identify MME is FFS) that allocated the S-TMSI. The identifier of MME is needed to ensure that the S-TMSI remains unique in a tracking area shared by multiple MMEs.

The structure of the S-TMSI is specified in 3GPP TS 23.003 [9].

NOTE: The combination of Tracking Area Code +MME Colour Code provides an MME identifier that is unique within the PLMN. (FFS)

5.2.3 Tracking Area Identity (TAI)

This is the identity used to identify tracking areas. The Tracking Area Identity is constructed from the MCC (Mobile Country Code), MNC (Mobile Network Code) and TAC (Tracking Area Code).

NOTE: Changes in the TAI of a cell can occur but are normally infrequent and linked with O+M activity.

5.2.4 eNodeB S1-AP UE Identity (eNB S1-AP UE ID)

This is the temporary identity used to identify a UE on the S1-MME reference point within the eNodeB. It is unique within the eNodeB per S1-MME reference point instance.

5.2.5 MME S1-AP UE Identity (MME S1-AP UE ID)

This is the temporary identity used to identify a UE on the S1-MME reference point within the MME. It is unique within the MME per S1-MME reference point instance.

5.3 Authentication, Security and Location Management

<This section describes the MM functionality and signalling flows for, eg attach, detach, identity check, paging, gateway selection, IP address allocation etc.>

5.3.1 IP Address allocation

One of the following ways shall be used to allocate IP addresses for the UE:

- a) The HPLMN allocates the IP address to the UE when the default bearer is activated (dynamic HPLMN address);
- b) The VPLMN allocates the IP address to the UE when the default bearer is activated (dynamic VPLMN address);
or
- c) The PDN operator or administrator allocates an IP address to the UE when the default bearer is activated (External PDN Address Allocation).

Editor's Note: It is FFS whether permanent (static) IP address allocation by the HPLMN will be supported in EPS.

The IP address allocated for the UE's default bearer shall also be used for the UE's dedicated bearers towards the same PDN. The IP address allocation for the multiple PDN GW case is FFS.

It is the HPLMN operator that shall define in the subscription whether a dynamic HPLMN or VPLMN address may be used.

5.3.2 Attach procedure

A UE/user needs to register with the network to receive services that require registration. This registration is described as Network Attachment. The always-on IP connectivity for UE/users of the EPS is enabled by establishing a default EPS bearer during Network Attachment. The PCC rules applied to the default EPS bearer may be predefined in the PDN GW and activated in the attachment by the PDN GW itself. The Attach procedure may trigger one or multiple Dedicated Bearer Establishment procedures to establish dedicated EPS bearer(s) for that UE. During the attach procedure, the UE may request for an IP address allocation. Terminals utilising only IETF based mechanisms for IP address allocation are also supported.

Editor's note: The specific triggers for the Dedicated Bearer Activation procedure(s), i.e. the initial step(s) of the procedure, are FFS in this case.

Editor's note: The procedure needs to cover also the case if the old node is an SGSN.

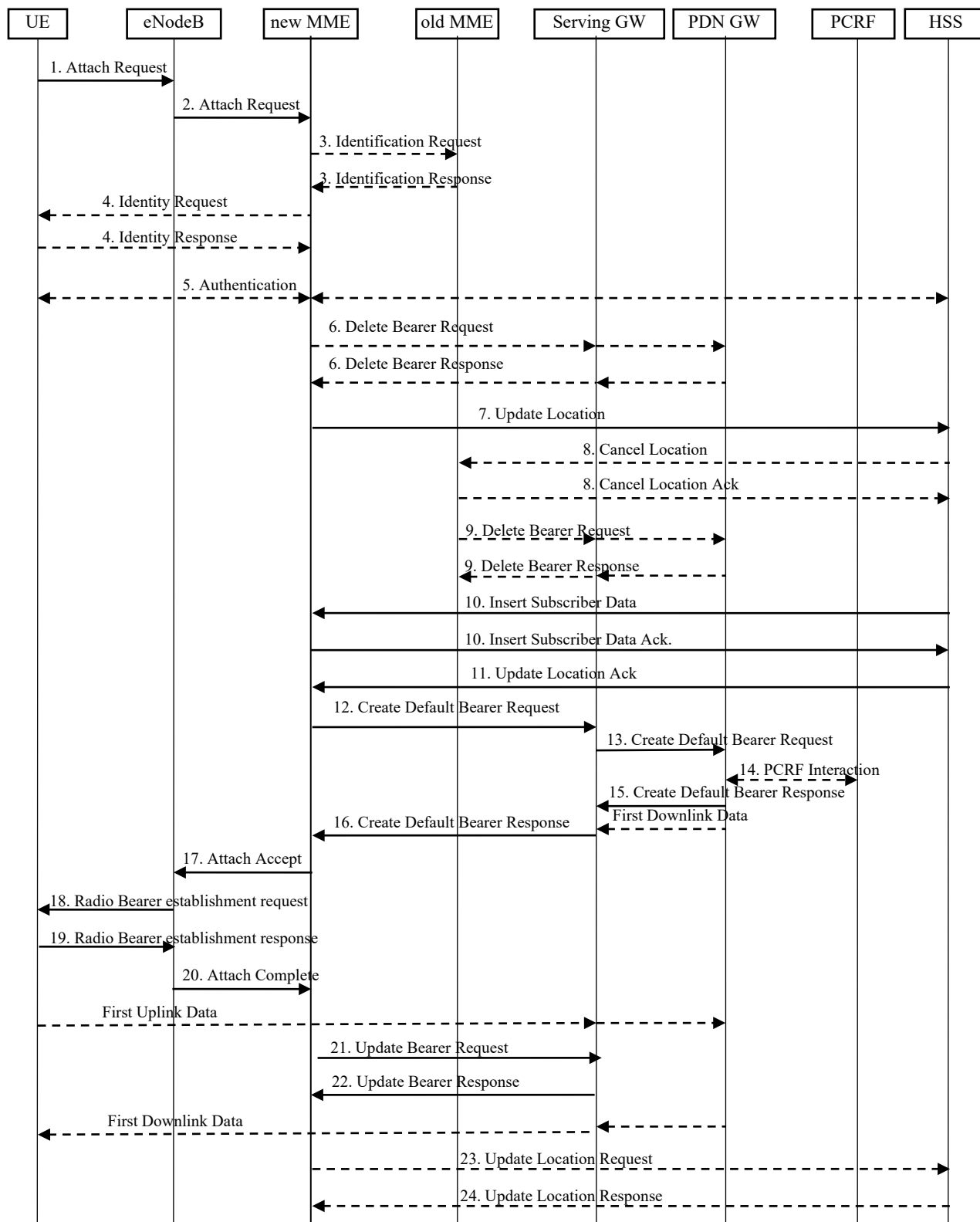


Figure 5.3.2-1: Attach Procedure

1. The UE initiates the Attach procedure by the transmission of an Attach Request (IMSI or S-TMSI and old TAI, UE Network Capability, PDN Address Allocation) message together with an indication of the Selected Network to the eNodeB. IMSI shall be included if the UE does not have a valid S-TMSI available. If the UE has a valid S-

TMSI, S-TMSI and the old TAI associated with S-TMSI shall be included. Selected Network indicates the PLMN that is selected for network sharing purposes. UE Network Capability is described in clause "UE capabilities". If a NAS security association between the UE and the MME already exists, the Attach Request message shall be integrity protected in order to allow validation of the UE by the MME. It is FFS if the Attach Request message, or any individual information elements included in it, may also be encrypted to ensure its confidentiality. The PDN Address Allocation includes the UE IP version information and a PDN address request (requested, not requested).

Editor's note: The eNodeB may need to read S-TMSI/IMSI or other information elements from NAS message (e.g. to derive MME routing), therefore it is assumed that at least these parts of that message are not encrypted.

Editor's note: It's assumed that all the radio capabilities of the UE that the eNodeB has to know in order to handle radio resources for this UE are sent to eNodeB upon RRC connection establishment.

Editor's note: the details of the meaning of IP version information are FFS.

Editor's note: It's FFS whether the other values of the PDN Address Allocation and related use should be considered.

2. The eNodeB derives the MME from the S-TMSI and from the indicated Selected Network. If no MME can be derived the eNodeB selects an MME as described in clause 4.3.7.3 on "MME selection function". The eNodeB forwards the Attach Request message to the new MME contained in a S1-MME control message (Initial UE message) together with the Selected Network and an indication of the E-UTRAN Area identity, a globally unique E-UTRAN ID of the cell from where it received the message to the new MME.
3. If the UE identifies itself with S-TMSI and the MME has changed since detach, the new MME sends an Identification Request (S-TMSI, old TAI) to the old MME to request the IMSI. The old MME responds with Identification Response (IMSI, Authentication Quintets). If the UE is not known in the old MME, the old MME responds with an appropriate error cause.
4. If the UE is unknown in both the old and new MME, the new MME sends an Identity Request to the UE to request the IMSI. The UE responds with Identity Response (IMSI).
5. If no UE context for the UE exists anywhere in the network, authentication is mandatory. Otherwise this step is optional. The authentication functions are defined in clause "Security Function". If performed, this step involves AKA authentication and establishment of a NAS level security association with the UE in order to protect further NAS protocol messages.
6. If there are active bearer contexts in the new MME for this particular UE (i.e. the UE re-attaches to the same MME without having properly detached before), the new MME deletes these bearer contexts by sending Delete Bearer Request (TEIDs) messages to the GWs involved. The GWs acknowledge with Delete Bearer Response (TEIDs) message.

Editor's note: The concept of bearer context needs to be defined.

7. If the MME has changed since the last detach, or if it is the very first attach, the MME sends an Update Location (MME Identity, IMSI) to the HSS.
8. The HSS sends Cancel Location (IMSI, Cancellation Type) to the old MME with Cancellation Type set to Update Procedure. The old MME acknowledges with Cancel Location Ack (IMSI) and removes the MM and bearer contexts.
9. If there are active bearer contexts in the old MME for this particular UE, the old MME deletes these bearer contexts by sending Delete Bearer Request (TEIDs) messages to the GWs involved. The GWs return Delete Bearer Response (TEIDs) message to the new MME.
10. The HSS sends Insert Subscriber Data (IMSI, Subscription Data) message to the new MME. The Subscription Data contains the Default APN. The new MME validates the UE's presence in the (new) TA. If due to regional subscription restrictions or access restrictions the UE is not allowed to attach in the TA, the new MME rejects the Attach Request with an appropriate cause, and may return an Insert Subscriber Data Ack message to the HSS. If subscription checking fails for other reasons, the new MME rejects the Attach Request with an appropriate cause and returns an Insert Subscriber Data Ack message to the HSS including an error cause. If all checks are successful then the new MME constructs a context for the UE and returns an Insert Subscriber Data Ack message to the HSS.

11. The HSS acknowledges the Update Location message by sending an Update Location Ack to the new MME. If the Update Location is rejected by the HSS, the new MME rejects the Attach Request from the UE with an appropriate cause.

Editor's note: Further considerations on subscription data handling needed, e.g. if transferred between MMEs, if insertion by separated procedure from HSS necessary or if Steps 10 and 11 can be combined as one message.

12. The new MME selects a Serving GW as described in clause 4.3.7.2 on Serving GW selection function and sends a Create Default Bearer Request (IMSI, MME Context ID, RAT type, Default Bearer QoS, PDN Address Information) message to the selected Serving GW. The RAT type is provided in this message for the later PCC decision.

Editor's note: it is FFS how static IP address allocation is managed.

13. The Serving GW creates a new entry in its EPS Bearer table and sends a Create Default Bearer Request (Serving GW Address for the user plane, Serving GW TEID of the user plane, Serving GW TEID of the control plane, RAT type, Default Bearer QoS, PDN Address Information) message to the PDN GW. After this step, the Serving GW buffers any downlink packets it may receive from the PDN GW until receives the message in step 21 below.

Editor's Note: It's FFS which entity will select the PDN GW.

Editor's Note: This step is for GTP based S5/S8 reference point, it's FFS for IETF based S5/S8 reference point.

14. The PDN GW may interact with the PCRF to get the default PCC rules for the UE if PCRF is applied in the network. This may optionally lead to the establishment of a number of dedicated bearers following the procedures defined in clause 5.4.1 in association with the establishment of the default bearer. **It is FFS how the establishment of the default and dedicated bearers is synchronized.**

The RAT type is provided to the PCRF by the PDN GW if received by the previous message. If the PDN GW/PCEF is configured to activate predefined PCC rules for the default bearer, the interaction with the PCRF is not required (e.g. operator may configure to do this) at the moment.

Editor's note: It is FFS which kind of information will be provided by the PCRF.

15. The PDN GW returns a Create Default Bearer Response (PDN GW Address for the user plane, PDN GW TEID of the user plane, PDN GW TEID of the control plane, PDN Address Information) message to the Serving GW. PDN Address Information is included if the PDN GW allocated a PDN address. based on PDN Address Allocation received in the Create Default Bearer Request. The PDN GW takes into account the UE IP Version Information and the policies of operator when the PDN GW allocates the PDN Address Information.

Editor's Note: This step is for GTP based S5/S8 reference point, it's FFS for IETF based S5/S8 reference point.

16. The Serving GW returns a Create Default Bearer Response (PDN Address Information, Serving GW address for User Plane, Serving GW TEID for User Plane, Serving GW Context ID) message to the new MME. PDN Address Information is included if it was provided by the PDN GW.

17. The new MME sends an Attach Accept (S-TMSI, PDN Address Information, TA List) message to the eNodeB. S-TMSI is included if the new MME allocates a new S-TMSI. This message is contained in an S1_MME control message Initial Context Setup Request. This S1 control message also includes the security context for the UE, Handover Restriction List and QoS information needed to set up the radio bearer, as well as the TEID at the Serving GW used for user plane and the address of the Serving GW for user plane. The PDN address information, if assigned by the PDN GW, is included in this message. Handover Restriction List contains roaming and area restrictions; its usage is described in clause **"Roaming and Area Restrictions"**.

18. The eNodeB sends Radio Bearer Establishment Request to the UE and the Attach Accept Message (S-TMSI, PDN address, TA List, PDN Address Information) will be sent along to the UE.

19. The UE sends the Radio Bearer Establishment Response (**FFS**) to the eNodeB. In this message, the Attach Complete Message will be included.

20. The eNodeB forwards the Attach Complete message to the new MME. On the S1_MME reference point, this message is contained in an S1_MME control message Initial Context Setup Complete. This S1 control message also includes the TEID of the eNodeB and the address of the eNodeB used for downlink traffic on the S1_U reference point.

After the Attach Accept message and once the UE has obtained a PDN Address Information, the UE can then send uplink packets towards the eNodeB which will then be tunnelled to the Serving GW and PDN GW.

21. The new MME sends an Update Bearer Request (eNodeB address, eNodeB TEID) message to the Serving GW.
22. The Serving GW acknowledges by sending Update Bearer Response to the new MME. The Serving GW can then send its buffered downlink packets.
- 23) After the MME receives Update Bearer Response in step 22, if an EPS bearer was established, the MME may send an Update Location Request including the PDN GW address to the HSS for mobility with non-3GPP accesses.
- 24) The HSS stores the PDN GW address and sends an Update Location Response to the MME.

Editor’s Note: The exact message name which is used to transfer the PDN GW address to the HSS is FFS.

5.3.3 Tracking Area Update procedures

5.3.3.1 Tracking Area Update procedure with MME and Serving GW change

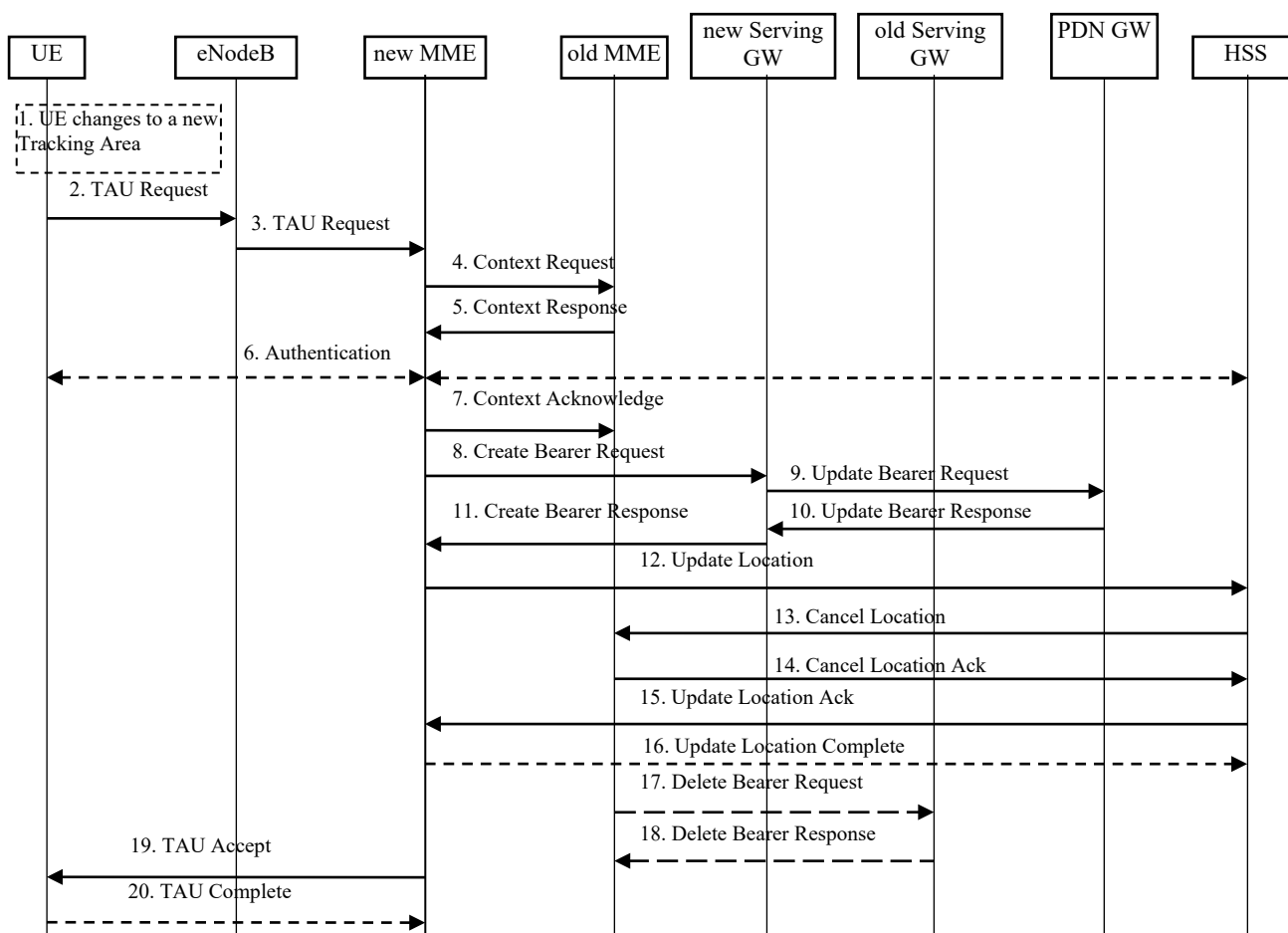


Figure 5.3.3-1: Tracking Area Update procedure with MME and Serving GW change

1. The UE detects a change to a new TA by discovering that its current TA is not in the list of TAs that the UE registered with the network.
2. The UE initiates the TAU procedure by sending a TAU Request (S-TMSI, old TAI and active flag) message together with an indication of the Selected Network to the eNodeB. The S-TMSI and the old TAI associated with S-TMSI shall be included. Selected Network indicates the network that is selected. Active flag is a request by UE to establish the user plane by the TAU procedure when the UE is in LTE-IDLE state.

Editor's note: FFS whether all or selected bearers shall be established as part of the TAU procedure when 'active flag' indicates that the UE wants to re-establish bearers.

3. The eNodeB derives the MME from the S-TMSI and from the indicated Selected Network. If no MME can be derived the eNodeB selects an MME as described in clause 4.3.7.3 on "MME Selection Function".

The eNodeB forwards the TAU Request message together with an indication of the E-UTRAN Area Identity, a globally unique EUTRAN ID, of the cell from where it received the message and with the Selected Network to the new MME.

4. The new MME sends a Context Request (S-TMSI, old TAI) message to the old MME to retrieve user information. The new MME derives the old MME from old TAI and old S-TMSI. If the new MME indicates that it has authenticated the UE or if the old MME correctly validates the UE, then the old MME starts a timer.

Editor's note: It is FFS if the legacy solution with S-TMSI Signature shall be used for integrity check of the message or if the NAS security functionality can be used.

5. The old MME responds with a Context Response (MME context (e.g. IMSI, Authentication Quintets, bearer contexts, Serving GW signalling Address and TEID(s)), Subscription Data) message. The PDN GW Address and TEID(s) is part of the Bearer Context. If the UE is not known in the old MME, the old MME responds with an appropriate error cause.

Editor's note: It is FFS if the Subscription Data may be sent from the old MME in the Context Response message.

6. The authentication functions are defined in clause "Security Function". Ciphering procedures are described in clause "Security Function". If S-TMSI allocation is going to be done and the network supports ciphering, the NAS messages shall be ciphered.
7. The new MME sends a Context Acknowledge message to the old MME. The old MME marks in its context that the information in the GWs and the HSS are invalid. This ensures that the old MME updates the GWs and the HSS if the UE initiates a TAU procedure back to the old MME before completing the ongoing TAU procedure. If the security functions do not authenticate the UE correctly, then the TAU shall be rejected, and the new MME shall send a reject indication to the old MME. The old MME shall continue as if the Identification and Context Request was never received.
8. The MME constructs an MM context for the UE. The new MME determines whether to relocate the Serving GW or not. The Serving GW is relocated when the old Serving GW cannot continue to serve the UE. The new MME may also decide to relocate the Serving GW in case a new Serving GW is expected to serve the UE longer and/or with a more optimal UE to PDN GW path, or in case a new Serving GW can be co-located with the PDN GW. Selection of a new Serving GW is performed according to clause 4.3.7.2 on "Serving GW selection function". If the new MME selected a new Serving GW it sends a Create Bearer Request (IMSI, bearer contexts, MME Context ID) message to the selected new Serving GW. The PDN GW address is indicated in the bearer Contexts.
9. The new Serving GW sends the message Update Bearer Request (Serving GW Address, Serving GW Tunnel Endpoint Identifier) to the PDN GW concerned.

Editor's note: Steps 9 and 10 are specific for the GTP based option of S5/S8

10. The PDN GW updates its bearer contexts and returns an Update Bearer Response (PDN GW address and TEID(s)) message.
11. The Serving GW updates its bearer context. This allows the Serving GW to route Bearer PDUs to the PDN GW when received from eNodeB.

The Serving GW returns a Create Bearer Response (MME Context ID, Serving GW address and TEID for user plane, Serving GW Context ID) message to the new MME.

12. The new MME sends an Update Location (MME Identity, IMSI) message to the HSS.
13. The HSS sends the message Cancel Location (IMSI, Cancellation Type) to the old MME with Cancellation Type set to Update Procedure.
14. If the timer started in step 4 is not running, the old MME removes the MM context. Otherwise, the contexts are removed when the timer expires. It also ensures that the MM context is kept in the old MME for the case the UE

initiates another TAU procedure before completing the ongoing TAU procedure to the new SGSN. The old MME acknowledges with the message Cancel Location Ack (IMSI).

15. The HSS acknowledges the Update Location (Subscription Data) message by sending an Update Location Ack message to the MME. If the Update Location is rejected by the HSS, the MME rejects the TAU Request from the UE with an appropriate cause sent in the TAU Reject message to the UE.

16) If subscription data was transferred in the Update Location Ack message the MME acknowledges the received Subscription Data by returning an Update Location Complete message to the HSS.

Editor's note: FFS if step 16 is needed. If the MME doesn't receive an Update Location Ack message from HSS, it will re-send the Update Location message.

17. When the old MME removes the MM context, the old MME deletes the EPS bearer resources by sending Delete Bearer Request (TEID) messages to the Serving GW. Cause indicates to the old Serving GW that the old Serving GW shall not initiate a delete procedure towards the PDN GW. If the Serving GW has not changed, the Serving GW does not delete the bearers. If the MME has not changed, step 11 triggers the release of EPS bearer resources when a new Serving GW is allocated.

18. The Serving GW acknowledges with Delete Bearer Response (TEID) messages.

19. The new MME validates the UE's presence in the (new) TA, after it has received valid and updated subscription data. If due to regional subscription restrictions or access restrictions the UE is not allowed to attach in the TA, the MME rejects the TAU Request with an appropriate cause. If subscription checking fails for other reasons, the MME rejects the TAU Request with an appropriate cause. If all checks are successful then the MME sends a TAU Accept (S-TMSI, TA list) message to the UE. S-TMSI is included if the MME allocates a new S-TMSI. If the "active flag" is set in the TAU Request message the user plane setup procedure can be activated in conjunction with the TAU Accept message. The procedure is described in detail in 3GPP TS 36.300 [5]. The message sequence should be the same as for the UE triggered Service Request procedure specified in clause 5.3.4.1 from the step when MME establishes the bearer(s).

20. If S-TMSI was changed, the UE acknowledges the received S-TMSI by returning a TAU Complete message to the MME.

5.3.3.2 Tracking Area Update between UTRAN and E-UTRAN

5.3.3.2.1 UTRAN Iu mode to E-UTRAN Tracking Area Update

The UTRAN to E-UTRAN Tracking Area Update procedure takes place when a UE registered with a 3G-SGSN selects an E-UTRAN cell. In this case, the UE changes to a Tracking Area that the UE has not yet registered with the network. This procedure is initiated by an idle state UE. This TA update case is illustrated in Figure 5.3.3.2-1.

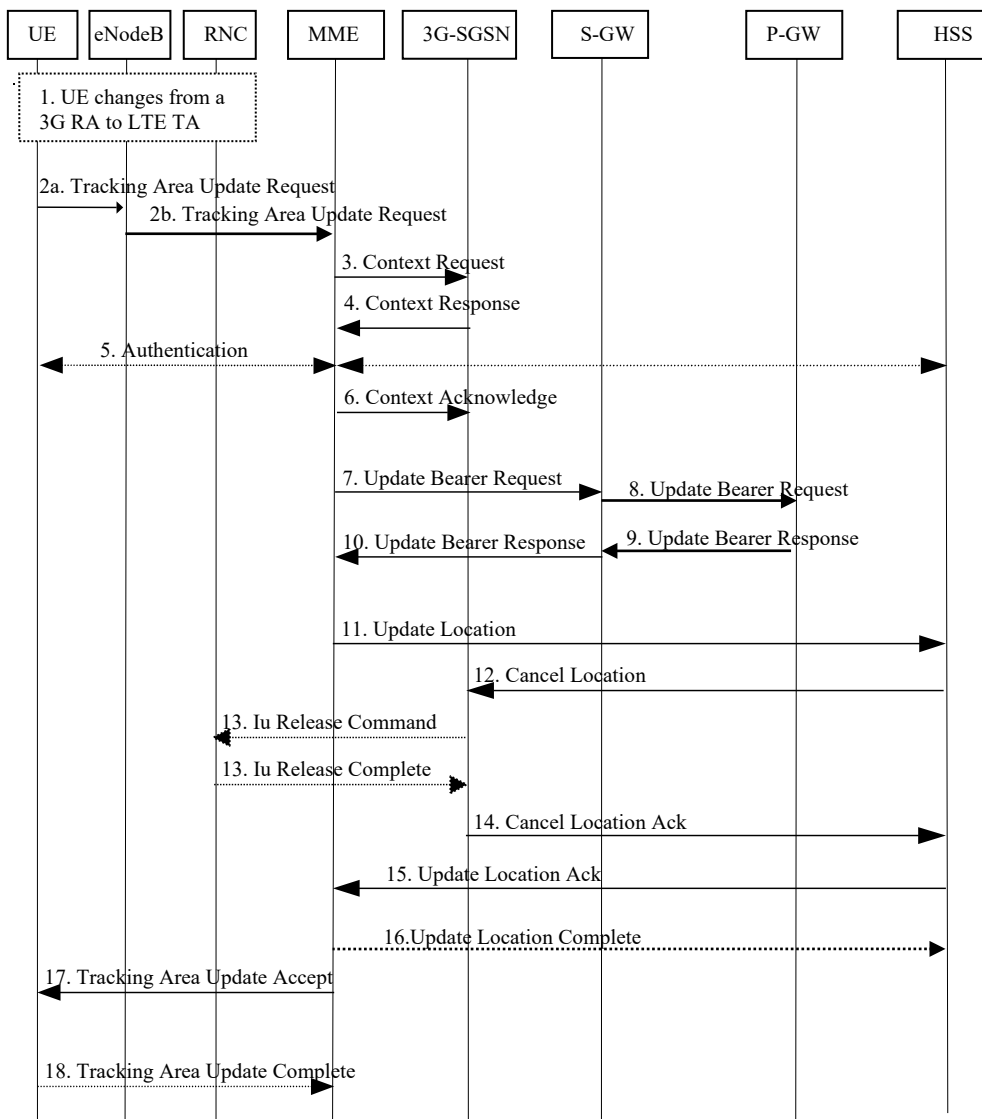


Figure 5.3.3.2-1: Tracking Area Update UTRAN to E-UTRAN

1. The UE selects an E-UTRAN cell of a Tracking Area which is not in the UE's TA list of TA's that the UE registered with the network.
 2. Tracking Area Update Request
 - a. The UE initiates a TAU procedure by sending a Tracking Area Update Request (old TAI, old S-TMSI, UE Network Capability, Selected Network, active flag) message to the eNodeB. Selected Network indicates the network that is selected. Active flag is a request by UE to establish the user plane by the TAU procedure. In the information element old TAI the UE indicates the RAI that the UE registered with the network. In the information element old S-TMSI, the UE indicates the P-TMSI that is allocated to the UE.
- Editor's note: FFS whether all or selected bearers shall be established as part of the TAU procedure when 'active flag' indicates that the UE wants to re-establish bearers.
- b. The eNodeB shall add the E-UTRAN Area Identity before forwarding the message to the MME. This E-UTRAN Area identity globally unique E-UTRAN ID for the eNodeB the UE is connected to the eNodeB derives the MME from the P-TMSI and the indicated Selected Network. If no MME can be derived the eNodeB selects the MME as described in clause 4.3.7.3 on "MME Selection Function". The eNodeB forwards the TAU Request message together with an indication of the Cell Global Identity of the cell from where it received the message and with the Selected Network to the MME.
3. The new MME sends a Context Request (old RAI, old P-TMSI, MME Address) message to the old SGSN to retrieve the user information. The MME derives the old SGSN from the old RAI and old P-TMSI. P-TMSI

Signature is used by the SGSN for integrity check. If the new MME indicates that it has authenticated the UE or if the SGSN authenticates the UE, the old MME starts a timer.

Editor's note: it is FFS how the old SGSN validates the TAU Request.

4. The old SGSN responds with a Context Response (3G-SGSN Context) message. PDN GW Address, Serving GW Address and Subscription Data are part of the 3G-SGSN Context. The MME shall ignore the UE Network Capability contained in the 3G-SGSN Context of SGSN Context Response only when it has previously received an UE Network Capability in the Tracking Area Update Request. If the UE is not known in the SGSN, the SGSN responds with an appropriate error cause.

Editor's note: it is FFS if subscriber data is sent in this step.

5. Authentication functions and ciphering procedures are defined in the clause "**Security Function**". Security functions may be executed.
6. The MME sends a Context Acknowledge message to the old SGSN. The SGSN marks in its context that the information in the GWs and the HSS are invalid. This ensures that the SGSN updates the GWs and the HSS if the UE initiates a TAU procedure back to the SGSN before completing the ongoing TAU procedure. If the security functions do not authenticate the UE correctly, then the TAU shall be rejected, and the MME shall send a reject indication to the old SGSN. The old SGSN shall continue as if the Identification and Context Request was never received.
7. The MME sends an Update Bearer Request (new MME address and TEID, QoS Negotiated, Serving network identity) message to the selected new Serving GW. The PDN GW address is indicated in the bearer contexts.

Editor's note: it is FFS how to handle the case when the UE has no PDP contexts.

8. The Serving GW informs the PDN GW(s) the change of for example the RAT type that e.g. can be used for charging, by sending the message Update Bearer Request (Serving GW Address and TEID, RAT type, etc.) to the PDN GW(s) concerned.
9. The PDN GW updates its context field to allow DL PDUs to be routed to the correct Serving GW. PDN GW returns an Update Bearer Response (PDN GW address and TEID, etc.) to the Serving GW.
10. The Serving GW updates its bearer context. This allows the Serving GW to route Bearer PDUs to the PDN GW when received from eNodeB. The Serving GW returns an Update Bearer Response (Serving GW address and TEID, PDN GW Address and TEID) message to the new MME.
11. The new MME informs the HSS of the change of SGSN to MME by sending an Update Location (MME Id, IMSI) message to the HSS.
12. The HSS sends a Cancel Location (IMSI, Cancellation type) message to the old SGSN with a Cancellation Type set to Update Procedure.
13. If the UE is Iu Connected, the old SGSN sends an Iu Release Command message to the RNC. The RNC responds with an Iu Release Complete message.
14. If the timer started in step 3 is not running, the SGSN removes the MM context. Otherwise, the contexts are removed when the timer expires. It also ensures that the MM context is kept in the SGSN for the case the UE initiates another TAU procedure before completing the ongoing TAU procedure to the new MME. The old SGSN acknowledges with a Cancel Location Ack (IMSI) message.
15. The HSS acknowledges the Update Location by returning an Update Location Ack (IMSI) message to the new MME after the cancelling of the old SGSN context is finished. If the Update Location is rejected by the HSS, the MME rejects the TAU Request from the UE with an appropriate cause sent in the TAU Reject message to the UE. If needed the HSS includes Subscription Data in the Update Location Ack message to the new MME.

Editor's note: It is FFS if subscriber data is included in this step, or it is sent in an Insert Subscriber Data message.

16. If Subscription Data was updated from the HSS the new MME acknowledge the received subscription data with an Update Location Complete message to the HSS.

Editor's note: It is FFS if this step is needed.

17. The MME validate the UE's presence in the new TA, after it has received valid and updated subscription data. If due to regional subscription restrictions or access restrictions the UE is not allowed to attach in the TA, the MME rejects the Attach Request with an appropriate cause sent in the TAU Reject message to the UE. If validation is successful the MME responds to the UE with a Tracking Area Update Accept (S-TMSI, TA-list) message. Restriction list shall be sent to eNodeB as eNodeB handles the roaming restrictions and access restrictions in the Intra E-UTRAN case. If the "active flag" is set in the TAU Request message the user plane setup procedure can be activated in conjunction with the TAU Accept message. The procedure is described in detail in 3GPP TS 36.300 [5]. The message sequence should be the same as for the UE triggered Service Request procedure specified in clause 5.3.4.1 from the step when MME establish the bearers(s).

18. If the S-TMSI was changed the UE acknowledges the new S-TMSI by returning a Tracking Area Update Complete message to the MME.

5.3.3.2.2 E-UTRAN to UTRAN Iu Mode Routing Area Update

The E-UTRAN to UTRAN Routing Area Update procedure takes place when a UE that is registered with an MME selects a UTRAN cell. In this case, the UE changes to a Routing Area that the UE has not yet registered with the network. This procedure is initiated by an idle state UE. The RA update case is illustrated in Figure 5.3.3.2-2.

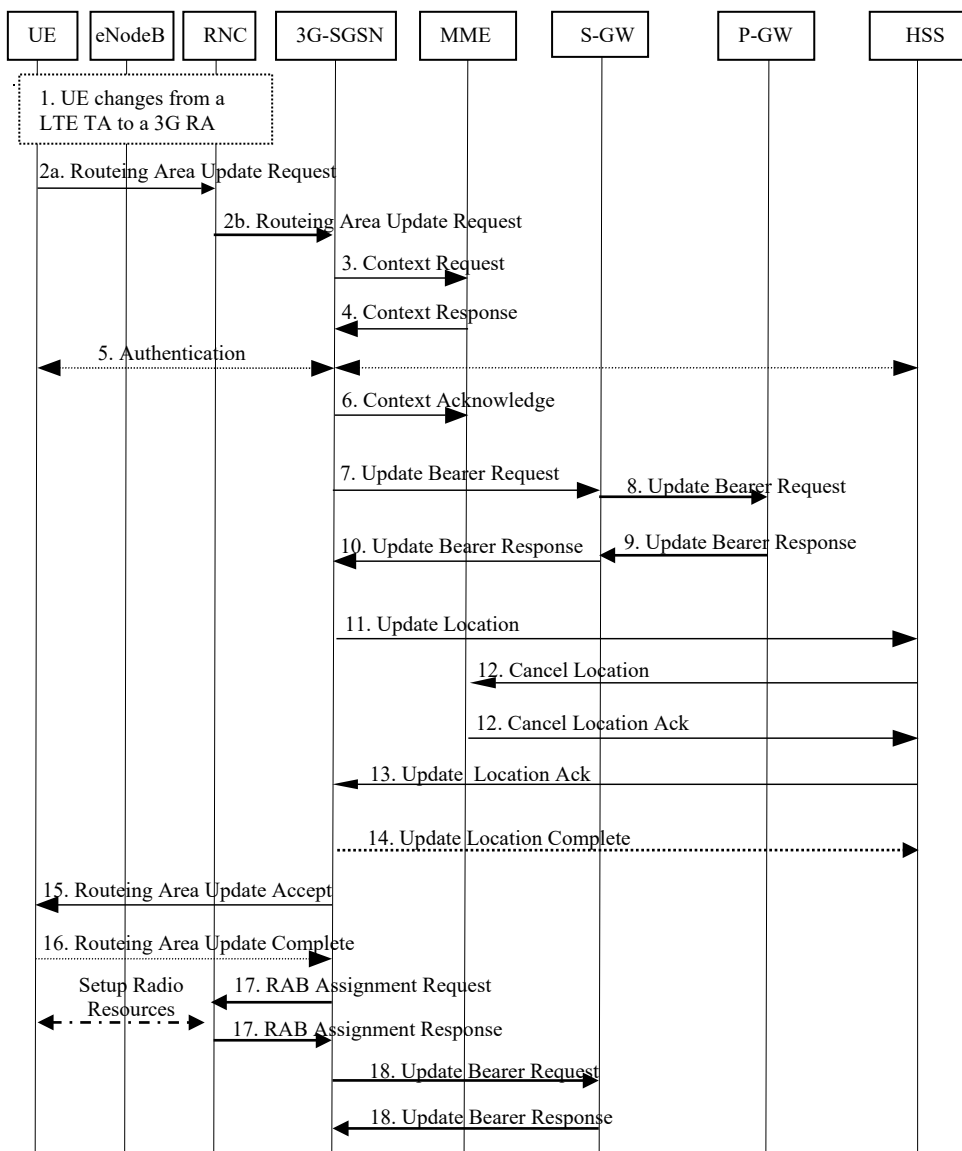


Figure 5.3.3.2-2: E-UTRAN to UTRAN RA Update

1. The UE selects a UTRAN cell. This cell is in a Routing Area that is not yet registered with the network.
2. Routing Area Update Request
 - a. The UE sends a Routing Area Update Request (old P-TMSI, old RAI, UE Network Capability) message to the SGSN. In the information element old RAI the UE indicates one TA from the TA list the UE registered with the network. In the information element old P-TMSI the UE indicates the S-TMSI that is allocated to the UE. If the UE has a follow-on request, i.e. if there is pending uplink traffic (signalling or data). The SGSN may use, as an implementation option, the follow-on request indication to release or keep the Iu connection after the completion of the RA update procedure.
 - b. The RNC shall add the Routing Area Identity before forwarding the message to the SGSN. This RA identity corresponds to the RAI in the MM system information sent by the RNC to the MS.
3. The new SGSN uses the old TAI and old S-TMSI received from the UE to derive the MME address, and sends a Context Request (old TAI, old S-TMSI, New SGSN Address) message to the MME to get the context for the UE. If the new SGSN indicates that it has authenticated the UE or if the old MME authenticates the UE, the old MME starts a timer.
4. The old MME responds with an Context Response (MME Context) message. The PDN GW address, Serving GW address and subscription data is part of the MME Context. The new SGSN shall ignore the UE Network Capability contained in the context of Context Response only when it has previously received an UE Network Capability in the Routing Area Update Request. If UE is not known in the old MME, the old MME responds with a appropriate error cause.

Editor's note: it is FFS if subscriber data is sent in this step.

5. Authentication functions and ciphering procedures are defined in the clause “Security Function”. Security functions may be executed.
6. The new SGSN sends an Context Acknowledge message to the old MME. The old MME marks in its context that the information in the GWs and the HSS are invalid. This ensures that the old MME updates the GWs and the HSS if the UE initiates a TAU procedure back to the old MME before completing the ongoing TAU procedure.
7. The SGSN sends an Update Bearer Request (new SGSN Address and TEID, QoS Negotiated, serving network identity, RAT type) message to the Serving GW.
8. The Serving GW informs the PDN GW(s) the change of for example the RAT type that e.g. can be used for charging, by sending the message Update Bearer Request (Serving GW Address and TEID, RAT type, etc.) to the PDN GW(s) concerned.
9. The PDN GW updates its context field and returns an Update Bearer Response (PDN GW address and TEID, etc.) message to the Serving GW.
10. The Serving GW updates its context fields and returns an Update Bearer Response (Serving GW address and TEID, PDN GW address and TEID, etc) message.
11. The new SGSN informs the HSS of the change of MME to SGSN by sending an Update Location (SGSN Number, SGSN Address, IMSI) message to the HSS.
12. The HSS sends a Cancel Location (IMSI, Cancellation Type) message to the old MME with the Cancellation Type set to Update Procedure.
If the timer started in step 3 is not running, the old MME removes the MM context. Otherwise, the contexts are removed when the timer expires. It also ensures that the MM context is kept in the old MME for the case the UE initiates another TAU procedure before completing the ongoing TAU procedure to the new SGSN. The old MME acknowledges with a Cancel Location Ack (IMSI) message.
13. The HSS acknowledges the Update Location by returning an Update Location Ack (IMSI, Subscription Data) message to the new SGSN. If needed the HSS includes Subscription Data in the Update Location Ack message to the new SGSN. If the Update Location is rejected by the HSS, the SGSN rejects the RAU Request from the UE with an appropriate cause sent in the RAU Reject message to the UE.

Editor's note: It is FFS if subscriber data is included in this step, or it is sent in an Insert Subscriber Data message.

14. If Subscription Data was updated from the HSS the new SGSN acknowledge the received subscription data with an Update Location Complete message to the HSS.

Editor's note: It is FFS if this step is needed.

15. The new SGSN validate the UE's presence in the new RA, after it has received valid and updated subscription data. If due to roaming restrictions or access restrictions the UE is not allowed to be attached in the RA, or if subscription checking fails, the new SGSN rejects the routeing area update with an appropriate cause sent in the RAU reject message to the UE.

If validation is successful the new SGSN responds to the UE with a Routeing Area Update Accept (P-TMSI, P-TMSI signature, TA-list) message to the UE. P-TMSI is included if the SGSN allocates a new P-TMSI.

16. If P-TMSI was changed, the UE acknowledges the new P-TMSI by returning a Routeing Area Update Complete message to the SGSN.

17. If the UE has uplink data or signalling pending it shall send a Service Request (P-TMSI, RAI, CKSN, Service Type) message to the SGSN. Service Type specifies the requested service. Service Type shall indicate one of the following: Data or Signalling.

18. If the UE has sent the Service Request, the new 3G-SGSN requests the RNC to establish a radio access bearer by sending a RAB Assignment Request (RAB ID(s), QoS Profile(s), GTP-SNDs, GTP-SNUs, PDCP-SNUs) message to the RNC. If Direct Tunnel is established the SGSN provides to the RNC the Serving GW's Address for User Plane and TEID for uplink data.

19. If the SGSN established Direct Tunnel in step 18) it shall send Update PDP Context Request to the Serving GW and include the RNC's Address for User Plane and downlink TEID for data. The Serving GW updates the Address for User Plane and TEID for downlink data and return an Update PDP Context Response.

5.3.3.3 Tracking Area Update GERAN – E-UTRAN

5.3.3.3.1 GERAN A/Gb mode to E-UTRAN Tracking Area Update

The GERAN to E-UTRAN Tracking Area Update procedure takes place when a UE registered with an SGSN selects an E-UTRAN cell. In this case, the UE changes to a Tracking Area that the UE has not yet registered with the network. This procedure is initiated by an idle state UE and may also be initiated if the UE is in Active state. This TA update case is illustrated in Figure 5.3.3.3-1.

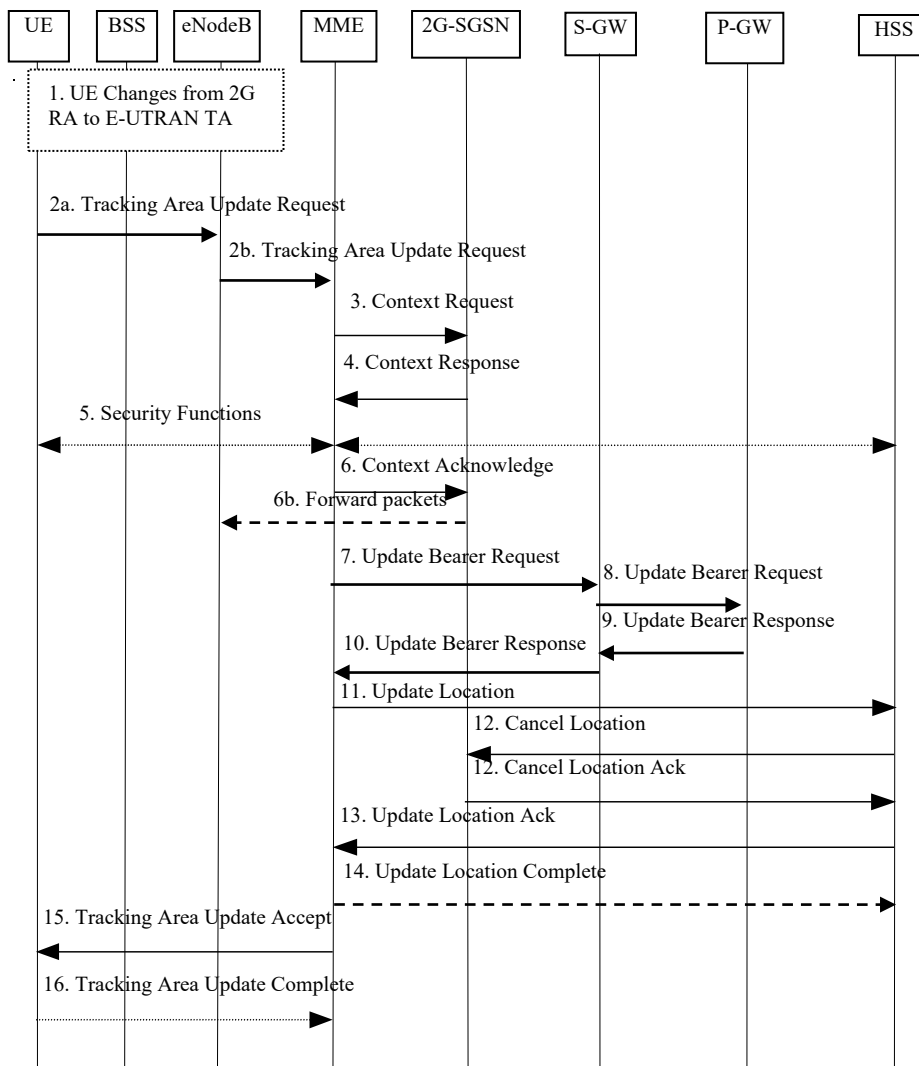


Figure 5.3.3.3-1: GERAN A/Gb mode to E-UTRAN Tracking Area Update

1. The UE selects an E-UTRAN cell of a Tracking Area that is not in the list of TAs that the UE registered with the network.
- 2a. The UE sends a Tracking Area Update Request (old S-TMSI, old TAI, UE Network Capability, active flag) message to the new MME. Active flag is a request by UE to establish the user plane by the TAU procedure. In the information element old TAI the UE indicates its RAI. In the information element old S-TMSI, the UE indicates the P-TMSI that is allocated to the UE.

Editor's note: FFS whether all or selected bearers shall be established as part of the TAU procedure when 'active flag' indicates that the UE wants to re-establish bearers.

- 2b. The eNodeB shall add the E-UTRAN Area Identity before forwarding the message to the MME. This E-UTRAN Area identity globally unique E-UTRAN ID for the eNodeB the UE is connected to.
3. The new MME uses the old RAI received from the UE to derive the old 2G-SGSN address, and sends a Context Request (old RAI, old P-TMSI, New MME Address) message to the old 2G-SGSN to get the contexts for the UE. The old 2G-SGSN validates the old P-TMSI Signature and responds with an appropriate error cause if it does not match the value stored in the old 2G-SGSN. If the received old P-TMSI Signature does not match the stored value, the old 2G-SGSN should initiate the security functions in the new MME. If the security functions authenticate the UE correctly, the new MME shall send a Context Request (old RAI, IMSI, UE Validated, New MME Address) message to the old 2G-SGSN. UE Validated indicates that the new MME has authenticated the UE. If the old P-TMSI Signature was valid or if the new MME indicates that it has authenticated the UE correctly. If the new MME indicates that it has authenticated the UE or if the old 2G-SGSN authenticates the UE, the old 2G-SGSN starts a timer.

Editor's note: it is FFS how the old SGSN validates the TAU Request.

4. The old 2G-SGSN responds with a Context Response (2G-SGSN Context) message. The PDN GW Address and Serving GW Address is part of the 2G-SGSN Context. The new MME shall ignore the UE Network Capability contained in 2G-SGSN Context of Context Response only when it has previously received an UE Network Capability in the Tracking Area Request. The 2G-SGSN Context includes also the Subscriber Data. If the UE is not known in the old 2G-SGSN, the old 2G-SGSN responds with an appropriate error cause.

Editor's note: it is FFS if subscriber data is sent in this step.

5. Security functions may be executed. Procedures are defined in the clause "Security Function".
6. The new MME sends a Context Acknowledge message to the old 2G-SGSN. The old 2G-SGSN marks in its context that the information in the GWs and the HSS are invalid. This ensures that the old 2G-SGSN updates the GWs and the HSS if the UE initiates a TAU procedure back to the old 2G-SGSN before completing the ongoing TAU procedure.
Forwarding occurs if applicable.

Editor's note: It is FFS if data forwarding needs to be avoided for this procedure.

7. The new MME sends an Update Bearer Request (new MME Address and TEID, QoS Negotiated, serving network identity) message to the Serving GW. The MME shall send the serving network identity to the Serving GW.

Editor's note: it is FFS how to handle the case when the UE has no PDP contexts.

8. The Serving GW informs the PDN GW(s) about the change of the RAT type. The Serving GW sends an Update Bearer Request (Serving GW Address and TEID, RAT type, etc.) message to the PDN GW(s) concerned.
9. The PDN GW updates its context field and returns an Update Bearer Response (PDN GW address and TEID, etc.) message to the Serving GW.
10. The Serving GW updates its context and returns an Update Bearer Response (Serving GW address and TEID, PDN GW address and TEID, etc.) message.
11. The new MME informs the HSS of the change of SGSN by sending an Update Location (MME Address, IMSI) message to the HSS.
12. The HSS sends a Cancel Location (IMSI, Cancellation Type) message to the old 2G-SGSN. The old 2G-SGSN removes the contexts.
If the timer started in step 3 is not running, the old 2G-SGSN removes the MM context. Otherwise, the contexts are removed when the timer expires. It also ensures that the MM context is kept in the old 2G-SGSN for the case the UE initiates another TAU procedure before completing the ongoing TAU procedure to the new MME. The old 2G-SGSN acknowledges with a Cancel Location Ack (IMSI) message.
13. The HSS acknowledges the Update Location by returning an Update Location Ack (IMSI, Subscriber Data) message to the new MME. If needed the HSS includes also Subscriber Data in the Update Location Ack message to the new MME. If the Update Location is rejected by the HSS, the MME rejects the TAU Request from the UE with an appropriate cause sent in the TAU Reject message to the UE.

Editor's note: It is FFS if subscriber data is included in this step, or it is sent in an Insert Subscriber Data message.

14. If Subscription Data was updated from the HSS the new MME acknowledges the received subscriber data with an Update Location Complete message to the HSS.

Editor's note: It is FFS if this step is needed.

15. The new MME validate the UE's presence in the new TA, after it has received valid and updated subscription data. If due to roaming restrictions or access restrictions the UE is not allowed to be attached in the TA, or if subscription checking fails, the new MME rejects the tracking area update with an appropriate cause sent in the TAU Reject message to the UE.
If all checks are successful, the new MME responds to the UE with a Tracking Area Update Accept (S-TMSI, TA-list) message. If the "active flag" is set in the TAU Request message the user plane setup procedure can be activated in conjunction with the TAU Accept message. The procedure is described in detail in 3GPP TS 36.300

[5]. The messages sequence should be the same as for the UE triggered Service Request procedure specified in clause 5.3.4.1 from the step when MME establishes the bearer(s).

16. If the S-TMSI was changed, the UE acknowledges the new S-TMSI by returning a Tracking Area Update Complete message to the MME.

5.3.3.3.2 E-UTRAN to GERAN Routeing Area Update

The E-UTRAN to GERAN Routeing Area Update procedure takes place when a UE that is registered with an MME selects a GERAN cell. In this case, the UE changes to a Routeing Area that the UE has not yet registered with the network.. This procedure is initiated by an idle state UE and may also be initiated if the UE is in Active state. This RA update case is illustrated in Figure 5.3.3.3-2.

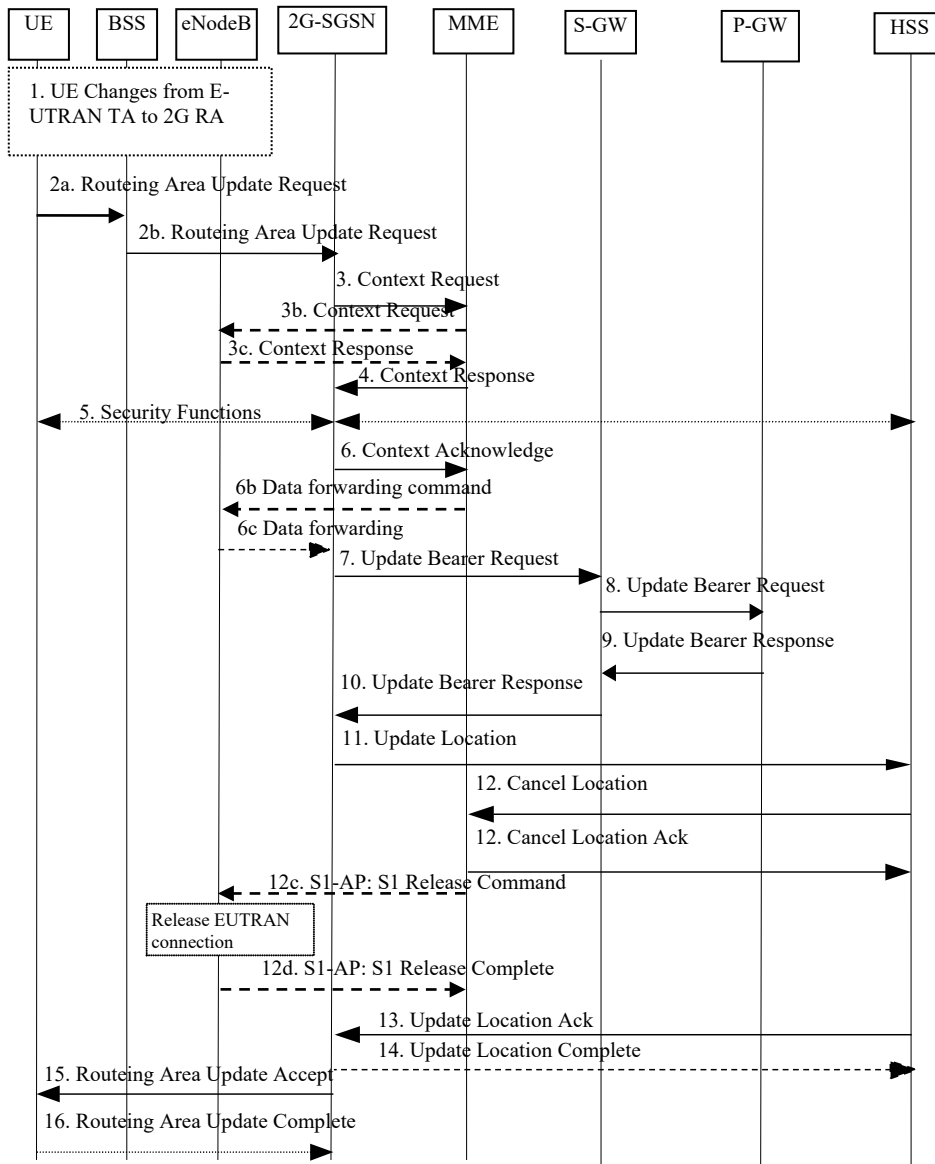


Figure 5.3.3.3-2: E-UTRAN to GERAN A/Gb mode Routeing Area Update

1. The UE selects a GERAN cell. This cell is in a Routeing Area that is not yet registered with the network.
- 2a. The UE sends a Routeing Area Update Request (old RAI, old P-TMSI, UE Network Capability) message to the new 2G-SGSN. In the information element old RAI the UE indicates one TA from the TA list the UE registered with the network. In the information element old P-TMSI, the UE indicates the S-TMSI that is allocated to the UE.

- 2b. The BSS shall add the Cell Global Identity (CGI) of the cell where the UE is located before passing the message to the new 2G-SGSN.
3. The new 2G-SGSN uses the old TAI and old S-TMSI received from the UE to derive the old MME address, and sends a Context Request (old TAI, old S-TMSI, New SGSN Address) message to the old MME to get the context for the UE. If the UE is not known in the old MME, the old MME responds with an appropriate error cause. If the new 2G-SGSN indicates that it has authenticated the UE or if the old MME authenticates the UE, the old MME starts a timer.
- 3b. If the UE was in LTE_Active state, the source MME sends a Context Request message to the source eNodeB. The source eNodeB begins buffering downlink packets for forwarding rather than transmitting them to the UE.
- 3c. The source eNodeB sends a Context Response message to the source MME. Data forwarding is optional.

Editor's note: It is FFS if data forwarding needs to be avoided for this procedure.

4. The old MME responds with a Context Response (MME Context) message. The PDN GW Address and Serving GW Address are part of the context. The new 2G-SGSN shall ignore the UE Network Capability contained in MME Context of Context Response only when it has previously received an UE Network Capability in the Routing Area Request. The MME Context includes also the Subscriber Data.

Editor's note: it is FFS if subscriber data is sent in this step.

5. Security functions may be executed. Procedures are defined in the clause "Security Function".
6. The new 2G-SGSN sends a Context Acknowledge message to the old MME. The old MME marks in its context that the information in the GWs and the HSS are invalid. This ensures that the old MME updates the GWs and the HSS if the UE initiates a RAU procedure back to the old MME before completing the ongoing RAU procedure.
If packets are to be forwarded, the source MME sends a Data Forwarding Command message to trigger the source eNodeB to begin data forwarding. Forwarding occurs if applicable.

Editor's note: It is FFS if data forwarding needs to be avoided for this procedure.

7. The new 2G-SGSN sends an Update Bearer Request (new SGSN Address and TEID, QoS Negotiated, serving network identity, RAT type) message to the Serving GW.
8. The Serving GW informs the PDN GW(s) about the change of the RAT type. The Serving GW sends an Update Bearer Request (Serving GW Address and TEID, RAT type, etc.) message to the PDN GW(s) concerned.
9. The PDN GW updates its context field and returns an Update Bearer Response (PDN GW address and TEID, etc.) message to the Serving GW.
10. The Serving GW updates its context and returns an Update Bearer Response (Serving GW address and TEID, PDN GE address and TEID, etc.) message to the SGSN.
11. The new 2G-SGSN informs the HSS of the change of SGSN by sending an Update Location (SGSN Number, SGSN Address, IMSI) message to the HSS.
12. If the timer started in step 3 is not running, the old MME removes the MM context. Otherwise, the contexts are removed when the timer expires. It also ensures that the MM context is kept in the old MME for the case the UE initiates another RAU procedure before completing the ongoing RAU procedure to the new 2G-SGSN. The HSS sends a Cancel Location (IMSI) message to the old MME. The old MME acknowledges with a Cancel Location Ack (IMSI) message.

If the old MME has an S1-MME association for the UE, the source MME sends a S1-U Release Command to the source eNodeB. **It is FFS what triggers the sending of this message.** The RRC connection is released by the source eNodeB. The source eNodeB confirms the release of the RRC connection and of the S1-U connection by sending a S1-U Release Complete message to the source MME.

13. The HSS acknowledges the Update Location by returning an Update Location Ack (IMSI, Subscriber Data) message to the new 2G-SGSN. If needed, the HSS includes also Subscriber Data in the Update Location Ack message to the new 2G-SGSN. If the Update Location is rejected by the HSS, the 2G-SGSN rejects the RAU Request from the UE with an appropriate cause sent in the RAU Reject message to the UE.

Editor's note: It is FFS if subscriber data is included in this step, or it is sent in an Insert Subscriber Data message.

14. If Subscription Data was updated from the HSS, the new 2G-SGSN acknowledges the received subscriber data with an Update Location Complete message to the HSS.

Editor's note: It is FFS if this step is needed.

15. The new 2G-SGSN validates the UE's presence in the new RA, after it has received valid and updated subscription data. If due to roaming restrictions or access restrictions the UE is not allowed to be attached in the RA, or if subscription checking fails, the new 2G-SGSN rejects the routeing area update with an appropriate cause sent in the RAU Reject message to the UE. If all checks are successful, the new 2G-SGSN constructs contexts for the UE. The new 2G-SGSN responds to the UE with a Routeing Area Update Accept (P-TMSI, P-TMSI Signature, etc.) message.

16. If the P-TMSI was changed, the UE acknowledges the new P-TMSI by returning a Routeing Area Update Complete message to the SGSN.

5.3.4 Service Request procedures

5.3.4.1 UE triggered Service Request

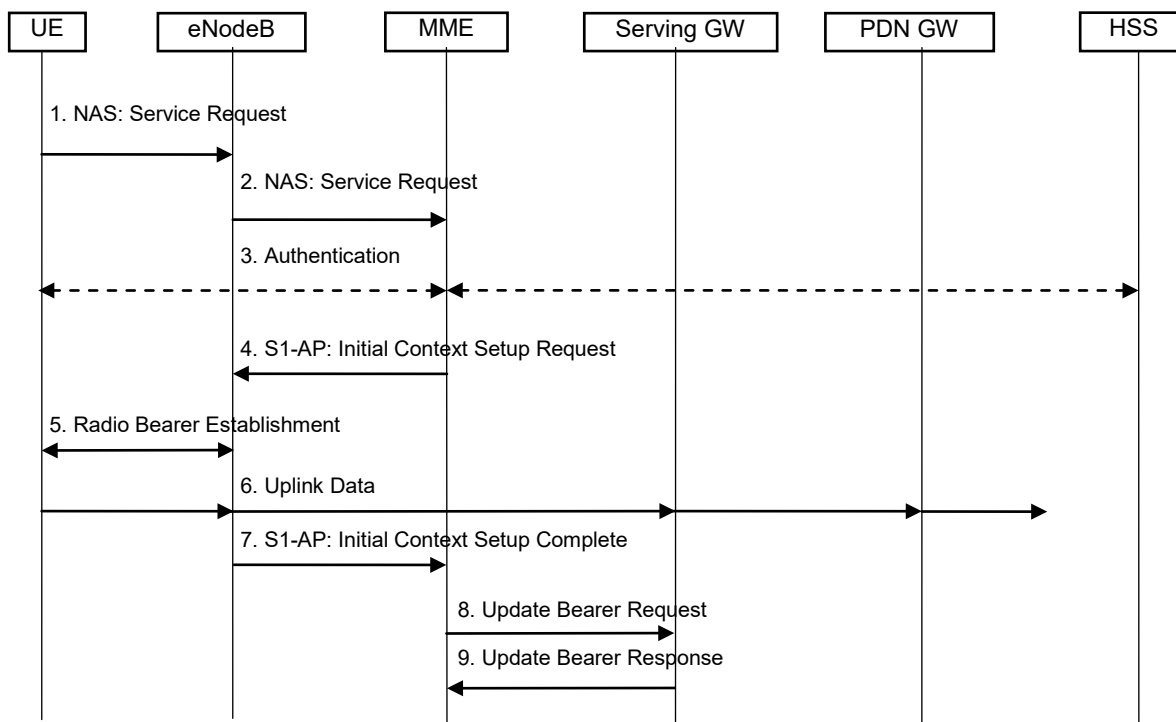


Figure 5.3.4-1: UE triggered Service Request procedure

1. The UE sends NAS message Service Request (S-TMSI, TAI, Service Type) towards the MME encapsulated in an RRC message to the eNodeB. The RRC message(s) that can be used to carry this NAS message are described in 3GPP TS 36.300 [5].
2. The eNodeB forwards NAS message to MME. NAS message is encapsulated in an S1-AP: *Initial UE Message* (NAS message, Cell Global ID of the serving cell). Details of this step are described in 3GPP TS 36.300 [5].
3. NAS authentication procedures may be performed.
4. The MME sends S1-AP Initial Context Setup Request (Serving GW address, S1-TEID(s) (UL), Bearer QoS(s), Security Context, MME Signalling Connection Id) message to the eNodeB. This step activates the radio and S1 bearers for the default bearer and the pre-established dedicated bearers. The need for a mechanism to activate only a subset of the existing EPS bearers is FFS. The eNodeB stores the Security Context, MME Signalling

Connection Id, Bearer QoS profile(s) and S1-TEID(s) in the UE RAN context. The step is described in detail in 3GPP TS 36.300 [5].

5. The eNodeB performs the radio bearer establishment procedure. The user plane security mode is established at this step. This step implicitly confirms the Service Request. This step is described in detail in 3GPP TS 36.300 [5].
6. The uplink data from the UE can now be forwarded by eNodeB to the Serving GW. The eNodeB sends the uplink data to the Serving GW address and TEID provided in the step 4.

It is FFS if the uplink data can be forwarded onwards by Serving GW only after step 8.

7. The eNodeB sends an S1-AP message Initial Context Setup Complete (eNodeB address, S1 TEID(s) (DL)) to the MME. This step is described in detail in 3GPP TS 36.300 [5].
8. The MME sends an Update Bearer Request message (eNodeB address, S1 TEID(s) (DL)) to the Serving GW. The Serving GW is now able to transmit downlink data towards the UE.
9. The Serving GW sends an Update Bearer Response to the MME.

5.3.4.2 Network Triggered Service Request

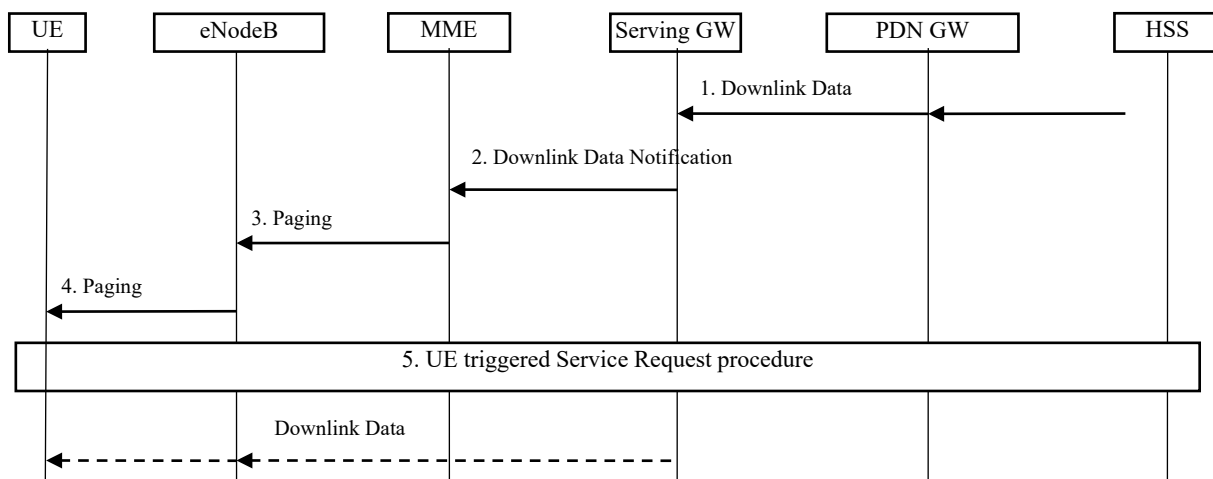


Figure 5.3.4-2: Network triggered Service Request procedure

1. The Serving GW receives a downlink data packet for a UE in IDLE state and buffers the downlink data packet.
2. The Serving GW sends a Downlink Data Notification message to the MME.

If the Serving GW receives additional downlink data packets for this UE, the Serving GW buffers these downlink data packets and the Serving GW does not send a new Paging Request to the MME.
3. The MME sends a Paging message (NAS Paging ID, TAI(s), Paging DRX ID) to each eNodeB belonging to the tracking area(s) in which the UE is registered. The step is described in detail in 3GPP TS 36.300 [5]. Steps 3-4 are omitted if the MME already has a signalling connection over S1-MME towards the UE.
4. The UE is paged by the eNodeBs. The step is described in detail in 3GPP TS 36.300 [5].
5. The UE initiates the UE triggered Service Request procedure, which is specified in clause 5.3.4.1.

5.3.5 S1 release procedure

This procedure is used for the release of all S1 bearers for a UE, including all S1-U bearers and the S1-MME signaling connection for the UE. This procedure results in the UE state in MME being set to LTE_IDLE and all UE related context information is deleted in the eNodeB.

The initiation of S1 Release procedure is either:

- eNodeB-initiated with cause e.g. O&M Intervention, Unspecified Failure, User Inactivity, Repeated RRC signalling Integrity Check Failure, Release due to UE generated signalling connection release, etc, or
- MME-initiated with cause e.g. authentication failure, detach, etc.

Both eNodeB-initiated and MME-initiated S1 release procedures are shown in Figure 5.3.5-1.

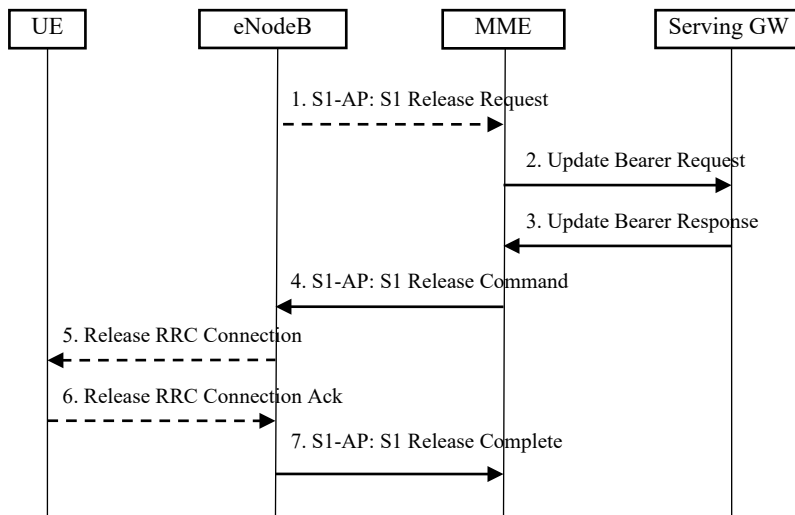


Figure 5.3.5-1: S1 Release Procedure

1. If the eNodeB detects a need to release the UE's signalling connection and all radio bearers for the UE, the eNodeB sends an S1 Release Request (Cause) message to the MME. Cause indicates the reason for the release (e.g. O&M intervention, unspecified failure, user inactivity, repeated integrity checking failure, or release due to UE generated signalling connection release).

NOTE: Step 1 is only performed when the eNodeB-initiated S1 release procedure is considered. Step 1 is not performed and the procedure starts with Step 2 when the MME-initiated S1 release procedure is considered.

2. The MME sends an Update Bearer Request message to the S-GW that requests the release of all S1-U bearers for the UE. This message is triggered either by an S1 Release Request message from the eNodeB, or by another MME event.
3. The S-GW releases all eNodeB related information (address and TEIDs) for the UE, sets the UE's status to idle and responds with an Update Bearer Response message to the MME. Other elements of the UE's S-GW context are not affected. The S-GW retains the S1-U configuration that the S-GW allocated for the UE's bearers. The S-GW starts buffering downlink packets received for the UE and initiating the "Network Triggered Service Request" procedure, described in sub-clause 5.3.4.2, if downlink packets arrive for the UE.
4. The MME releases S1 by sending the S1 Release Command (Cause) message to the eNodeB.
5. If the RRC connection is not already released, the eNodeB sends a Release RRC Connection message to the UE.
6. The UE returns a Release RRC Connection Acknowledge message to the eNodeB. In the situation that the RRC connection has not yet been successfully released, the eNodeB shall keep sufficient UE context information to complete the RRC connection release with the UE. When the RRC connection is released successfully, the eNodeB deletes the UE's context.
7. This step shall be performed promptly after step 4, e.g. it shall not be delayed in situations where the eNodeB does not receive a Release RRC Connection Acknowledge from the UE.

The eNodeB confirms the S1 Release by returning an S1 Release Complete message to the MME. With this, the signalling connection between the MME and the eNodeB for that UE is released.

The MME deletes any eNodeB related information (address and TEIDs) from the UE's MME context, but, retains the rest of the UE's MME context including the S-GW's S1-U configuration information (address and TEIDs). All EPS bearers established for the UE are preserved in the MME and in the Serving GW.

It is FFS if additional EPS bearer preservation rules need to be specified, e.g. if the EPS Bearer Context information in MME and UE are modified, or if GBR bearers cannot be preserved and have to be released.

5.3.6 ME identity check procedure

Editor's note: This subclause will contain details on ME identity checking (e.g. IMEI checking).

5.3.7 S-TMSI Reallocation procedure

The MME may initiate the S-TMSI Reallocation procedure to reallocate the S-TMSI and TA list at any time when a signalling association is established between UE and MME. The S-TMSI Reallocation procedure allocates a new S-TMSI and a new TA list to the UE. The S-TMSI and the TA list may also be reallocated by the Attach or the Tracking Area Update procedures.

The S-TMSI Reallocation procedure is illustrated in Figure 5.3.7-1.

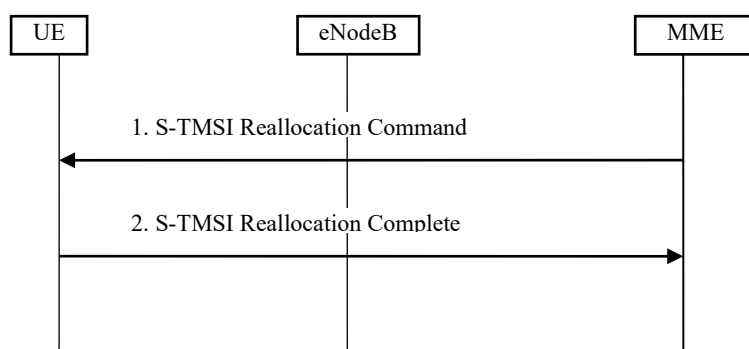


Figure 5.3.7-1 S-TMSI Reallocation Procedure

1. The MME sends S-TMSI Reallocation Command (S-TMSI, TA list) to the UE.
2. The UE returns S-TMSI Reallocation Complete message to the MME.

5.3.8 Purge function

The Purge function allows an MME to inform the HSS that it has deleted the subscription data and MM context of a detached MS. The MME may, as an implementation option, delete the subscription data and MM context of an UE immediately after the implicit or explicit detach of the UE. Alternatively the MME may keep for some time the subscription data and the MM context of the detached UE, so that the data can be reused at a later attach without accessing the HSS.

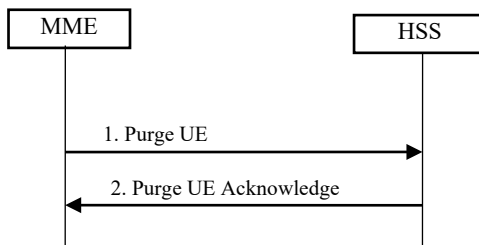


Figure 5.3.8-1: Purge Procedure

1. After deleting the Subscription data and MM contexts of a detached UE, the MME sends Purge UE (IMSI) message to the HSS.
2. The HSS sets the UE Purged for E-UTRAN flag and acknowledges with a Purge UE Ack message.

5.3.9 Detach procedure

The Detach procedure allows:

- the UE to inform the network that it does not want to access the EPS any longer, and
- the network to inform the UE that it does not have access to the EPS any longer.

The UE is detached either explicitly or implicitly:

- Explicit detach: The network or the UE explicitly requests detach and signal with each other.
- Implicit detach: The network detaches the UE, without notifying the UE. This is typically the case when the network presumes that it is not able to communicate with the UE, e.g. due to radio conditions.

Three detach procedures are provided when the UE accesses the EPS through E-UTRAN. The first detach procedure is UE-initiated detach procedure and other detach procedures are network-initiated detach procedure:

- UE-Initiated Detach Procedure;
- MME-Initiated Detach Procedure;
- HSS-Initiated Detach Procedure.

Editor's note: it is FFS whether a PDN GW or Serving GW may also initiate a Detach procedure.

Editor's Note: These procedures should cover the case that detach is required because the UE is attached to a non-3GPP RAT, these procedures need to be updated according to later conclusions.

5.3.9.1 UE-initiated Detach procedure

The Detach procedure when initiated by the UE is illustrated in Figure 5.3.9.1-1.

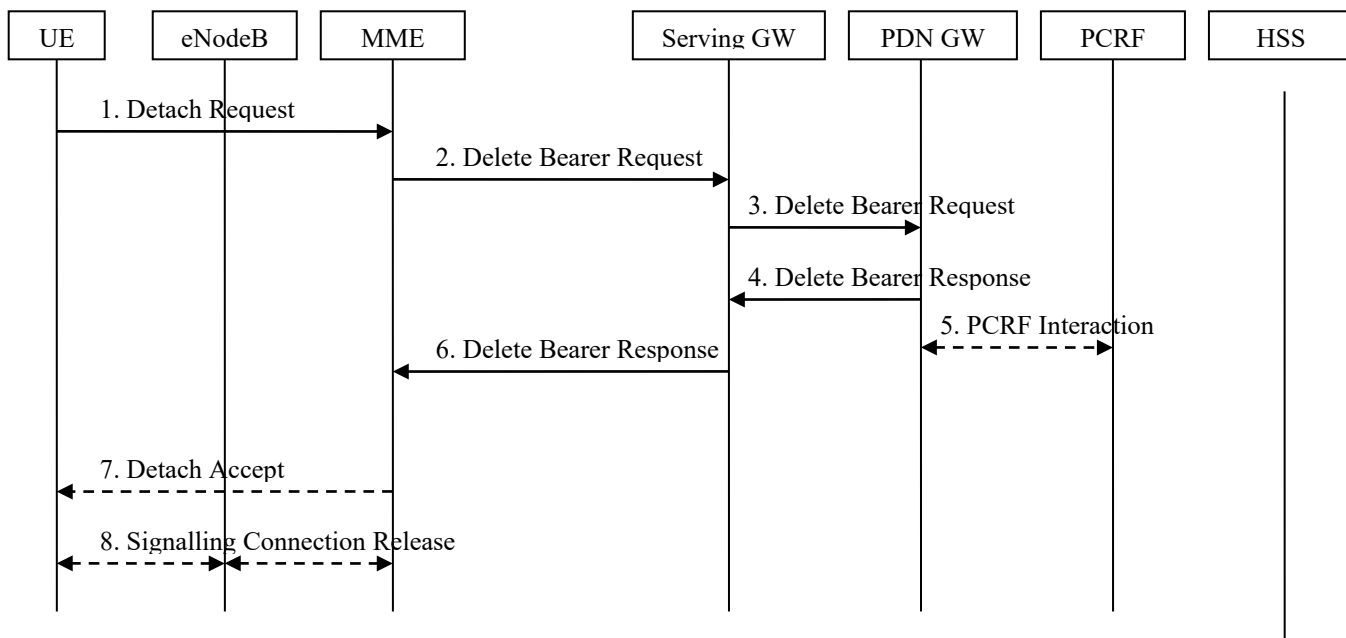


Figure 5.3.9.1-1: UE-Initiated Detach Procedure

1. The UE sends NAS message Detach Request (Switch Off) to the MME. Switch Off indicates whether detach is due to a switch off situation or not.
2. The active EPS Bearers in the Serving GW regarding this particular UE are deactivated by the MME sending Delete Bearer Request (TEID) to the Serving GW.
3. The Serving GW sends Delete Bearer Request (TEID) to the PDN GW.

4. The PDN GW acknowledges with Delete Bearer Response (TEID).
5. The PDN GW may interact with the PCRF to indicate to the PCRF that EPS Bearer is released if PCRF is applied in the network.
6. The Serving GW acknowledges with Delete Bearer Response (TEID).
7. If Switch Off indicates that detach is not due to a switch off situation, the MME sends a Detach Accept to the UE.
8. The MME releases the S1-MME signalling connection for the UE by sending S1 Release Command to the eNodeB with Cause = Detach. The details of this step are covered in the "S1 Release Procedure", as described in clause 5.3.5.

Editor's Note: The step 3,4 are for GTP based S5/S8 reference point, it's FFS for IETF based S5/S8 reference point.

5.3.9.2 MME-initiated Detach procedure

The MME-Initiated Detach procedure when initiated by the MME is illustrated in Figure 5.3.9.2-1.

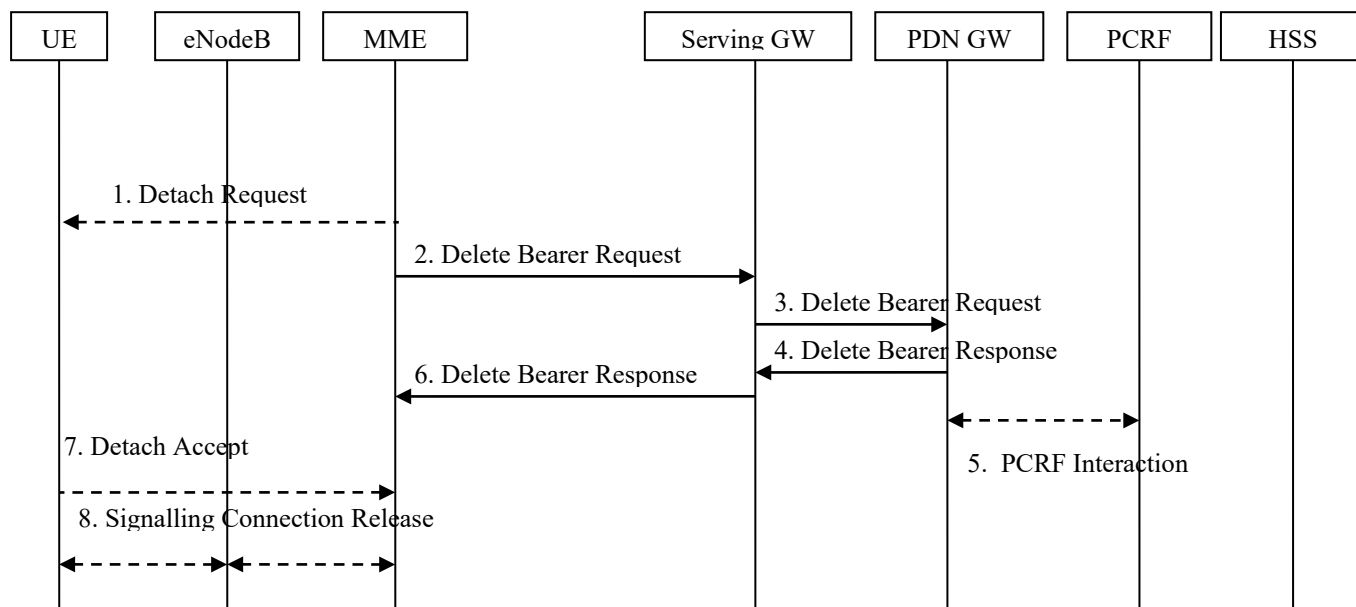


Figure 5.3.9.2-1: MME-Initiated Detach Procedure

1. The MME initiated detach procedure is either explicit or implicit. The MME may implicitly detach a UE, if it has not had communication with UE for a long period of time. The MME does not send the Detach Request (Detach Type) message to the UE in case of implicit detach. The MME may explicitly detach the UE by sending a Detach Request message to the UE. The Detach Type may be set to re-attach in which case the UE should re-attach at the end of the detach process.
2. Any EPS Bearers in the Serving GW regarding this particular UE are deactivated by the MME sending Delete Bearer Request (TEID) message to the Serving GW.
3. The Serving GW sends a Delete Bearer Request (TEID) message to the PDN GW.
4. The PDN GW acknowledges with Delete Bearer Response (TEID) message.
5. The PDN GW may interact with the PCRF to indicate to the PCRF that the EPS Bearer(s) are released if a PCRF is configured.
6. The Serving GW acknowledges with Delete Bearer Response (TEID) message.
7. If the UE receives the Detach Request message from the MME in the step 1, the UE sends a Detach Accept message to the MME any time after step 1.

- After receiving the Detach Accept message, if Detach Type did not request the UE to make a new attach, the MME releases the S1-MME signalling connection for the UE by sending an S1 Release Command (Cause) message to the eNodeB with Cause set to Detach. The details of this step are covered in the "S1 Release Procedure", as described in clause 5.3.5.

Editor's Note: The step 3,4 are for GTP based S5/S8 reference point, it's FFS for IETF based S5/S8 reference point.

5.3.9.3 HSS-initiated Detach procedure

The HSS-Initiated Detach procedure is initiated by the HSS. The HSS uses this procedure for operator-determined purposes to request the removal of a subscriber's MM and EPS bearer at the MME.

It is FFS, if the HSS initiates a detach procedure to update the subscriber's MM context at the MME and to delete the EPS bearer because that the UE 's accessing RAT is changed from 3GPP to Non-3GPP.

The HSS-Initiated Detach Procedure is illustrated in Figure 5.3.9.3-1.

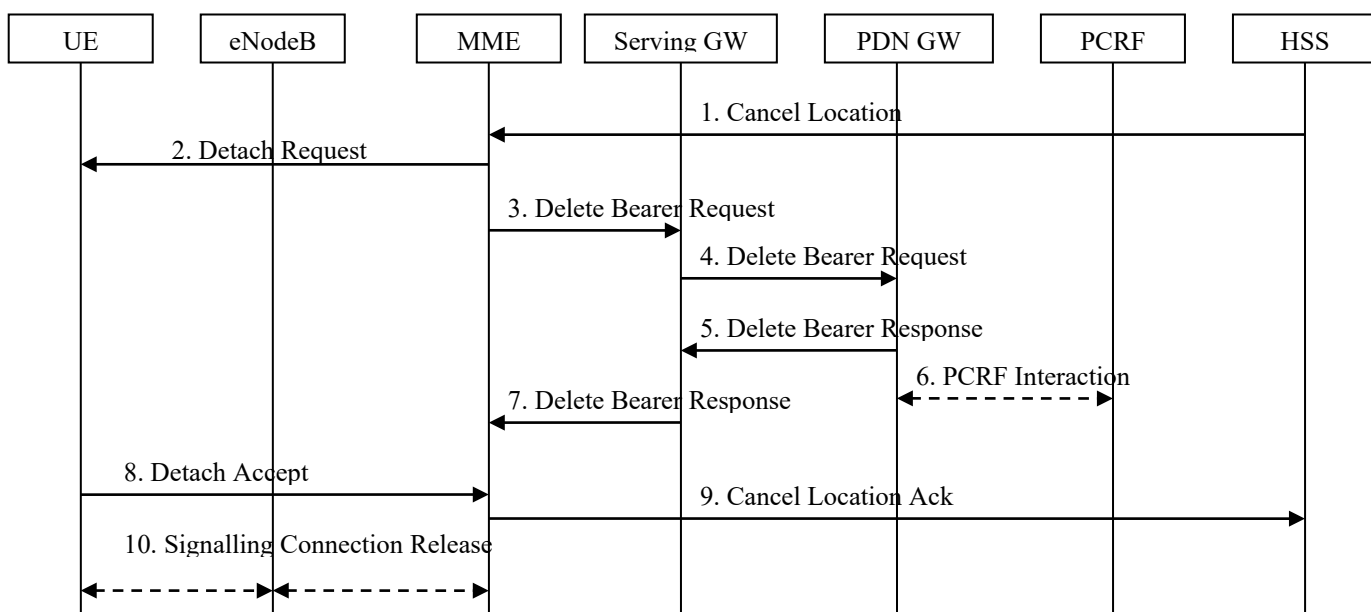


Figure 5.3.9.3-1: HSS-Initiated Detach Procedure

- If the HSS wants to request the immediate deletion of a subscriber's MM contexts and EPS Bearers, the HSS shall send a Cancel Location (IMSI, Cancellation Type) message to the MME with Cancellation Type set to Subscription Withdrawn.

It is FFS whether the Cancellation type can be set to "implicit detach because of UE's accessing RAT changed from 3GPP to Non-3GPP".

- If Cancellation Type is Subscription Withdrawn, the MME informs the UE, that it has been detached, by sending Detach Request message to the UE.
- The EPS Bearers in the Serving GW regarding this particular UE are deactivated by the MME sending a Delete Bearer Request (TEID) message to the Serving GW.
- The Serving GW sends Delete Bearer Request (TEID) message to the PDN GW.
- The PDN GW acknowledges with Delete Bearer Response (TEID) message.

It is FFS, If the Cancellation type is set to "implicit detach because of UE 's accessing RAT changed from 3GPP to Non-3GPP", after the PDN deletes the EPS Bearer, the PDN GW should not release the UE's PDP address of the Bearer. If the Cancellation type is set to "Subscription Withdrawn", after the PDN deletes the EPS Bearer, the PDN GW should release the UE's PDP address of the Bearer and assign the PDP address to other UE.

- The PDN GW may interact with the PCRF to indicate to the PCRF that the EPS bearer is released if a PCRF is configured.

7. The Serving GW acknowledges with Delete Bearer Response (TEID) message.
8. If the UE receives the Detach Request message from the MME, the UE sends a Detach Accept message to the MME any time after step 2.
9. The MME confirms the deletion of the MM contexts and the EPS Bearer(s) with a Cancel Location Ack (IMSI) message.
10. After receiving the Detach Accept message, the MME releases the S1-MME signalling connection for the UE by sending S1 Release Command (Cause) message to the eNodeB with Cause set to Detach. The details of this step are covered in the "S1 Release Procedure", as described in clause 5.3.5.

NOTE: Steps 2,8,10 are only for the Cancellation type is set to Subscription Withdrawn.

Editor's Note: The step 4,5 are for GTP based S5/S8 reference point, it's FFS for IETF based S5/S8 reference point.

5.4 Session Management, QoS and interaction with PCC functionality

<This section describes the SM and QoS functionality and signalling flows for, eg establishment of higher QoS bearers, release etc.>

Editor's note: The MME provides bearer management functions including dedicated bearer establishment.

5.4.1 Dedicated bearer activation

The dedicated bearer activation procedure for a GTP based S5/S8 is depicted in figure 5.4.1-1. In this procedure, the UE is assumed to be in active mode.

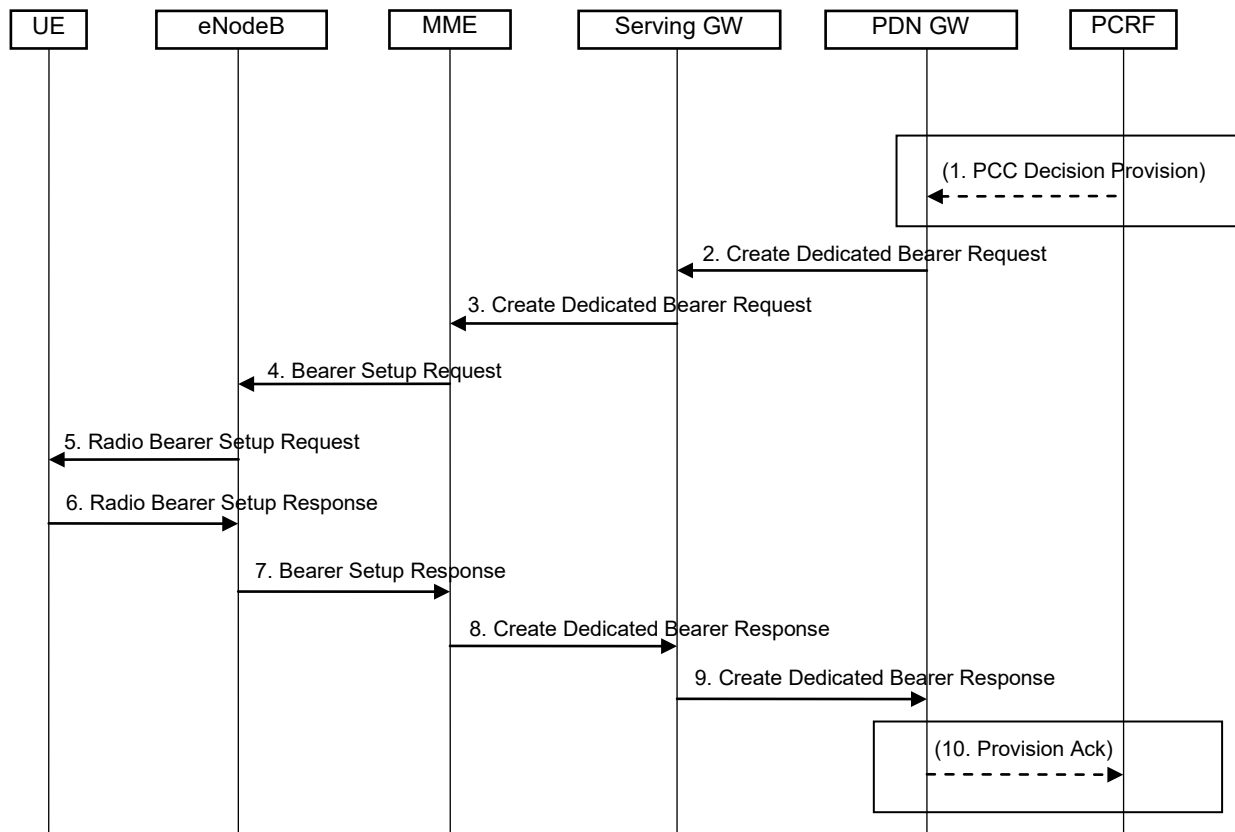


Figure 5.4.1-1: Dedicated Bearer Activation Procedure, UE in Active Mode

NOTE: Steps 3-8 are common for architecture variants with GTP based S5/S8 and IETF based S5/S8. For an IETF based S5/S8, steps 1, 2, 9 and 10 are FFS.

1. For GTP based S5/S8: Optionally, the PCRF sends a PCC decision provision (QoS policy) message to the PDN GW. If the PCC architecture is not present, the PDN GW may apply a local QoS policy.
2. For GTP based S5/S8: The PDN GW uses this QoS policy to assign the bearer QoS, i.e., it assigns the values to the bearer level QoS parameters (excluding AMBR); see clause 4.6.2. The PDN GW sends a Create Dedicated Bearer Request message (Bearer QoS, UL TFT, S5/S8 TEID) to the Serving GW.

Editor's note: The identifier(s) used for bearer identification and linking with the default bearer is FFS.

3. The Serving GW sends the Create Dedicated Bearer Request (Bearer QoS, UL TFT, S1-TEID) message to the MME.
4. The MME builds a Session Management Configuration IE including the UL TFT. The MME then signals the Bearer Setup Request (Bearer QoS, Session Management Configuration, S1-TEID) message to the eNodeB.
5. The eNodeB maps the bearer QoS to the Radio Bearer QoS. It then signals a Radio Bearer Setup Request (Radio Bearer QoS, Session Management Configuration) message to the UE. The UE uses the uplink packet filter (UL TFT) to determine the mapping of service data flows to the radio bearer.
6. NOTE: The details of the Radio Bearer QoS are specified by RAN2.
7. The UE NAS layer builds a Session Management Response IE. The UE then acknowledges the radio bearer activation to the eNodeB with a Radio Bearer Setup Response (Session Management Response) message.
8. The eNodeB acknowledges the bearer activation to the MME with a Bearer Setup Response (S1-TEID, Session Management Response) message. The eNodeB indicates whether the requested Bearer QoS could be allocated or not.
9. The MME acknowledges the bearer activation to the Serving GW by sending a Create Dedicated Bearer Response (S1-TEID) message.
10. For GTP based S5/S8: The Serving GW acknowledges the bearer activation to the PDN GW by sending a Create Dedicated Bearer Response (S5/S8-TEID) message.
11. For GTP based S5/S8: If the dedicated bearer activation procedure was triggered by a PCC Decision Provision message from the PCRF, the PDN GW indicates to the PCRF whether the requested PCC decision (QoS policy) could be enforced or not by sending a Provision Ack message.

NOTE: The exact signalling of step 1 and 10 (e.g. in case of local break-out) is outside the scope of this specification. This signalling and its interaction with the dedicated bearer activation procedure are to be specified in 3GPP TS 23.203 [6]. Steps 1 and 10 are included here only for completeness.

5.4.2 Dedicated bearer modification with bearer QoS update

The dedicated bearer modification procedure (including Bearer QoS update) for a GTP based S5/S8 is depicted in figure 5.4.2-1. In this procedure, the UE is assumed to be in active mode.

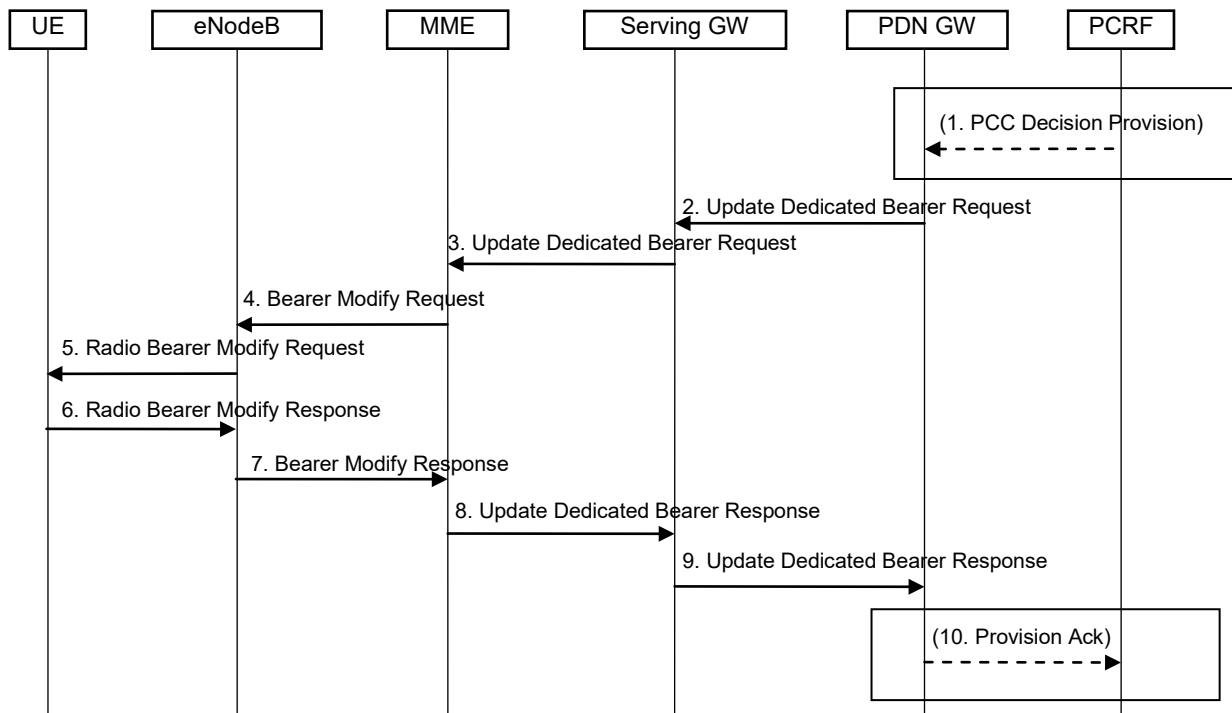


Figure 5.4.2-1: Dedicated Bearer Modification Procedure with Bearer QoS Update, UE in active mode

NOTE: Steps 3-8 are common for architecture variants with GTP based S5/S8 and IETF based S5/S8. For an IETF based S5/S8, steps 1, 2, 9 and 10 are FFS.

1. For GTP based S5/S8: Optionally, the PCRF sends a PCC decision provision (QoS policy) message to the PDN GW. If a PCC architecture is not present, the PDN GW may apply a local QoS policy.
2. For GTP based S5/S8: The PDN GW uses this QoS policy to determine that a service data flow shall be aggregated to or removed from an active dedicated bearer. The PDN GW generates the UL TFT and updates the Bearer QoS to match the aggregated set of service data flows. The PDN GW then sends the Update Dedicated Bearer Request (Bearer QoS, UL TFT) message to the Serving GW.

NOTE: The identifier(s) used for bearer identification and linking with the default bearer is FFS.

3. The Serving GW sends the Update Dedicated Bearer Request (Bearer QoS, UL TFT) message to the MME.
4. The MME builds a Session Management Configuration IE including the UL TFT. The MME then sends the Bearer Modify Request (Bearer QoS, Session Management Configuration) message to the eNodeB.
5. The eNodeB maps the modified Bearer QoS to the Radio Bearer QoS. It then signals a Radio Bearer Modify Request (Radio Bearer QoS, Session Management Configuration) message to the UE. The UE uses the uplink packet filter (UL TFT) to determine the mapping of service data flows to the radio bearer.

NOTE: The details of the Radio Bearer QoS are specified by RAN2.
6. The UE NAS layer builds a Session Management Response IE. The UE then acknowledges the radio bearer modification to the eNodeB with a Radio Bearer Modify Response (Session Management Response) message.
7. The eNodeB acknowledges the bearer modification to the MME with a Bearer Modify Response (Session Management Response) message. With this message, the eNodeB indicates whether the requested Bearer QoS could be allocated or not.
8. The MME acknowledges the bearer modification to the Serving GW by sending an Update Dedicated Bearer Response message.
9. For GTP based S5/S8: The Serving GW acknowledges the bearer modification to the PDN GW by sending an Update Dedicated Bearer Response message.

10. For GTP based S5/S8: If the dedicated Bearer modification procedure was triggered by a PCC Decision Provision message from the PCRF, the PDN GW indicates to the PCRF whether the requested PCC decision (QoS policy) could be enforced or not by sending a Provision Ack message.

NOTE: The exact signalling of step 1 and 10 (e.g. in case of local break-out) is outside the scope of this specification. This signalling and its interaction with the dedicated bearer activation procedure are to be specified in 3GPP TS 23.203 [6]. Steps 1 and 10 are included here only for completeness.

5.4.3 Dedicated bearer modification without bearer QoS update

The bearer modification procedure without QoS update is used to update the UL TFT for an active dedicated bearer. This procedure for a GTP based S5/S8 is depicted in figure 5.4.3-1. In this procedure, the UE is assumed to be in active mode.

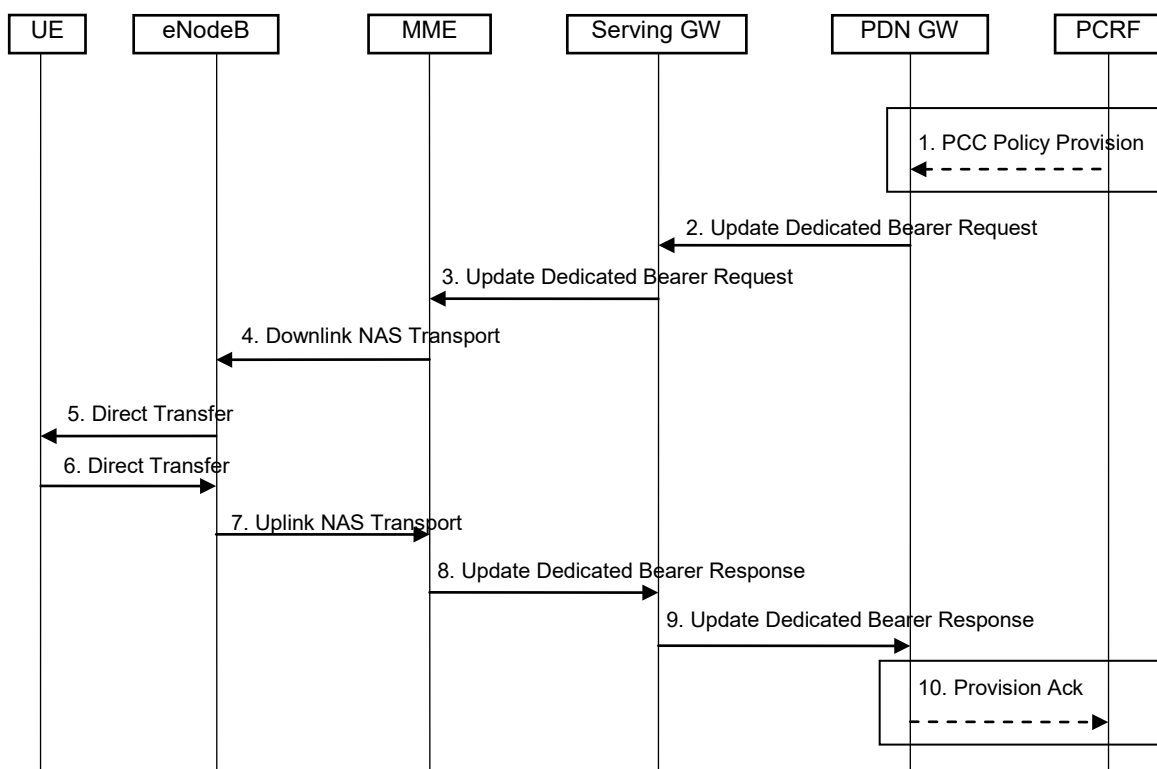


Figure 5.4.3-1: Dedicated Bearer Modification Procedure without Bearer QoS Update, UE in active mode

NOTE: Steps 3-8 are common for architecture variants with GTP based S5/S8 and IETF based S5/S8. For an IETF based S5/S8, steps 1,2,9 and 10 are FFS.

- For GTP based S5/S8: Optionally, the PCRF sends a PCC decision provision (QoS policy) message to the PDN GW. If a PCC architecture is not present, the PDN GW may apply a local QoS policy.
- For GTP based S5/S8: The PDN GW uses this QoS policy to determine that a service data flow shall be aggregated to or removed from an active dedicated bearer. The PDN GW generates the UL TFT and determines that no update of the Bearer QoS is needed. The PDN GW then sends the Update Dedicated Bearer Request (UL TFT) message to the Serving GW.

Editor's note: The identifier(s) used for bearer identification and linking with the default bearer is FFS.

- The Serving GW sends the Update Dedicated Bearer Request (UL TFT) message to the MME.
- The MME builds a Session Management Configuration IE including the UL TFT. The MME then sends a Downlink NAS Transport (Session Management Configuration) message to the eNodeB.
- The eNodeB sends the Direct Transfer (Session Management Configuration) message to the UE. The UE uses the uplink packet filter (UL TFT) to determine the mapping of service data flows to the radio bearer.

6. The UE NAS layer builds a Session Management Response. The UE then sends a Direct Transfer (Session Management Response) message to the eNodeB.
7. The eNodeB sends an Uplink NAS Transport (Session Management Response) message to the eNodeB.
8. The MME acknowledges the bearer modification to the Serving GW by sending an Update Dedicated Bearer Response message.
9. For GTP based S5/S8: The Serving GW acknowledges the bearer modification to the PDN GW by sending an Update Dedicated Bearer Response message.

Editor's note: For IETF based S5/S8, this step is FFS.

10. For GTP based S5/S8: If the dedicated bearer modification procedure was triggered by a PCC Decision Provision message from the PCRF, the PDN GW indicates to the PCRF whether the requested PCC decision (QoS policy) could be enforced or not by sending a Provision Ack message.

NOTE: The exact signalling of step 1 and 10 (e.g. in case of local break-out) is outside the scope of this specification. This signalling and its interaction with the dedicated bearer activation procedure are to be specified in 3GPP TS 23.203 [6]. Steps 1 and 10 are included here only for completeness.

5.4.4 Dedicated bearer deactivation

5.4.4.1 PDN GW Initiated Dedicated Bearer Deactivation

The dedicated bearer deactivation procedure for a GTP based S5/S8 is depicted in figure 5.4.4-1. In this procedure, the UE is assumed to be in active mode.

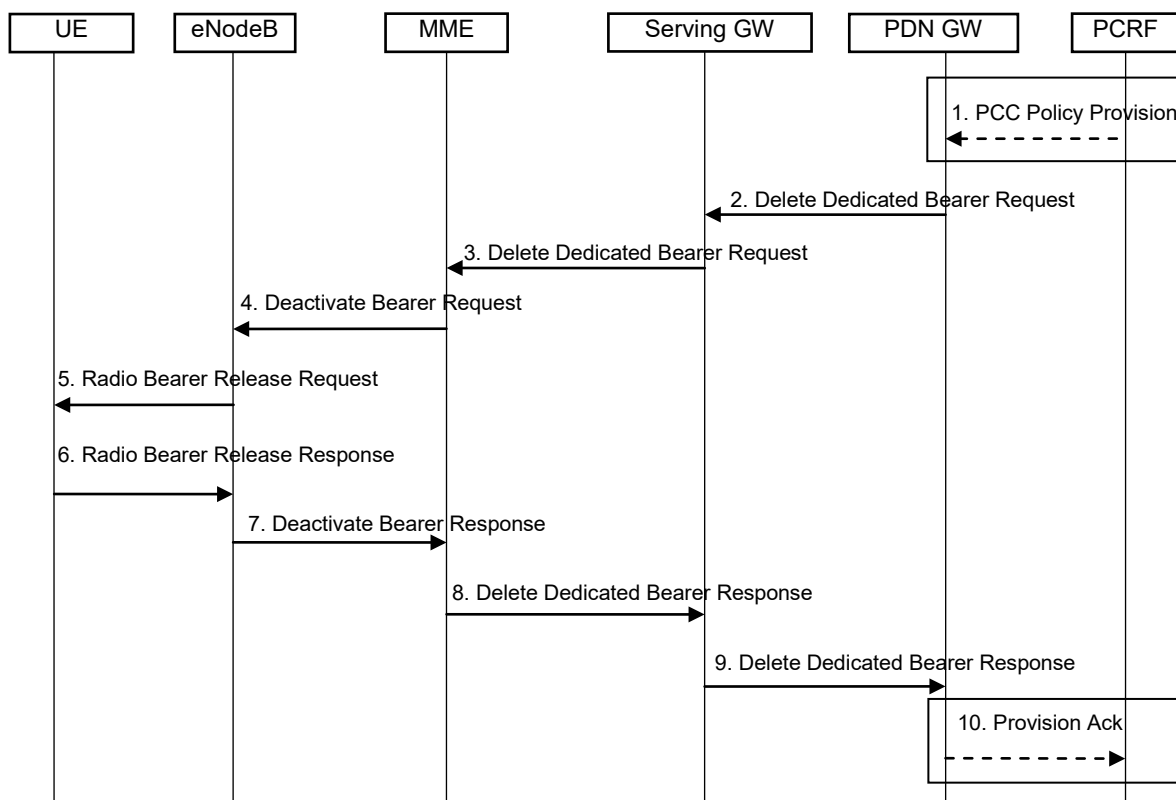


Figure 5.4.4-1: PDN GW Initiated Dedicated Bearer Deactivation, UE in active mode

NOTE: Steps 3-8 are common for architecture variants with GTP based S5/S8 and IETF based S5/S8. For an IETF based S5/S8, steps 1, 2, 9 and 10 are FFS.

1. For GTP based S5/S8: Optionally, the PCRF sends a PCC decision provision (QoS policy) message to the PDN GW. If a PCC architecture is not present, the PDN GW may apply a local QoS policy.

2. For GTP based S5/S8: The PDN GW is triggered by the QoS policy to initiate dedicated bearer deactivation procedure. The PDN GW sends a Delete Dedicated Bearer Request message to the Serving GW.
3. The Serving GW sends the Delete Dedicated Bearer Request message to the MME.
4. The MME signals the Deactivate Bearer Request message to the eNodeB.
5. The eNodeB signals a Radio Bearer Release Request message to the UE.
6. The UE removes the UL TFTs corresponding to the released radio bearer. The UE then acknowledges the radio bearer release to the eNodeB with a Radio Bearer Release Response message.
7. The eNodeB acknowledges the bearer deactivation to the MME with a Deactivate Bearer Response message.
8. The MME acknowledges the bearer deactivation to the Serving GW by sending a Delete Dedicated Bearer Response message.
9. For GTP based S5/S8: The Serving GW acknowledges the bearer deactivation to the PDN GW by sending a Delete Dedicated Bearer Response message.
10. For GTP based S5/S8: If the dedicated bearer deactivation procedure was triggered by a PCC Decision Provision message from the PCRF, the PDN GW indicates to the PCRF that the requested PCC decision was enforced by sending a Provision Ack message.

NOTE: The exact signalling of step 1 and 10 (e.g. in case of local break-out) is outside the scope of this specification. This signalling and its interaction with the dedicated bearer activation procedure are to be specified in 3GPP TS 23.203 [6]. Steps 1 and 10 are included here only for completeness.

5.5 Handover

<This section describes the functionality and signalling flows for intra and inter-RAT handover etc. Handovers between IPv4 and IPv6 can be documented here. For intra-EUTRAN handover it is FFS how this section relates to the RAN 3 TS. >

5.5.1 Inter eNodeB handover with CN node relocation

The *inter eNodeB handover with CN node relocation* procedure can be used to relocate MME, Serving GW or both. The procedure is initiated in the source eNodeB. The source MME selects the target MME. If the MME is not relocated, then Source and Target MME in the following message flows are considered to be the same node and all the signalling messages between them are internal functions within the MME. **It is FFS which node decides if the Serving GW needs to be relocated.** If the Serving GW needs to be relocated the target MME selects the target Serving GW, as specified in clause 4.3.7.2 on Serving GW selection function.

The source eNodeB decides which of the EPS bearers are subject for forwarding of packets from the source eNodeB to the target eNodeB. The EPC does not change the decisions taken by the RAN node. Packet forwarding can take place either directly from the source eNodeB to the target eNodeB, or indirectly (**FFS**) from the source eNodeB to the target eNodeB via the source and target Serving GWs (or if the Serving GW is not relocated, only the single Serving GW).

Editor's note: It is FFS if the indirect forwarding option needs to be defined.

The availability of a direct forwarding path is determined in the source eNodeB and indicated to the source MME. If X2 connectivity is available between the source and target eNodeBs, a direct forwarding path is available.

If a direct forwarding path is not available, indirect forwarding may be used (**FFS**). The MMEs (source and target) use configuration data to determine whether indirect forwarding paths are to be established. Depending on configuration data, the source MME determines and indicates to the target MME whether indirect forwarding paths should be established. Based on this indication and on its configuration data, the target MME determines whether indirect forwarding paths are established.

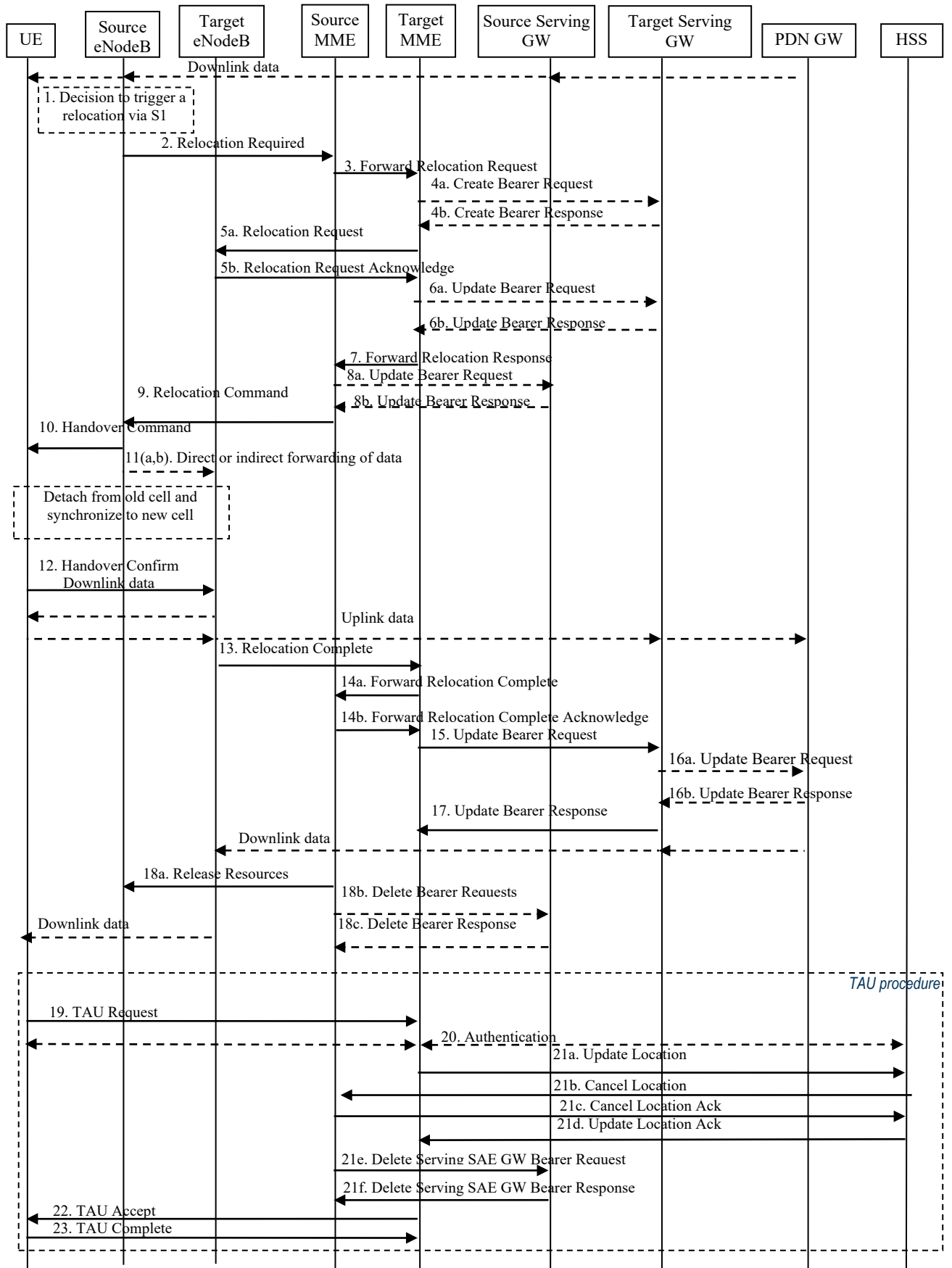


Figure 5.5.1-1: Title needed

1. The source eNodeB decides to initiate an inter-eNodeB handover with CN node relocation to the target eNodeB. This can be triggered e.g. by no X2 connectivity to the target eNodeB, or by an error indication from the target eNodeB after an unsuccessful X2-based handover, or by dynamic information learnt by the source eNodeB.
2. The source eNodeB sends Relocation Required to the source MME. The source eNodeB indicates which bearers are subject to data forwarding. This message contains an indication whether direct forwarding is available from the source eNodeB to the target eNodeB. This indication from source eNodeB can be based on e.g. the presence of X2.
3. The source MME selects the target MME as described in clause 4.3.7.3 on "MME Selection Function" and sends a Forward Relocation Request (MME UE context and includes the PDN GW addresses and TEIDs at the PDN GW(s) for uplink traffic and Serving GW addresses and TEIDs for uplink traffic) message to it. This message also includes an indication if direct forwarding is applied, or if indirect forwarding is going to be set up by the source side.
4. The new MME verifies whether the old Serving GW can continue to serve the UE. If not, it selects a new Serving GW as described in clause 4.3.7.2 on "Serving GW Selection Function".

If the old Serving GW continues to serve the UE, no message is sent in this step. In this case, the target Serving GW is identical to the source Serving GW.

If a new Serving GW is selected, the target MME sends a Create Bearer Request (bearer context(s) with PDN GW addresses and TEIDs for uplink traffic) message to the target Serving GW. The target Serving GW allocates the S-GW addresses and TEIDs for the uplink traffic on S1_U reference point (one TEID per bearer). The target Serving GW sends a Create Bearer Response (Serving GW addresses and uplink TEID(s) for user plane) message back to the target MME.

5. The Target MME sends Relocation Request (Serving GW addresses and uplink TEID(s) for user plane) message to the target eNodeB. This message creates the UE context in the target eNodeB, including information about the bearers, and the security context. The target eNodeB sends a Relocation Request Acknowledge message to the MME. This includes the addresses and TEIDs allocated at the target eNodeB for downlink traffic on S1_U reference point (one TEID per bearer). **It is FFS if the TEIDs used for forwarding are different from the TEIDs used for downlink packets.**

Editor's note: TEID used for forwarding and TEID used for downlink packets is FFS in RAN

6. If indirect forwarding is used, the target MME sets up forwarding parameters in the target Serving GW. **Indirect Forwarding is FFS**
7. The target MME sends a Forward Relocation Response message to the source MME.
8. If indirect forwarding is used, the source MME updates the source Serving GW about the tunnels used to the target serving GW. **Indirect Forwarding is FFS**
9. The source MME sends a Relocation Command (target addresses and TEID(s) for data forwarding) message to the source eNodeB.
10. The Handover Command is sent to the UE.
11. The source eNodeB should start forwarding of downlink data from the source eNodeB towards the target eNodeB for bearers subject to data forwarding. This may be either direct or indirect forwarding. **Indirect forwarding is FFS.**
12. After the UE has successfully synchronized to the target cell, it sends a Handover Confirm message to the target eNodeB. Downlink packets forwarded from the source eNodeB can be sent to the UE. Also, uplink packets can be sent from the UE, which are forwarded to the target Serving GW and on to the PDN GW.
13. The target eNodeB sends a Relocation Complete message to the target MME.
14. The target MME sends a Forward Relocation Complete to the source MME. The source MME in response sends a Forward Relocation Complete Acknowledge to the target MME.
15. The target MME sends an Update Bearer Request (eNodeB addresses and TEIDs allocated at the target eNodeB for downlink traffic on S1_U) message to the target Serving GW.

16. If the Serving GW is relocated, the target Serving GW assigns addresses and TEIDs (one per bearer) for downlink traffic from the PDN GW. It sends an Update Bearer Request (Serving GW addresses for user plane and TEID(s)) message to the PDN GW(s). The PDN GW starts sending downlink packets to the target GW using the newly received address and TEIDs. These downlink packets will use the new downlink path via the target Serving GW to the target eNodeB. An Update Bearer Response message is sent back to the target serving GW. If the Serving GW is not relocated, no message is sent in this step and downlink packets from the Serving-GW are immediately sent on to the target eNodeB.

It is FFS if the target eNodeB needs to take any action to avoid sending DL PDUs received from the Serving-GW to the UE before data received from the old eNodeB have been sent to the UE.

17. The target Serving GW sends an Update Bearer Response message to the target MME.

18. On receiving the Forward Relocation Complete message, the MME sends a Release Resources message to the source eNodeB. When the Release Resources message has been received and there is no longer any need for the eNodeB to forward data, the Source eNodeB releases its resources. In case of intra-MME handover with Serving GW changed, the MME releases the resource in the source Serving GW by sending a Delete Bearer Request message to the source Serving GW.

19. If the UE is handovered to a TA that it has not registered with the network, the UE sends a Tracking Area Update Request message, which arrives to the target MME.

NOTE: As it is important that the HSS knows the identity of the serving MME, it is important that the RAN and source MME are configured correctly to ensure that a TA update occurs if the MME is relocated.

20. The target MME may optionally authenticate the UE.

Editor's note: whether this step is optional needs confirmation from SA 3.

21.

- a. The target MME updates the HSS by sending an Update Location message
- b. The HSS sends a Cancel Location message to the source MME.
- c. The source MME sends a Cancel Location Ack message to the HSS.
- d. After the HSS has received the Cancel Location Ack message, it sends an Update Location Ack to the target MME.

Editor's note: it is FFS how the HSS ensures that the UE context received from the source MME in step 3 is still valid in the target MME.

- e. The source MME releases the bearer(s) in the source Serving GW by sending a Delete Bearer Request message. Note that if the Serving GW is not relocated, only the signalling relationship is released between the Serving GW and the source MME, but the UE context continues to exist in the Serving GW.
- f. The source Serving GW sends a Delete Bearer Response message to the source MME.

22. The target MME sends a Tracking Area Update Accept (S-TMSI) message to the UE. The S-TMSI is allocated by the target MME.

23. The UE acknowledges the new S-TMSI by sending a Tracking Area Update Complete message.

5.5.2 Inter RAT handover

5.5.2.1 E-UTRAN to UTRAN Iu mode Inter RAT handover based on PS handover

5.5.2.1.1 General

Pre-conditions:

- The UE is in LTE_ACTIVE state (E-UTRAN mode).

5.5.2.1.2 Preparation phase

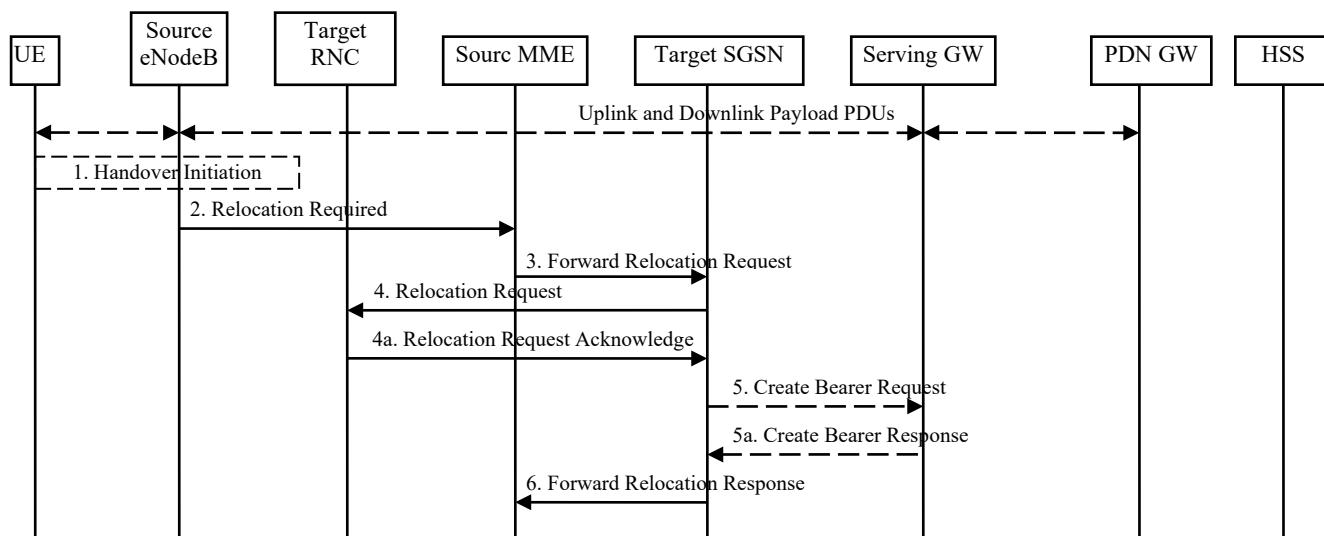


Figure 5.5.2.1-1: E-UTRAN to UTRAN Iu mode Inter RAT HO, preparation phase

1. The source eNodeB decides to initiate a PS handover to the target access network, UTRAN Iu mode. At this point both uplink and downlink user data is transmitted via the following: Bearer(s) between UE and source eNodeB, GTP tunnel(s) between source eNodeB, Serving GW and PDN GW.
2. The source eNodeB sends a Relocation Required (Cause, Target RNC Identifier, Source eNodeB Identifier, Source to Target Transparent Container, Bearers Requesting Data Forwarding List) message to the source MME to request the CN to establish resources in the target RNC, target SGSN and the Serving GW. Bearers Requesting Data Forwarding List contains that list of bearers for which the source eNodeB decided that data forwarding (direct or indirect) is necessary.
3. The source MME will forward the request to the target SGSN using the message Forward Relocation Request (IMSI, Target Identification, MM Context, PDP Context, PDP Context Prioritization, Tunnel Endpoint Identifier Control Plane, MME Address for Control plane, Source to Target Transparent Container, S1-AP Cause Direct Forwarding Flag). This message includes all PDP contexts corresponding to the bearers established in the source system and the uplink Tunnel endpoint parameters of the Serving GW. 'Direct Forwarding Flag' IE indicates if Direct Forwarding of payload PDUs to Target side shall be used or not. This flag is set by the source MME.

The MM context contains security related information, e.g. supported ciphering algorithms as described in 3GPP TS 29.060 [14]. **The relation between UTRAN and EPS security parameters is FFS.**

Editor's note: It is FFS if the EPS bearers are mapped 1:1 to PDP contexts. It is FFS how the mapping is done. It is FFS how the bearer identifiers are mapped.

The target SGSN determines if the Serving GW is relocated, e.g., due to PLMN change. If the Serving GW is relocated, the target SGSN selects the target Serving GW as described under clause 4.3.7.2 on "Serving GW selection function".

Editor's note: Serving GW change needs to be described in the signalling flow.

4. The target SGSN will request the target RNC to establish the necessary resources (RABs) by sending the message Relocation Request (UE Identifier, Cause, CN Domain Indicator, Integrity protection information (i.e. IK and allowed Integrity Protection algorithms), Encryption information (i.e. CK and allowed Ciphering algorithms), RAB to be setup list, Source to Target Transparent Container, Serving GW Address(es) and TEID(s) for User Traffic Data). The ciphering and integrity protection keys will be sent transparently from the target RNC to the UE in the Target to Source Transparent Container.

- 4a. The target access network allocates the resources and returns the applicable parameters to the target SGSN in the message Relocation Request Acknowledge(Target to Source Transparent Container, RABs setup list, RABs failed to setup list).
5. If the "Direct Forwarding" is not applicable, the Target SGSN shall send the message Create Bearer Request (Cause, RNC Address(es) and TEID(s) for User Traffic) to the Serving GW used for indirect packet forwarding. Indirect forwarding may be performed via a Serving GW which is different from the Serving GW used as the anchor point for the UE.

Editor's note: It is FFS if this step should use "Create" or "Update" Bearer Request message.

- 5a. The Serving GW returns the forwarding parameters by sending the message Create Bearer Response (Cause, Serving GW Address(es) and TEID(s) for Data Forwarding). If the Serving GW doesn't support data forwarding, an appropriate cause value shall be returned and the Serving GW Address(es) and TEID(s) will not be included in the message.

Editor's note: It's currently an open issue if the source MME or the target SGSN updates the Serving GW about the mapping between bearers and PDP contexts.

6. The target SGSN completes the preparation phase by sending the message Forward Relocation Response (Cause, Tunnel Endpoint Identifier Control Plane, RANAP cause, SGSN Address for control plane, SGSN number, Target to Source Transparent Container, RAB Setup Information, Additional RAB Setup Information, Address(es) and TEID(s) for User Traffic Data Forwarding) to the source MME.

If 'Direct Forwarding' is applicable, then the IEs 'Address(es) and TEID(s) for User Traffic Data Forwarding' contain the GTP-U tunnel endpoint parameters to the Target RNC. Otherwise the IEs "Address(es) and TEID(s) for User Traffic Data Forwarding" contain the GTP-U tunnel endpoint parameters to the Serving GW (see step 5a).

Editor's note: The ordering of step 5 and step 6 is FFS, i.e. if the Source MME or Target SGSN will inform the Serving GW regarding the data forwarding tunnel end-points parameters

5.5.2.1.3 Execution phase

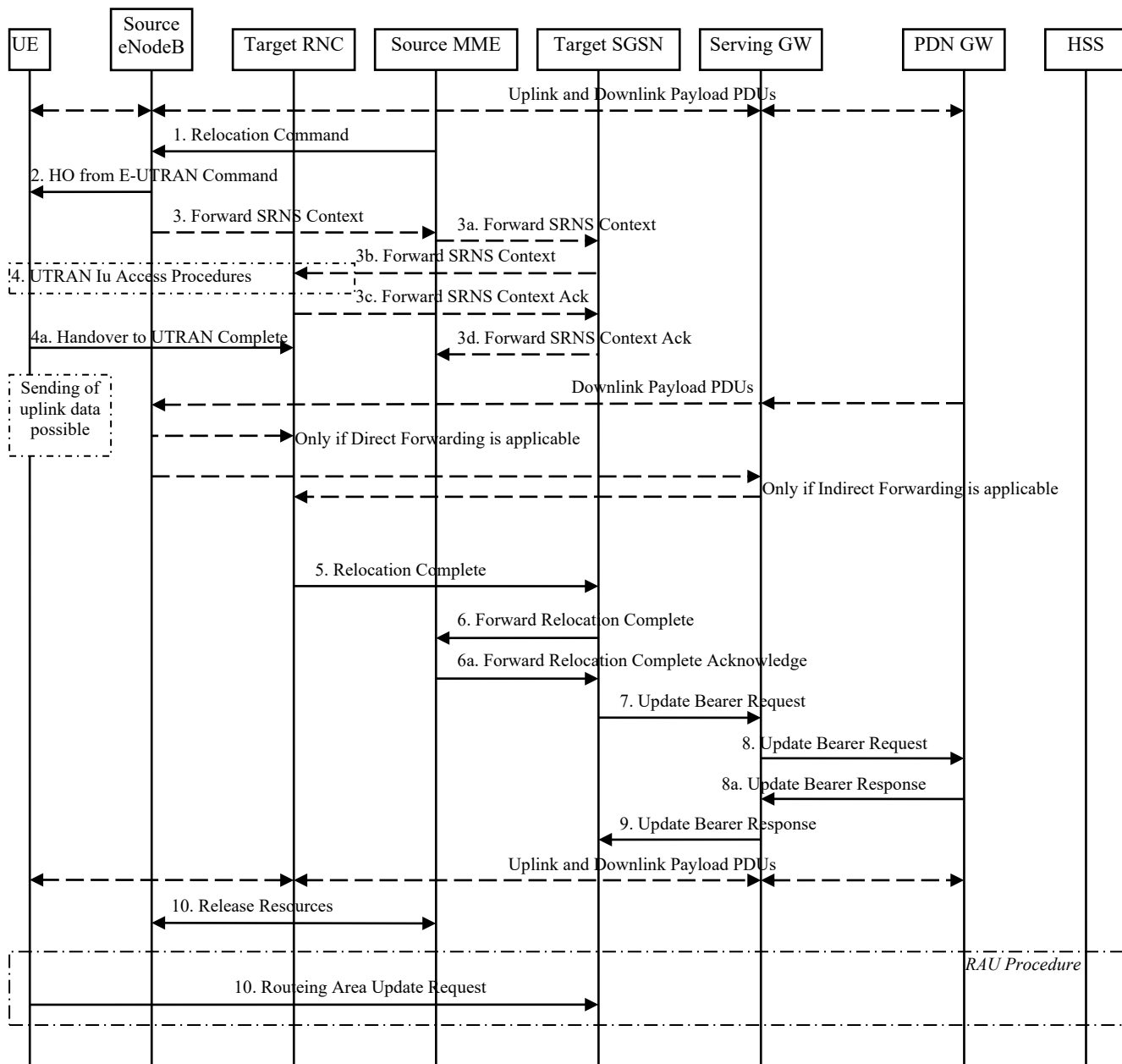


Figure 5.5.2.1-2: E-UTRAN to UTRAN Iu mode Inter RAT HO, execution phase

1. The source MME completes the preparation phase towards source eNodeB by sending the message Relocation Command (Target to Source Transparent Container, Bearers Subject to Data Forwarding List). "Bearers Subject to Data forwarding list" may be included in the message and it shall be a list of 'Address(es) and TEID(s) for user traffic data forwarding' received from target side in the preparation phase (Step 6)..

The source eNodeB initiates data forwarding for bearers specified in the "Bearers Subject to Data Forwarding List". The data forwarding may go directly to target RNC or alternatively go via the Serving GW if so decided by source MME and or/ target SGSN in the preparation phase.

2. The source eNodeB will give a command to the UE to handover to the target access network via the message HO from E-UTRAN Command. This message includes a transparent container including radio aspect parameters that

the target RNC has set-up in the preparation phase. The details of this E-UTRAN specific signalling are described in 3GPP TS 36.300 [5].

3. The source eNodeB informs the source MME which then informs the target SGSN regarding "delivery order" parameters in the message Forward SRNS Context. The Target SGSN forwards the SRNS Context to the Target RNC.

Editor's Note: The need for step 3 is FFS.

4. The UE moves to the target UTRAN Iu (3G) system and executes the handover according to the parameters provided in the message delivered in step 2. The procedure is the same as in step 6 in subclause 5.2.2.2 in TS 43.129 [8] with the additional function of association of the received RABs and existing Bearer Id related to the particular NSAPI. **Relation between NSAPI, RAB and Bearer Id is FFS.**

The UE may resume the user data transfer only for those NSAPIs for which there are radio resources allocated in the target RNC.

5. When the UE has successfully accessed the target RNC, the target RNC informs the target SGSN about the completion of the PS Handover procedure by sending the message Relocation Complete..
6. Then the target SGSN knows that the UE has arrived to the target side and target SGSN informs the source MME by sending the message Forward Relocation Complete. The source MME will also acknowledge that information. Further action in the source MME continues at step 10.
7. The target SGSN will now complete the PS Handover procedure by informing the Serving GW that the target SGSN is now responsible for all the PDP Context the UE have established. This is performed in the message Update Bearer Request (Cause, Tunnel Endpoint Identifier Control Plane, NSAPI, SGSN Address for Control Plane, RNC Address(es) and TEID(s) for User Traffic, and RAT type)..
8. The Serving GW may inform the PDN GW(s) the change of for example the RAT type that e.g. can be used for charging, by sending the message Update Bearer Request. The PDN GW must acknowledge the request with the message Update Bearer Response. **This is FFS.**
9. The Serving GW acknowledges the user plane switch to the target SGSN via the message Update Bearer Response (Cause, Tunnel Endpoint Identifier Control Plane, and Serving GW Address for Control Plane). At this stage the user plane path is established for all PDP contexts between the UE, target RNC, target SGSN, Serving GW and PDN GW.

Editor's Note: It is FFS when the Serving GW releases the resources used for indirect forwarding.

10. After the source MME has received the Forward Relocation Complete message, it sends a Release Resources message to the source eNodeB. When the Release Resources message has been received and there is no longer any need for the eNodeB to forward data, the Source eNodeB releases its resources.
11. The UE sends a Routeing Area Update Request message that triggers a subset of Routeing Area Update procedure in the Target SGSN as described in 3GPP TS 23.060 [7]. Part of the Routeing Area Update procedure is the Cancel Location message from HSS. When the Source MME receives the Cancel Location message the source MME releases the bearer(s) in the Serving GW by sending a Delete Bearer Request message. Note that only the signalling relationship is released between the Serving GW and the source MME, but the UE context continues to exist in the Serving GW.

Editor's Note: It is FFS when the bearer(s) between Source MME and Serving GW shall be released if the Cancel Location message is not received.

5.5.2.2 UTRAN Iu mode to E-UTRAN Inter RAT handover based on PS handover

5.5.2.2.1 General

Pre-conditions:

- The UE is in PMM_CONNECTED state (UTRAN Iu mode).

5.5.2.2.2 Preparation phase

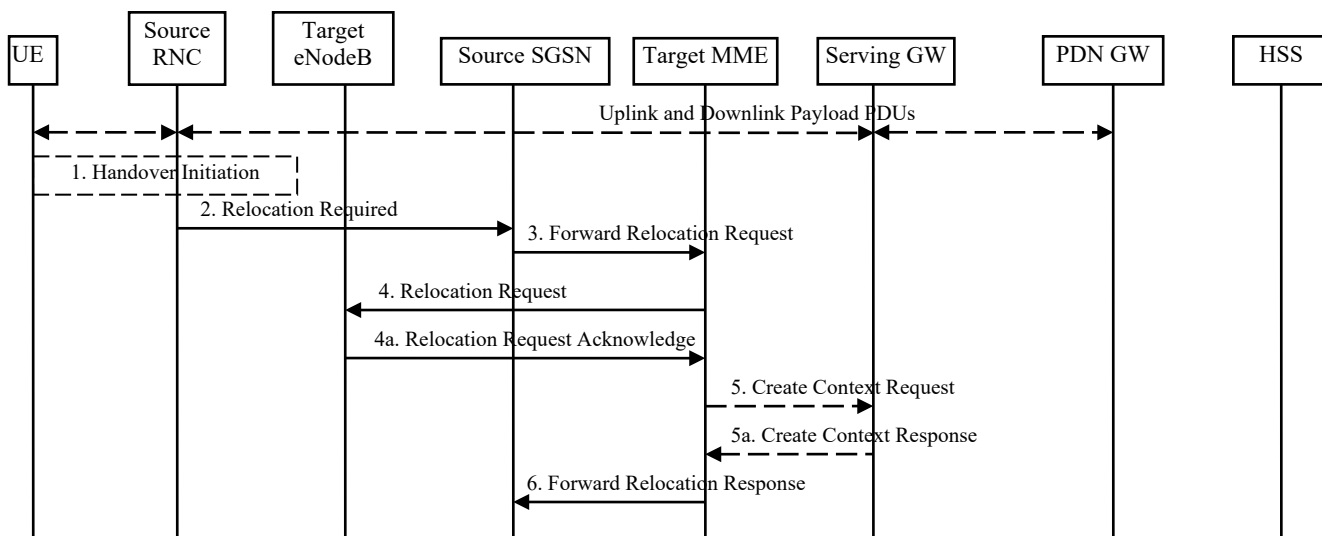


Figure 5.5.2.2-1: UTRAN Iu mode to E-UTRAN Inter RAT HO, preparation phase

1. The source RNC decides to initiate a PS handover to the E-UTRAN. At this point both uplink and downlink user data is transmitted via the following: Bearers between UE and source RNC, GTP tunnel(s) between source RNC, Serving GW and PDN GW.
2. The source RNC sends a Relocation Required (Cause, Target eNodeB Identifier, Source RNC Identifier, Source to Target Transparent Container, Bearers Requesting Data Forwarding List) message to the source SGSN to request the CN to establish resources in the target eNodeB, Target MME and the Serving GW. Bearers Requesting Data Forwarding List contains that list of bearers for which the source RNC decided that data forwarding (direct or indirect) is necessary.
3. The source SGSN will forward the request to the target MME using the message Forward Relocation Request (IMSI, Target Identification, MM Context, PDP Context, PDP Context Prioritization, Tunnel Endpoint Identifier Control Plane, SGSN Address for Control plane, Source to Target Transparent Container, Direct Forwarding Flag). This message includes all PDP contexts corresponding to the bearers established in the source system and the uplink Tunnel endpoint parameters of the Serving GW.

The 'Direct Forwarding Flag' IE indicates if Direct Forwarding of payload PDUs to Target side shall be used or not. This flag is set by the source SGSN.

The MM context contains security related information, e.g. supported ciphering algorithms as described in 3GPP TS 29.060 [14]. **The relation between UTRAN and EPS security parameters is FFS.**

The target MME selects the ciphering algorithm to use. This algorithm will be sent transparently from the target eNodeB to the UE in the Target to Source Transparent Container.

Editor's note: This needs to be aligned with security requirements for Release 8.

Editor's note: It is FFS if the EPS bearers are mapped 1:1 to PDP contexts. It is FFS how the mapping is done. It is FFS how the bearer identifiers are mapped.

The target MME determines if the Serving GW is relocated, e.g. due to PLMN change. If the Serving GW is relocated, the target SGSN selects the target Serving GW as described under clause 4.3.7.2 on "Serving GW selection function".

Editor's note: Serving GW change needs to be described in the signalling flow.

4. The target MME will request the target eNodeB to establish the bearer(s) by sending the message Relocation Request (UE Identifier, Cause, CN Domain Indicator, Integrity protection information (i.e. IK and allowed Integrity Protection algorithms), Encryption information (i.e. CK and allowed Ciphering algorithms), EPS Bearers to be setup list, Source to Target Transparent Container, Serving GW Address(es) and TEID(s) for User Traffic Data).

- 4a. The target eNodeB allocates the request resources and returns the applicable parameters to the target MME in the message Relocation Request Acknowledge (Target to Source Transparent Container, EPS Bearers setup list, EPS Bearers failed to setup list).
- 5) If "Direct Forwarding" is not applicable, the Target MME shall send the message Create Bearer Request (Cause, eNodeB Address(es) and TEID(s) for User Traffic) to the Serving GW used for indirect packet forwarding.

Indirect forwarding may be performed via a Serving GW which is different from the Serving GW used as the anchor point for the UE.

Editor's note: It is FFS if this step should use "Create" or "Update" Bearer Request message.

- 5a) The Serving GW returns the forwarding payload parameters by sending the message Create Bearer Response (Cause, Serving GW Address(es) and TEID(s) for Data Forwarding). If the Serving GW doesn't support data forwarding, an appropriate cause value shall be returned and the Serving GW Address(es) and TEID(s) will not be included in the message.
6. The target MME completes the preparation phase by sending the message Forward Relocation Response (Cause, List of Set Up RABs, Tunnel Endpoint Identifier Control Plane, S1-AP cause, MME Address for control plane, Target to Source Transparent Container, Address(es) and TEID(s) for Data Forwarding) to the source SGSN.

If "Direct Forwarding" is used, the IEs 'Address(es) and TEID(s) for Data Forwarding' contain the GTP-U tunnel endpoint parameters to the eNodeB. Otherwise the IEs 'Address(es) and TEID(s) for Data Forwarding' contain the GTP-U tunnel endpoint parameters to the Serving GW (see step 5a).

Editor's note: The ordering of step 5 and step 6 is FFS, i.e. if the Source SGSN or Target MME will inform the Serving GW regarding the data forwarding tunnel end-points parameters.

5.5.2.2.3 Execution phase

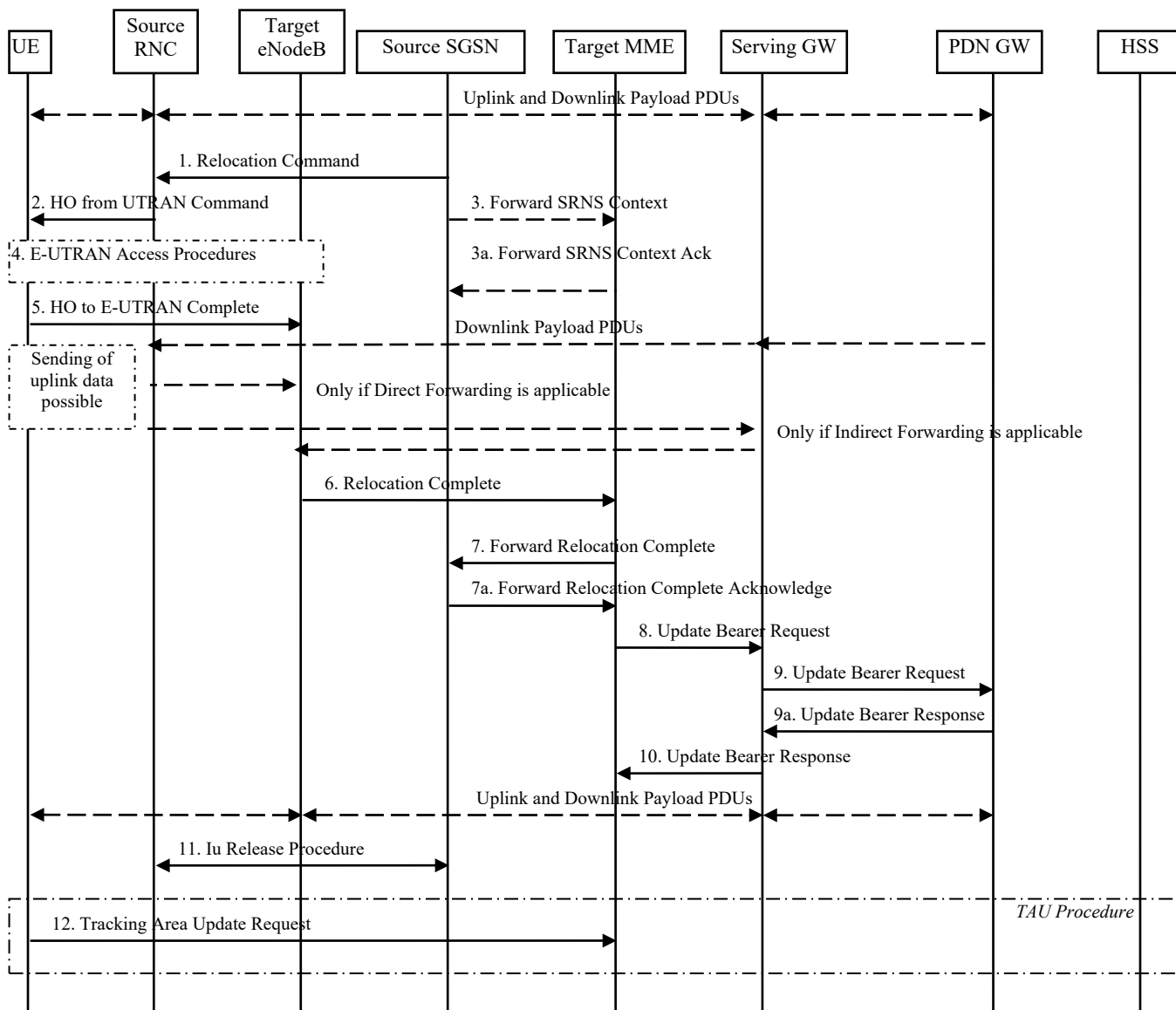


Figure 5.5.2.2-2: UTRAN Iu mode to E-UTRAN Inter RAT HO, execution phase

1. The source SGSN completes the preparation phase towards source RNC by sending the message Relocation Command (Target to Source Transparent Container, RABs to be Released List, RABs Subject to Data Forwarding List). "RABs to be Released list" will be the list of all NSAPIs (RAB Ids) for which a Bearer was not established in Target eNode. "RABs Subject to Data forwarding list" may be included in the message and it shall be a list of 'Address(es) and TEID(s) for user traffic data forwarding' received from target side in the preparation phase (Step 6)).

2. The source RNC will command to the UE to handover to the target eNodeB. The access network specific message to UE includes a transparent container including radio aspect parameters that the target eNodeB has set-up in the preparation phase. **The procedures for this are FFS.**

The source RNC may initiate data forwarding for the indicated RABs/PDP contexts specified in the "RABs Subject to Data Forwarding List". The data forwarding may go directly to target eNodeB, or alternatively go e.g. via the Serving GW if so decided by source SGSN and/or target MME in the preparation phase.

3. The source SGSN informs the target MME regarding source access network contexts in the message Forward SRNS Context.

The target MME forwards the SRNS Context to eNodeB.

The need for the step 3 is *FFS*.

4. The UE moves to the E-UTRAN and performs access procedures toward target eNodeB.
5. When the UE has got access to target eNodeB it sends the message HO to E-UTRAN Complete.
6. When the UE has successfully accessed the target eNodeB, the target eNodeB informs the target MME by sending the message Relocation Complete.
7. Then the target MME knows that the UE has arrived to the target side and target MME informs the source SGSN by sending the message Forward Relocation Complete. The source SGSN will also acknowledge that information. Further action in the source SGSN continues at step 11.
8. The target MME will now complete the PS Handover procedure by informing the Serving GW that the target MME is now responsible for all the bearers the UE have established. This is performed in the message Update Bearer Request (Cause, Tunnel Endpoint Identifier Control Plane, NSAPI, MME Address for Control Plane, eNodeB Address(es) and TEID(s) for User Traffic, and RAT type).
9. The Serving GW may inform the PDN GW the change of for example the RAT type that e.g. can be used for charging, by sending the message Update Bearer Request. The PDN GW must acknowledge the request with the message Update Bearer Response. *This is FFS*.
10. The Serving GW acknowledges the user plane switch to the target MME via the message Update Bearer Response (Cause, Tunnel Endpoint Identifier Control Plane, and Serving GW Address for Control Plane). At this stage the user plane path is established for all bearers between the UE, target eNodeB, Serving GW and PDN GW.

Editor's Note: It is FFS when the Serving GW releases the resources used for indirect forwarding.

11. After step 7 the source SGSN will clean-up all its resources towards source RNC by performing the Iu Release procedures. When there is no longer any need for the RNC to forward data, the source RNC responds with an Iu Release Complete message.
12. The UE sends a Tracking Area Update Request message that triggers a subset of Tracking Area Update procedure (see clause 5.3.2). Part of the Tracking Area Update procedure is the Cancel Location message from HSS. When the Source SGSN receives the Cancel Location message the source SGSN releases the bearer(s) in the Serving GW by sending a Delete Bearer Request message. Note that only the signalling relationship is released between the Serving GW and the source MME, but the UE context continues to exist in the Serving GW.

Editor's Note: It is FFS when the bearer(s) between Source SGSN and Serving GW shall be released if the Cancel Location message is not received.

5.5.2.3 E-UTRAN to GERAN A/Gb mode Inter RAT handover based on PS handover

5.5.2.3.1 General

Pre-conditions:

- The UE is in LTE_ACTIVE state (E-UTRAN mode).
- The BSS must support PFM, Packet Flow Management, procedures.

5.5.2.3.2 Preparation phase

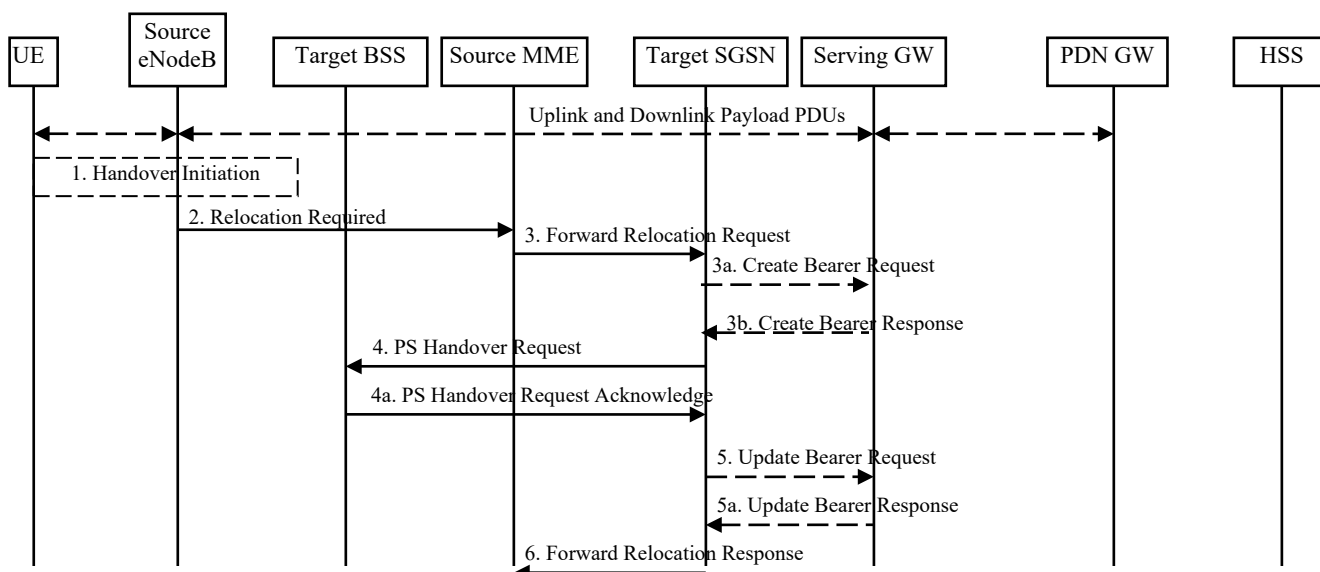


Figure 5.5.2.3-1: E-UTRAN to GERAN A/Gb Inter RAT HO, preparation phase

1. The source eNodeB decides to initiate a PS handover to the target GERAN A/Gb mode (2G) system. At this point both uplink and downlink user data is transmitted via the following: Bearer(s) between UE and Source eNodeB, GTP tunnel(s) between Source eNodeB, Serving GW and PDN GW.
2. The source eNodeB sends a Relocation Required (Cause, Target System Identifier, Source eNodeB Identifier, Source to Target Transparent Container, Bearers Requesting Data Forwarding List) message to the Source MME to request the CN to establish resources in the Target BSS, Target SGSN and the Serving GW.

The 'Target System Identifier' IE contains the identity of the target global cell Id. Bearers Requesting Data Forwarding List contains that list of bearers for which the source eNodeB decided that data forwarding (direct or indirect) is necessary.

3. The Source MME will forward the request to the target SGSN using the message Forward Relocation Request (IMSI, Target Identification (shall be set to "empty"), MM Context, PDP Context, PDP Context Prioritization, Tunnel Endpoint Identifier Control Plane, MME Address for Control plane, Source to Target Transparent Container, Packet Flow ID (if available), XID parameters (if available), Cell Identification, Direct Forwarding Flag). This message includes all PDP contexts corresponding to the bearers established in the source system and the uplink Tunnel endpoint parameters of the Serving GW.

The 'Direct Forwarding Flag' IE indicates if Direct Forwarding of payload PDUs to Target side shall be used or not. This flag is set by the source MME.

The MM context contains security related information, e.g. supported ciphering algorithms, as described in 3GPP TS 29.060 [14]. **The relation between GSM and EPS security parameters is FFS.**

The target SGSN selects the ciphering algorithm to use. This algorithm will be sent transparently from the target SGSN to the UE in the NAS container for PS Handover (part of the Target to Source Transparent Container). The IOV-UI parameter, generated in the target SGSN, is used as input to the ciphering procedure and it will also be transferred transparently from the target SGSN to the UE in the NAS container for PS Handover.

Editor's note: This needs to be aligned with security requirements for Release 8.

Editor's note: It is FFS if the EPS bearers are mapped 1:1 to PDP contexts. It is FFS how the mapping is done. It is FFS how the bearer identifiers are mapped.

The target SGSN determines if the Serving GW is relocated, e.g. due to PLMN change. If the Serving GW is relocated, the target SGSN selects the target Serving GW as described under clause 4.3.7.2 on "Serving GW selection function".

Editor's note: Serving GW change needs to be described in the signalling flow.

4. The Target SGSN will request the Target BSS to establish the necessary resources (PFCs) by sending the message PS Handover Request (TLLI, IMSI, Cause, Target Cell Identifier, PFCs to be set-up list, Source to Target Transparent Container and NAS container for PS handover).
- 4a. The Target BSS allocates the requested resources and returns the applicable parameters to the Target SGSN in the message PS Handover Request Acknowledge (TLLI, List of set-up PFCs, Target to Source Transparent Container).

The NAS container for PS Handover, received by Target BSS in step 4, is part of the Target to Source Transparent Container.

5. If "Direct Forwarding" is not applicable, the Target SGSN shall send the message Update Bearer Request (Cause, SGSN Address(es) and TEID(s) for User Traffic) to the Serving GW used for indirect packet forwarding.

Indirect forwarding may be performed via a Serving GW which is different from the Serving GW used as the anchor point for the UE.

Editor's note: It is FFS if this step should use "Create" or "Update" Bearer Request message.

- 5a) The Serving GW returns the forwarding payload parameters by sending the message Update Bearer Response (Cause, Serving GW Address(es) and TEID(s) for Data Forwarding). If the Serving GW doesn't support data forwarding, an appropriate cause value shall be returned and the Serving GW Address(es) and TEID(s) will not be included in the message.

NOTE: It's currently an open issue if the source MME or the target SGSN updates the Serving GW about the mapping between bearers and PDP contexts.

6. The Target SGSN completes the preparation phase by sending the message Forward Relocation Response (Cause, Tunnel Endpoint Identifier Control Plane, SGSN Address for Control Plane, Target to Source Transparent Container, BSSGP Cause, List of set-up PFIs, Address(es) and TEID(s) for User Traffic Data Forwarding) to the Source MME.

If "Direct Forwarding" is applicable, then the IEs 'Address(es) and TEID(s) for User Traffic Data Forwarding' contain the GTP-U tunnel endpoint parameters to the Target SGSN. Otherwise the IEs 'Address(es) and TEID(s) for User Traffic Data Forwarding' contain the GTP-U tunnel endpoint parameters to the Serving GW (see step 5a).

Editor's note: The ordering of step 5 and step 6 is FFS, i.e. if the Source MME or Target SGSN will inform the Serving GW regarding the data forwarding tunnel end-points parameters.

5.5.2.3.3 Execution phase

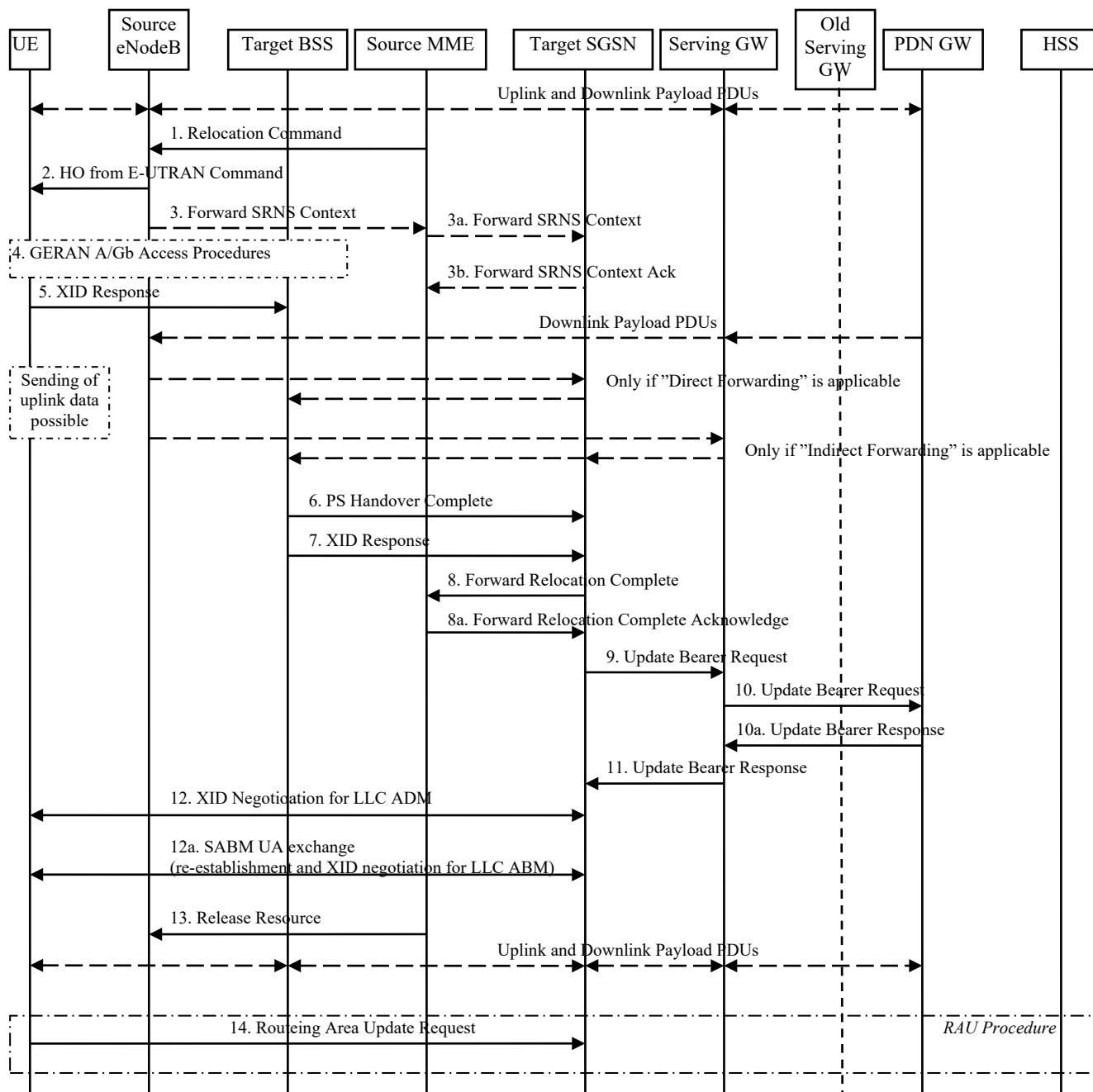


Figure 5.5.2.3-1: E-UTRAN to GERAN A/Gb mode Inter RAT HO, execution phase

1. The Source MME completes the preparation phase towards Source eNodeB by sending the message Relocation Command (Target to Source Transparent Container (PS Handover Command with RN part and EPC part), Bearers Subject to Data Forwarding List). "Bearers Subject to Data forwarding list" may be included in the message and it shall be a list of 'Address(es) and TEID(s) for user traffic data forwarding' received from target side in the preparation phase (Step 6).

Source eNodeB initiate data forwarding for the bearers specified in the "Bearers Subject to Data Forwarding List". The data forwarding may go directly i.e. to target SGSN or alternatively go via the Serving GW if so decided by source MME and/or target SGSN in the preparation phase.

2. The Source eNodeB will give a command to the UE to handover to the Target Access System via the message HO from E-UTRAN Command. This message includes a transparent container including radio aspect parameters that the Target BSS has set-up in the preparation phase. This message also includes the XID and IOV-UI parameters received from the Target RNC.
3. The Source eNodeB informs the Source MME which then informs the Target SGSN regarding "delivery order" parameters in the message Forward SRNS Context.

The need for step 3 is FFS.

4. The UE moves to the Target GERAN A/Gb (2G) system and performs executes the handover according to the parameters provided in the message delivered in step 2. The procedure is the same as in step 6 in subclause 5.3.2.2 in TS 43.129 [8] with the additional function of association of the received PFI and existing Bearer Id related to the particular NSAPI. *Relation between NSAPI, PFI and Bearer Id is FFS.*
5. When the UE has successfully accessed the Target BSS, it sends the message XID response. Upon sending the XID Response message, the UE shall resume the user data transfer only for those NSAPIs for which there are radio resources allocated in the target cell. For NSAPIs using LLC ADM, for which radio resources were not allocated in the target cell, the MS may request for radio resources using the legacy procedures.

If the Target SGSN indicated XID Reset (i.e. reset to default XID parameters) in the NAS container included in the Handover from E-UTRAN Command message, and to avoid collision cases the mobile station may avoid triggering XID negotiation for any LLC SAPI used in LLC ADM, but wait for the SGSN to do so (see step 12). In any case the mobile station may avoid triggering XID negotiation for any LLC SAPI used in LLC ABM, but wait for the SGSN to do so (see step 12a).

This step is the same as specified in clause 5.3.2.2 in TS 43.129 [8].

6. Upon reception of the first correct RLC/MAC block (sent in normal burst format) from the UE to the Target BSS, the Target BSS informs the Target SGSN by sending the message PS Handover Complete (IMSI, and Local TLLI).
7. The Target BSS also relays the message XID Response to the Target SGSN. Note, the message in step 6 and 7 may arrive in any order in the Target SGSN.
8. Then the Target SGSN knows that the UE has arrived to the target side and Target SGSN informs the Source MME by sending the message Forward Relocation Complete. The Source MME will also acknowledge that information. Further action in the Source MME continues at step 13.
9. The Target SGSN will now complete the PS Handover procedure by informing the Serving GW that the Target SGSN is now responsible for all the PDP Context the UE have established. This is performed in the message Update Bearer Request (Cause, Tunnel Endpoint Identifier Control Plane, NSAPI, SGSN Address for Control Plane, SGSN Address(es) and TEID(s) for User Traffic, and RAT type).
10. The Serving GW informs the PDN GW the change of, for example, the RAT type, that e.g. can be used for charging, by sending the message Update Bearer Request. The PDN GW must acknowledge the request with the message Update Bearer Response. *This is FFS.*
11. The Serving GW acknowledges the user plane switch to the Target SGSN via the message Update Bearer Response (Cause, Tunnel Endpoint Identifier Control Plane, and Serving GW Address for Control Plane). At this stage the user plane path is established for all PDP contexts between the UE, Target BSS, Target SGSN, Serving GW and PDN GW.
- 12) If the Target SGSN indicated XID Reset (i.e. reset to default XID parameters) in the NAS container included in the Handover from E-UTRAN Command message, then on receipt of the PS Handover Complete the Target SGSN initiates an LLC/SNDCP XID negotiation for each LLC SAPI used in LLC ADM. In this case if the Target SGSN wants to use the default XID parameters, it shall send an empty XID Command. If the Target SGSN indicated 'Reset to the old XID parameters' in the NAS container, no further XID negotiation is required for LLC SAPIs used in LLC ADM only.
- 12a) The Target SGSN (re-)establishes LLC ABM for the PDP contexts which use acknowledged information transfer. During the exchange of SABM and UA the SGSN shall perform LLC/SNDCP XID negotiation.

These steps (12 and 12a) are the same as specified in clause 5.3.2.2 in TS 43.129 [8].

13. After the source MME has received the Forward Relocation Complete message, it sends a Release Resources message to the source eNodeB. When the Release Resources message has been received and there is no longer any need for the eNodeB to forward data, the Source eNodeB releases its resources.
14. The UE sends a Routeing Area Update Request message that triggers a subset of Routeing Area Update procedure in target SGSN as described in 3GPP TS 23.060 [7]. Part of the Routeing Area Update procedure is the Cancel Location message from HSS. When the Source MME receives the Cancel Location message the source MME releases the bearer(s) in the Serving GW by sending a Delete Bearer Request message. Note that only the signalling relationship is released between the Serving GW and the source MME, but the UE context continues to exist in the Serving GW.

Editor's Note: It is FFS when the bearer(s) between Source MME and Serving GW shall be released if the Cancel Location message is not received.

5.5.2.4 GERAN A/Gb mode to E-UTRAN Inter RAT handover based on PS handover

5.5.2.4.1 General

Pre-conditions:

- The UE is in READY state (GERAN A/Gb mode).
- The UE has at least one PDP Context established.
- The BSS must support PFM, Packet Flow Management, procedures.

5.5.2.4.2 Preparation phase

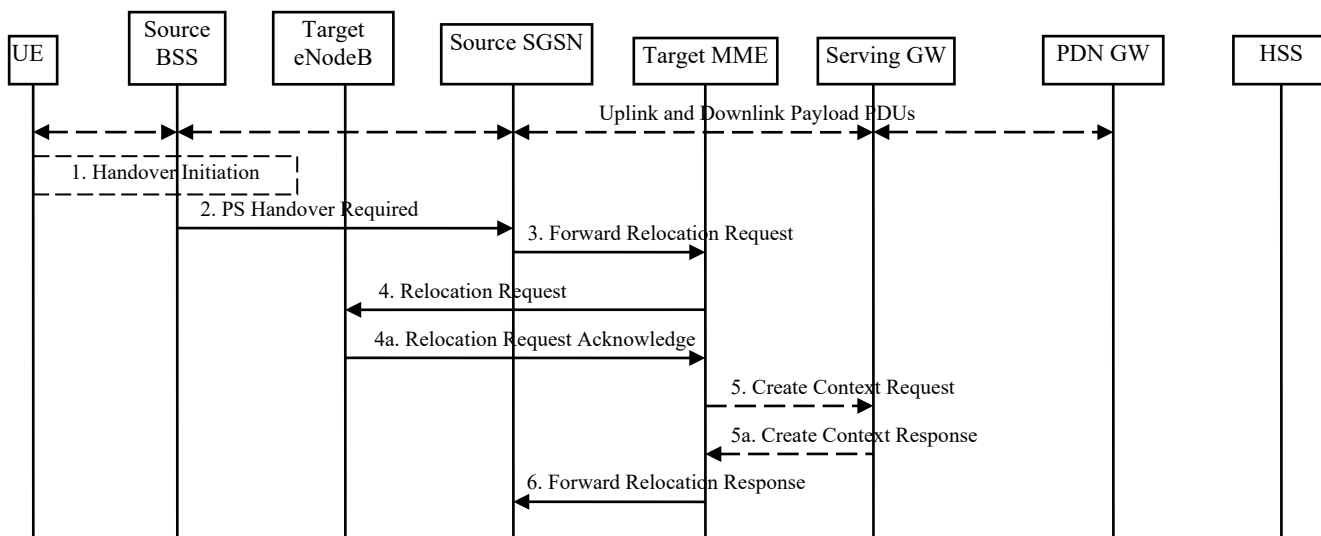


Figure 5.5.2.4-1: GERAN A/Gb mode to E-UTRAN inter RAT HO, preparation phase

- 1) The source access system, Source BSS, decides to initiate a PS handover to the E-UTRAN. At this point both uplink and downlink user data is transmitted via the following: Bearers between UE and Source BSS, BSSGP PFC tunnel(s) between source BSS and source SGSN, GTP tunnel(s) between Source SGSN, Serving GW and PDN GW.
- 2) The source BSS sends the message PS handover Required (TLLI, Cause, Source Cell Identifier, Target eNodeB Identifier, Source to Target Transparent Container, and active PFCs list) towards Source SGSN to request the CN to establish resources in the Target eNodeB, Target MME and the Serving GW.
- 3) The Source SGSN will forward the request to the Target MME using the message Forward Relocation Request (IMSI, Target Identification, MM Context, PDP Context, PDP Context Prioritization, Tunnel Endpoint Identifier Control Plane, SGSN Address for Control plane, Source to Target Transparent Container, Packet Flow ID, SMDCP XID parameters, LLC XID parameters, and Direct Forwarding Flag). This message includes all PDP contexts that are established in the source system and the uplink Tunnel endpoint parameters of the Serving GW.

The 'Direct Forwarding Flag' IE indicates if Direct Forwarding of payload PDUs to Target side shall be used or not. This flag is set by the source SGSN.

The MM context contains security related information, e.g. supported ciphering algorithms as described in 3GPP TS 29.060 [14]. **The relation between GSM and EPS security parameters is FFS.**

Editor's note: It is FFS if the EPS bearers are mapped 1:1 to PDP contexts. It is FFS how the mapping is done. It is FFS how the bearer identifiers are mapped.

The target MME determines if the Serving GW is relocated, e.g. due to PLMN change. If the Serving GW is relocated, the target SGSN selects the target Serving GW as described under clause 4.3.7.2 on "Serving GW selection function".

Editor's note: Serving GW change needs to be described in the signalling flow.

- 4) The Target MME will request the Target eNodeB to establish the Bearer(s) by sending the message Relocation Request (UE Identifier, Cause, CN Domain Indicator, Integrity protection information (i.e. IK and allowed Integrity Protection algorithms), Encryption information (i.e. CK and allowed Ciphering algorithms), EPS Bearers to be setup list, Source to Target Transparent Container, Serving GW Address(es) and TEID(s) for User Traffic Data).

The ciphering and integrity protection keys will be sent transparently from the target eNodeB to the UE in the Target to Source Transparent Container.

- 4a) The Target eNodeB allocates the request resources and returns the applicable parameters to the Target MME in the message Relocation Request Acknowledge (Target to Source Transparent Container, EPS Bearers setup list, EPS Bearers failed to setup list).
5. If "Direct Forwarding" is not applicable, the Target MME shall send the message Create Bearer Request (Cause, eNodeB Address(es) and TEID(s) for User Traffic) to the Serving GW used for indirect packet forwarding.

Indirect forwarding may be performed via a Serving GW which is different from the Serving GW used as the anchor point for the UE.

Editor's note: It is FFS if this step should use "Create" or "Update" Bearer Request message.

- 5a) The Serving GW returns the forwarding payload parameters by sending the message Create Bearer Response (Cause, Serving GW Address(es) and TEID(s) for Data Forwarding). If the Serving GW doesn't support data forwarding, an appropriate cause value shall be returned and the Serving GW Address(es) and TEID(s) will not be included in the message.
- 6) The Target MME completes the preparation phase by sending the message Forward Relocation Response (Cause, List of Set Up PFCs, Tunnel Endpoint Identifier Control Plane, S1-AP cause, MME Address for control plane, Target to Source Transparent Container, Address(es) and TEID(s) for Data Forwarding) to the Source SGSN.

If 'Direct Forwarding' is applicable, the IEs 'Address(es) and TEID(s) for Data Forwarding' contain the GTP-U tunnel endpoint parameters to the eNodeB. Otherwise the IEs 'Address(es) and TEID(s) for Data Forwarding' contain the GTP-U tunnel endpoint parameters to the Serving GW (see step 5a).

Editor's note: The ordering of step 5 and step 6 is FFS, i.e. if the Source SGSN or Target MME will inform the Serving GW regarding the data forwarding tunnel end-points parameters.

5.5.2.4.3 Execution phase

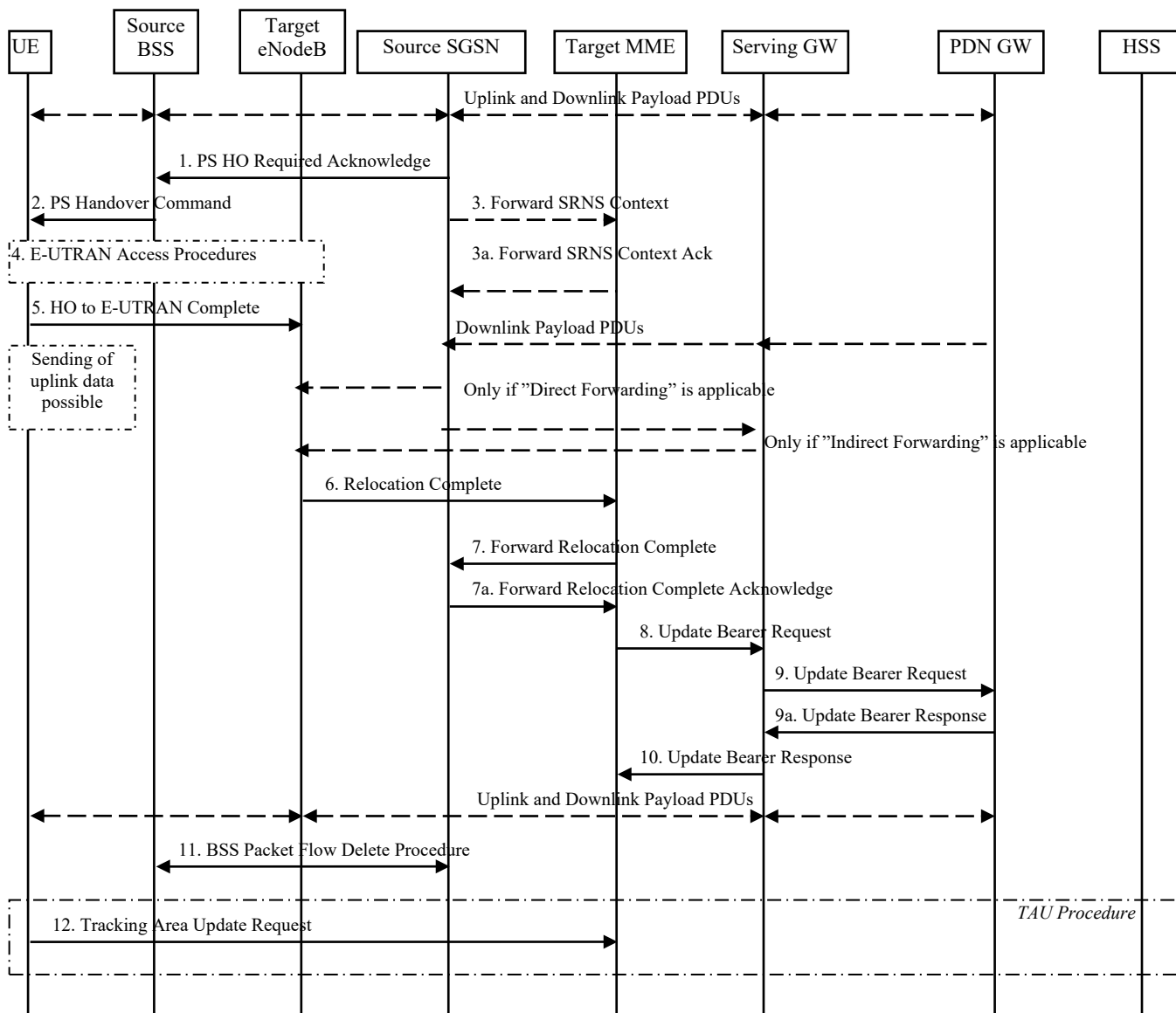


Figure 5.5.2.4-2: GERAN A/Gb mode to E-UTRAN Inter RAT HO, execution phase

1. The Source SGSN completes the preparation phase towards Source BSS by sending the message PS HO Required Acknowledge (TLLI, List of Set Up PFCs, Target to Source Transparent Container). This message includes all PFIs that could be established on the Target side.
2. The Source BSS will command the UE to handover to the target eNodeB. The access system specific message to UE includes a transparent container including radio aspect parameters that the Target eNodeB has set-up in the preparation phase. **The procedures for this are FFS.**

The source SGSN may initiate data forwarding for the PDP contexts. The data forwarding may go directly to target eNodeB or alternatively go via the Serving GW if so decided by source SGSN and/or target MME in the preparation phase.
3. Source SGSN informs the Target MME regarding source access system contexts in the message Forward SRNS Context.

The need for this step is FFS.
4. The UE moves to the E-UTRAN and performs access procedures toward Target eNodeB.
5. When the UE has got access to Target eNodeB it sends the message HO to E-UTRAN Complete.

6. When the UE has successfully accessed the Target eNodeB, the Target eNodeB informs the Target MME by sending the message Relocation Complete.
7. Then the Target MME knows that the UE has arrived to the target side and Target MME informs the Source SGSN by sending the message Forward Relocation Complete. The Source SGSN will also acknowledge that information. When the Forward Relocation Complete message has been received and there is no longer any need for the SGSN to forward data, the SGSN stops data forwarding. Further action in the Source SGSN continues at step 11.
8. The Target MME will now complete the PS Handover procedure by informing the Serving GW that the Target MME is now responsible for all the EPS bearers the UE have established. This is performed in the message Update Bearer Request (Cause, Tunnel Endpoint Identifier Control Plane, NSAPI, MME Address for Control Plane, eNodeB Address(es) and TEID(s) for User Traffic, and RAT type).
9. The Serving GW informs the PDN GW(s) the change of, for example, the RAT type, that e.g. can be used for charging, by sending the message Update Bearer Request. The PDN GW must acknowledge the request with the message Update Bearer Response. **This is FFS.**
10. The Serving GW acknowledges the user plane switch to the Target MME via the message Update Bearer Response (Cause, Tunnel Endpoint Identifier Control Plane, and Serving GW Address for Control Plane). At this stage the user plane path is established for all bearers between the UE, Target eNodeB, Serving GW and PDN GW.

Editor's Note: It is FFS when the Serving GW releases the resources used for indirect forwarding.

11. After step 7, the Source SGSN will clean-up all its resources towards Source BSS by performing the BSS Packet Flow Delete procedure.
12. The UE sends a Tracking Area Update Request message that triggers a subset of Tracking Area Update procedure in target MME (see clause 5.3.3). Part of the Tracking Area Update procedure is the Cancel Location message from HSS. When the Source SGSN receives the Cancel Location message the source SGSN releases the bearer(s) in the Serving GW by sending a Delete Bearer Request message. Note that only the signalling relationship is released between the Serving GW and the source MME, but the UE context continues to exist in the Serving GW.

Editor's Note: It is FFS when the bearer(s) between Source SGSN and Serving GW shall be released if the Cancel Location message is not received.

5.6 Information Storage

<This section describes the context information that is stored in the different nodes, eg in HSS, PDN GW, Serving GW, MME, eNodeB, UE, etc.

It also gives a high level overview of recovery and restoration procedures>

5.7 Charging

< This section gives a high level overview of the charging capabilities in EPC/E-UTRAN.>

5.8 MBMS

MBMS is a point-to-multipoint service in which data is transmitted from a single source entity to multiple recipients. Transmitting the same data to multiple recipients allows network resources to be shared.

The Evolved MBMS supports two modes, MBMS Broadcast Mode and MBMS Enhanced Broadcast Mode.

5.9 Interactions with Other Services

< This section describes the interactions with other services/features, eg location services, emergency/priority access, possibly terminal configuration, etc.>

Annex A (Normative): Agreed requirements, principles and content that should be moved to other TSs

< This section describes issues and agreements that, prior to approval of this Technical Specification, should be moved to other normative specifications, etc.>

A.1 Requirements derived from technical analysis

The local breakout architecture for the EPS shall satisfy the following design principles:

- It shall be possible for the UE to connect to one local PDN directly accessible through the VPLMN, to be used e.g. to gain connectivity with the public Internet. The connectivity with the local PDN directly accessible through the VPLMN shall be authorized by the HPLMN, based on operator's policies and customer's subscription profile.
- The UE shall be able to simultaneously connect to one PDN directly accessible through the VPLMN, such as the public Internet, and to PDNs reachable only from the HPLMN, such as a corporate network. The establishment of simultaneous connectivity with multiple PDNs shall be authorized by the HPLMN. For security reasons, it shall also be possible for the home operator to decide which of the subscribed PDNs can be accessed simultaneously by the UE.
- In case of IMS services, the usage of local breakout for the user plane related to a specific IMS session shall be authorized by the HPLMN. If local breakout is not authorized for a given IMS session, the user plane of that session shall be handled in home routed mode.

NOTE: the solution designed to address the principles listed above shall allow Rel8 UEs supporting simultaneous access to multiple PDNs to communicate with unmodified Rel7 UEs.

NOTE: A single application running on the UE shall not be required to send and receive traffic through multiple PDNs.

Annex B (Informative): Standardized QCI / Label Characteristics – Rationale and Principles

Table B-1 Standardized QCI/Label Characteristics

Name of QCI Characteristic (Note 1)	L2 Packet Delay Budget	L2 Packet Loss Rate	Example Services
1 (GBR)	< 50 ms	High (e.g. 10^{-1})	Realtime Gaming
2 (GBR)	50 ms (80 ms) (Note 2)	Medium (e.g. 10^{-2})	VoIMS
3 (GBR)	250 ms	Low (e.g. 10^{-3})	Streaming
4 (non-GBR)	Low (~50 ms)	e.g. 10^{-6}	IMS signalling
5 (non-GBR)	Low (~50ms)	e.g. 10^{-3}	Interactive Gaming
6 (non-GBR)	Medium(~250ms)	e.g. 10^{-4}	TCP interactive
7 (non-GBR)	Medium(~250ms)	e.g. 10^{-6}	Preferred TCP bulk data
8 (non-GBR)	High (~500ms)	n.a.	Best effort TCP bulk data

NOTE 1: New values offered by E-UTRAN could justify the addition of new lines. **This is FFS.**

NOTE 2: In label 2, the L2 packet delay of 50ms applies for E-UTRAN, while for UTRAN 80 ms should be expected.

Editor's note: FFS: Need for a strict priority for Non-GBR Label Characteristics.

Editor's note: Table B-1 is work in progress, the ultimate goal is to specify a table of Label Characteristics that is normative.

The following bullets capture design rationale and principles with respect to standardized Label Characteristics:

- In general, congestion related packet drop rates and per packet delays can not be controlled precisely for Non-GBR traffic. Both metrics are mainly determined by the current Non-GBR traffic load, the UE's current radio channel quality, and the configuration of user plane packet processing functions (e.g. scheduling, queue management, and rate shaping). That is the reason why sources running on a Non-GBR bearer should be prepared to experience congestion related packet drops and/or per packet delays that may exceed a given L2 PDB. The discarding (dropping) of packets is expected to be controlled by a queue management function, e.g. based on pre-configured dropping thresholds, and is relevant mainly for Non-GBR bearers. The discarding (dropping) of packets on GBR bearers should be considered to be an exception.

- An operator would choose GBR bearers for services where the preferred user experience is "service blocking over service dropping", i.e. rather block a service request than risk degraded performance of an already admitted service request. This may be relevant in scenarios where it may not be possible to meet the demand for those services with the dimensioned capacity (e.g. on "new year's eve"). Whether a service is realized based on GBR bearers or Non-GBR bearers is therefore an operator policy decision that to a large extent depends on expected traffic load vs. dimensioned capacity. Assuming sufficiently dimensioned capacity any service, both Real Time (RT) and Non Real Time (NRT), can be realized based only on Non-GBR bearers.
- Note that TCP's congestion control algorithm becomes increasingly sensitive to non congestion related packet losses (that occur in addition to congestion related packet drops) as the end-to-end bit rate increases. To fully utilise "EUTRA bit rates" TCP bulk data transfers will require an L2 PLR of less than 10^{-6} .

Annex C (Informative): Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2006-12					Initial version in S2-070327	-	0.0.0
2007-01	SA2 #56				First update of TS skeleton in S2-070544.	0.0.0	0.0.1
2007-01	SA2 #56				Second update of TS skeleton in S2-070545.	0.0.1	0.0.2
2007-01	SA2 #56				Third update of TS skeleton in S2-070549.	0.0.2	0.0.3
2007-01	SA2 #56				Inclusion of documents agreed at SA2 #56. S2-070564, S2-070329, S2-070591 and, S2-070572.	0.0.3	0.1.0
2007-02	SA2 #56b Adhoc				Inclusion of documents agreed at SA2 #56b Adhoc: S2-071047, S2-071050, S2-071051, S2-071053, S2-071056	0.1.0	0.2.0
2007-02	Email Review				Correction of implementation of S2-071051, S2-071050	0.2.0	0.2.1
2007-03	SA2 #56c Adhoc				Inclusion of documents agreed at Sa2 #56c Adhoc: S2-071500, S2-071512, S2-071590, S2-071593, S2-071604, S2-071609, S2-071610, S2-071611, S2-071612, S2-071613, S2-071614, S2-071615, S2-071616	0.2.1	0.3.0
2007-04	Terminology update				Update the terminology used within specification	0.3.0	0.4.0
2007-04	Editorial				Editorial tidy up	0.4.0	0.4.1
2007-05	SA2 #57				Inclusion of documents agreed at SA2 #57: S2-072274, S2-072228, S2-072182, S2-072259, S2-072289, S2-072288, S2-072284, S2-072295, S2-072285, S2-072286, S2-072287	0.4.1	0.5.0
2007-05	Email review				Update to the title of specification and general formatting changes to clause headings.	0.5.0	0.5.1
2007-05	SP-36	-	-	-	Editorial update by MCC for presentation to TSG SA#36 for information.	0.5.1	1.0.0
2007-07	SA2 #58				Inclusion of the documents agreed at SA2 #58: S2-072733, S2-073010, S2-073065, S2-073066, S2-073067, S2-072945, S2-072946, S2-072949, S2-072952, S2-072954, S2-072959, S2-072961, S2-072963, S2-072968, S2-073001, S2-073046, S2-073080, S2-072307r7, S2-072930r3, S2-072947r5, S2-072947r5, S2-072948r1, S2-072953r2, S2-072955r2, S2-072957r5, S2-072958r2, S2-072960r3, S2-072962r1, S2-072964r2, S2-072965r1, S2-072966r5, S2-072967r1, S2-072982r2, S2-072932r3, S2-073045r6	1.0.0	1.1.1