

3GPP TS 23.401 V1.0.0 (2007-05)

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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Keywords

3GPP, E-UTRAN, GPRS, LTE, SAES**3GPP**

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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".

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
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. >

4.2 Architecture Reference Model

4.2.1 Non-Roaming Architecture

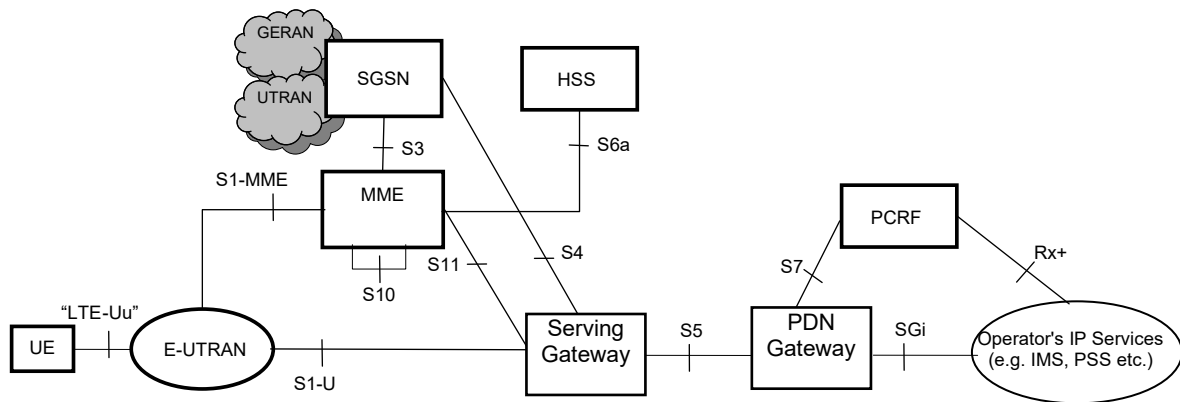


Figure 4.2.1-1: Non-Roaming Architecture for 3GPP Accesses

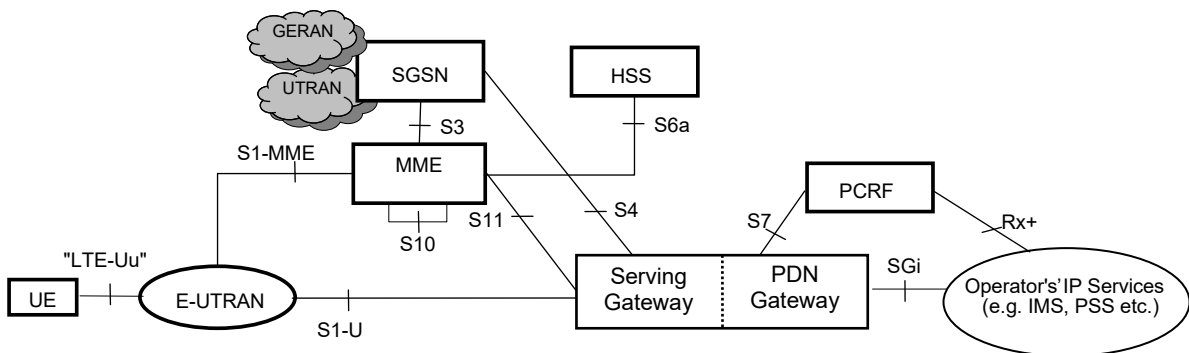


Figure 4.2.1-2: Non-Roaming Architecture for 3GPP Accesses . Single gateway configuration option

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

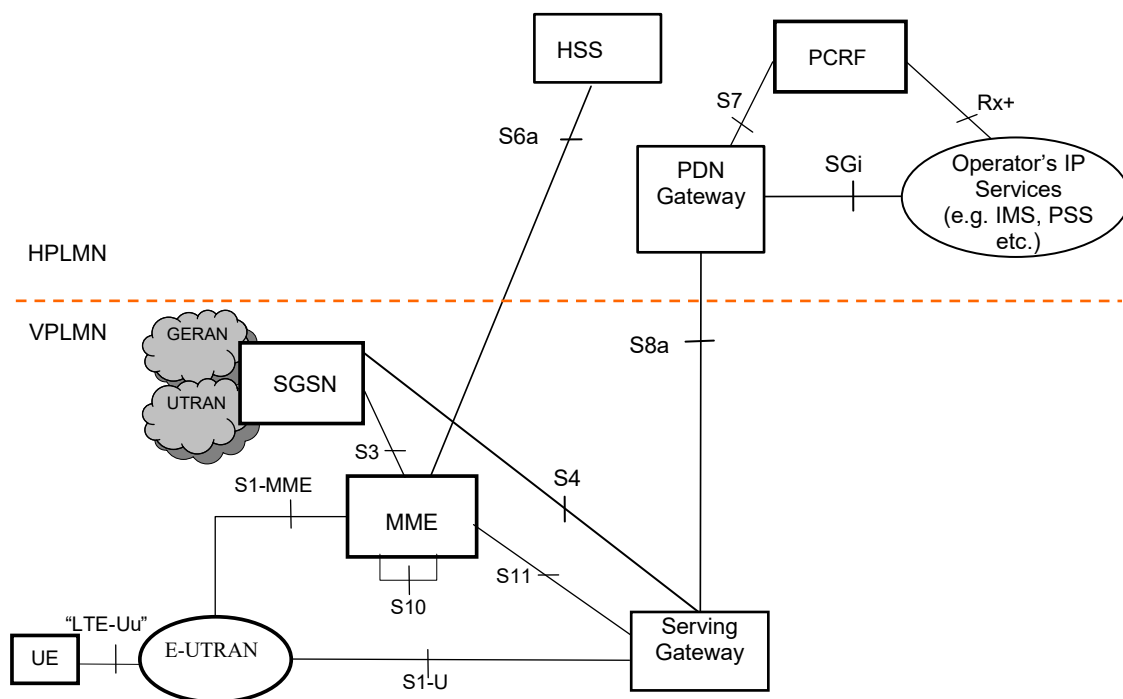


Figure 4.2.2-1: Roaming Architecture for 3GPP Accesses, Home Routed traffic

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

NOTE 1: 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.

Editor's Note: Following open issues exist for the above architecture diagram:

The roaming architecture for PCC is not included; as such the existence of S9 reference point between PCRF in the HPLMN and PCRF in the VPLMN is FFS.

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.

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. Routeing 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 routeing 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 GW selection

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 UE when connectivity to a PDN is established (i.e. no PDN GW has been assigned to the UE to connect to that PDN) via 3GPP access. The selection uses subscriber information provided by the HSS and possibly additional criteria. The HSS provides:

- either one or more IP addresses of one or more PDN GWs 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. The APN may be an FQDN.

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 a single 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 the HSS provides an APN of a PDN GW and the subscription does not allow for allocation of a PDN GW from the visited PLMN, the PDN GW selection function derives a PDN GW address from the subscriber's home PLMN.

NOTE: If the APN is provided as an FQDN then the selection function resolves it to an IP address of the PDN GW.

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

Editor's note: If 2G/3G access is connected to EPC and the SGSN does the PDN GW selection, the following additional principles are followed. PDN GW selection function shall be backwards compatible with existing GGSN selection as specified in Rel-7 version of 23.060 annex A. This implies that for 2G/3G access, the UE may also provide an APN which is authorized based on the subscription record received from the HSS. APN resolution is performed by DNS. If selection of a VPLMN PDN GW is allowed by the subscription record, a PDN GW in the VPLMN will be selected. If this fails or selection of a PDN GW in the VPLMN is not allowed, a PDN GW in the HPLMN will be selected. The APN is sent to the PDN GW to identify the PDN that the UE is connecting to.

4.3.7.2 PDN GW address retrieval (to 3GPP accesses)

To connect the UE with an already allocated PDN GW the HSS shall provide the IP address of the already allocated PDN GW during inter-access system mobility.

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

4.4 Network Elements

4.4.1 E-UTRAN

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

E-UTRAN functions include:

- Header compression and user plane ciphering

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)
- 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

4.5 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 EUTRAN and MME.

S1-U: Reference point between EUTRAN 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 the user plane with 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.

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.
- S10:** Reference point between MMEs for MME relocation and MME to MME information transfer.
- S11:** Reference point between MME and Serving GW
- 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+.

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.

4.6 Overall QoS Concept

4.6.1 The EPS Bearer

4.6.1.1 The EPS Bearer in general

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.

An EPS bearer is referred to as a *dedicated bearer* if it is associated with an UL TFT in the UE and a DL TFT in the PDN GW where the filters only match certain packets. An EPS bearer is referred to as a *default bearer* if it is associated with "match all" uplink and downlink packet filters in the UE and the PDN GW, respectively.

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.

4.6.1.2 The EPS Bearer with GTP-based S5/S8

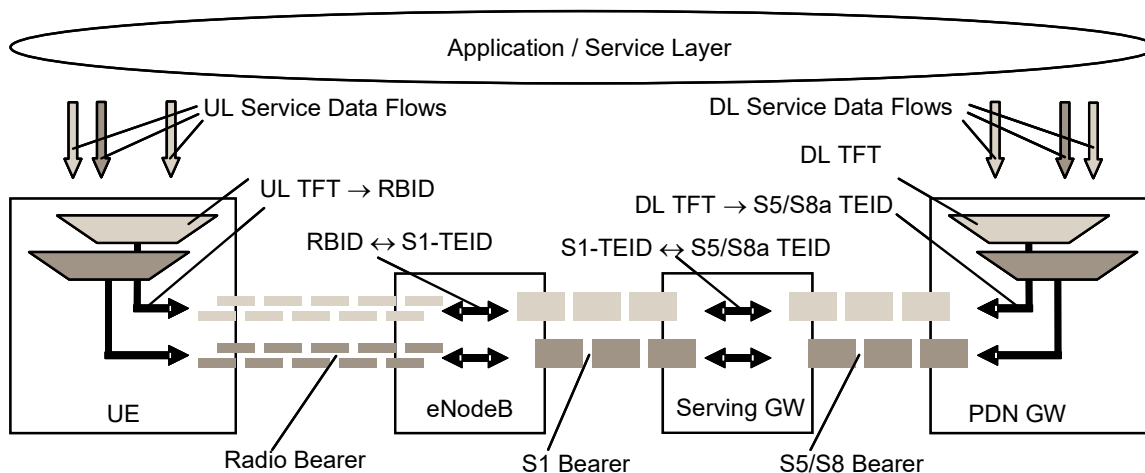


Figure 4.6-1: Two Unicast EPS bearers (GTP-u Based S5/S8)

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 (RLC connection) 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 (GTP-u tunnel) 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 bearer identifier (UL TFT → RBID) to create the binding between an SDF and a radio bearer in the uplink.
- If S5/S8 is based on GTP-u, a PDN GW stores a mapping between a downlink packet filter and an S5/S8a GTP-u tunnel end-point identifier (DL TFT → S5/S8a-TEID) 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 identifier and an S1 GTP-u tunnel end-point identifier (RBID ↔ S1-TEID) to create the binding between a radio bearer and an S1 bearer.
- If S5/S8 is based on GTP-u, a Serving GW stores a one-to-one mapping between an S1 GTP-u tunnel end-point identifier and an S5/S8a GTP-u tunnel end-point identifier (S1-TEID ↔ S5/S8a-TEID) to create the binding between an S1 bearer and an S5/S8a bearer.

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.

Editor's Note: The relationship between Label signalled on S1-MME, QCI signalled on S7, QoS profile signalled on S4 and QoS information signalled towards non-3GPP accesses needs to be clarified.

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 UE is associated with the following bearer level QoS parameter:

- Aggregate Maximum Bit Rate (AMBR).

Multiple EPS bearers of the same UE 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 of a UE. GBR bearers are outside the scope of AMBR.

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.

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 Attach procedure may trigger one or multiple Dedicated Bearer Establishment procedures to establish dedicated EPS bearer(s) for that UE.

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.

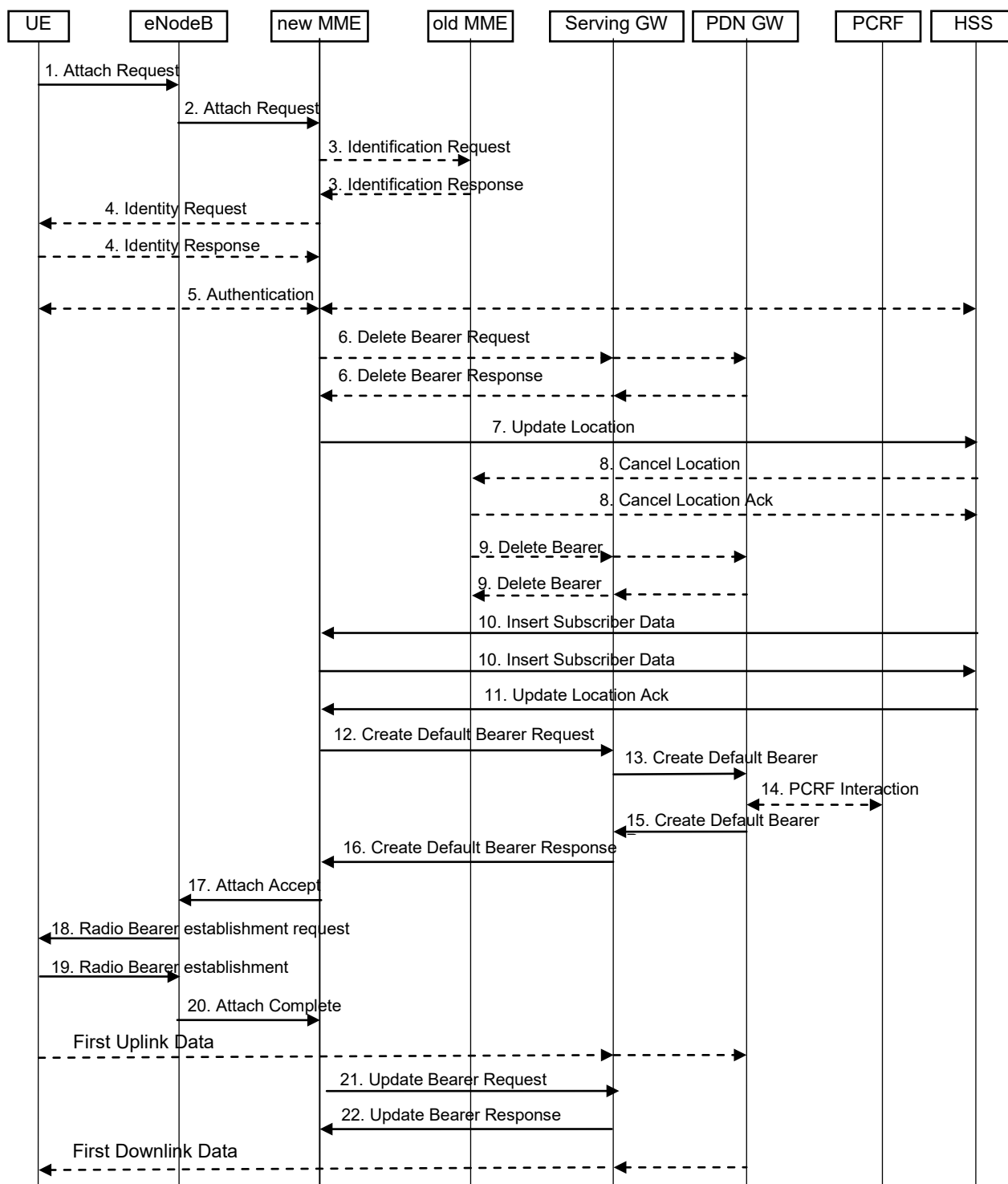


Figure 5.3.2-1: Attach Procedure

1. The UE initiates the Attach procedure by the transmission an Attach Request (IMSI or S-TMSI and old TAI, Selected Network) message 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 network that is selected.

Editor's note: It's FFS whether the APN information is provided by the UE.

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 "MME selection function". The eNodeB forwards

the Attach Request message together with an indication of the Cell Global Identity of the cell from where it received the message to the new MME.

Editor's note: It's FFS whether the eNodeB will provide the TEID to the MME in this step.

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 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. The authentication functions are defined in clause x.x.
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 messages to the GWs involved. The GWs acknowledge with Delete Bearer Response 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 messages to the GWs involved. The GWs return Delete Bearer Response message to the MME.

Editor's note: It's FFS which flow triggers the Delete Bearer Request messages.

10. The HSS sends Insert Subscriber Data (IMSI, Subscription Data) message to the new MME. 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 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 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 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 MME. If the Update Location is rejected by the HSS, the 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 9 and 10 can be combined as one message.

12. The MME selects a Serving GW as described under "GW Selection Function" and sends a Create Default Bearer Request (IMSI, MME Context ID) message to the selected Serving GW.
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) message to the PDN GW.

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.

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) message to the Serving GW. PDN Address is included if the PDN GW allocated a PDN address.

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, Serving GW address for User Plane, Serving GW TEID for User Plane, Serving GW Context ID) message to the MME.
17. The MME sends an Attach Accept (S-TMSI, PDN address, TA List) message to the eNodeB. S-TMSI is included if the 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 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 assigned to the UE is included in this message.
18. The eNodeB sends Radio Bearer Establishment Request to the UE and the Attach Accept Message (S-TMSI, PDN address, TA List) 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 will forward the Attach Complete message to the 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, the UE can then send uplink packets towards the eNodeB which will then be tunnelled to the Serving GW and PDN GW.

21. The 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 MME. The Serving GW can then send its buffered downlink packets.

NOTE: After Step 13, the PDN GW may assign the PDN address to the UE or leave the PDN address unassigned. In some cases (e.g. non-integrated devices, such as Laptop), the UE PDN address may need to be assigned after the completion of attach procedure (e.g. via DHCP).

Editor's Note: It's FFS how the EPS knows which type of PDN address to use.

5.3.3 Tracking Area Update procedures

5.3.3.1 Tracking Area Update procedure with MME and Serving GW change

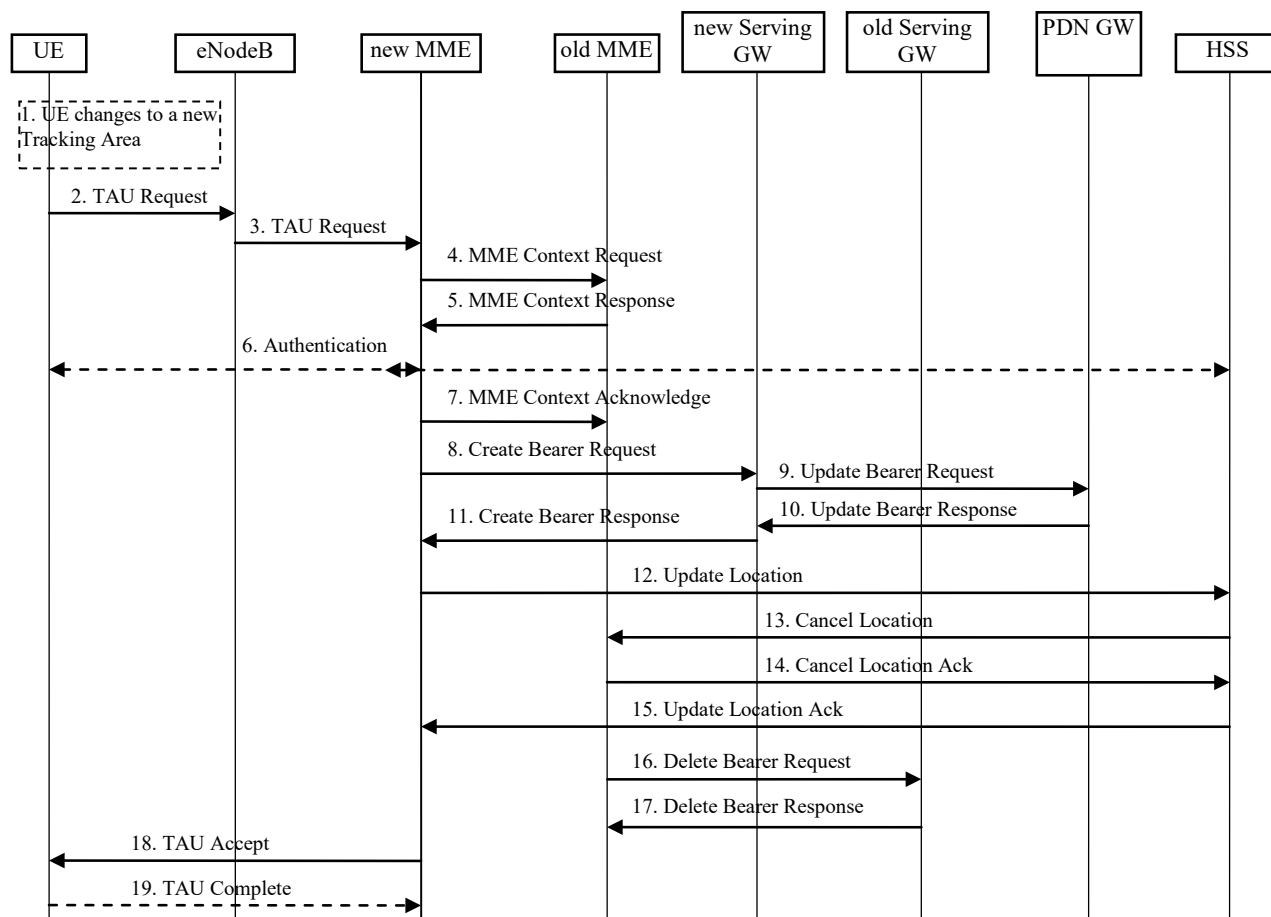


Figure 5.3.3-1: Tracking Area Update procedure with MME and Serving GW change

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 and old TAI, Selected Network) message 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.

Editor's note: FFS whether to add an indication to the message that allows the UE to request to establish the user plane on radio and S1 as part of the TAU procedure

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.

Editor's note: MME selection function needs to be resolved.

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 to the new MME.

4. The new MME sends an MME Context Request (S-TMSI, old TAI) to the old MME to retrieve user information. The new MME derives the old MME from old TAI and old S-TMSI.

FFS whether TAU Request message needs to be forwarded to old MME, e.g. to perform integrity check of the message if this cannot be done by the new MME. An alternative may be using an S-TMSI signature.

5. The old MME responds with an MME Context Response (MME context (e.g. IMSI, Authentication Quintets, bearer contexts)). 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 whether MME stores all bearer context parameters including PDN GW address or whether it needs to ask the Serving GW

6. The authentication functions are defined in the 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 an MME 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 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 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 constructs an MM context for the UE.

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 under "GW selection function" and 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 Update Bearer Request message (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 TEID) 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) to the HSS.
13. The HSS sends Cancel Location (IMSI, Cancellation Type) to the old MME with Cancellation Type set to Update Procedure.
14. The old MME acknowledges with Cancel Location Ack (IMSI).
15. The HSS acknowledges the Update Location (Subscription Data) message by sending an Update Location Ack message to the MME after the cancelling of old MM 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.

Editor's note: Further considerations on subscription data handling needed, e.g. if transferred between MMEs, if inserted by separated procedure from HSS or combined with Update Location procedure

16. If there are active bearers in the old MME for this particular UE and the new MME has indicated that Serving GW functionality is to be moved, the old MME deletes these bearers by sending Delete Bearer Request (TEID) messages to the Serving GW.

Editor's note: It is FFS when this step is triggered, e.g. by step 7 (by an indication from new to old MME that old MME can release the Serving GW) or by step 13

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

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

5.3.4 Service Request procedures

5.3.4.1 UE triggered Service Request

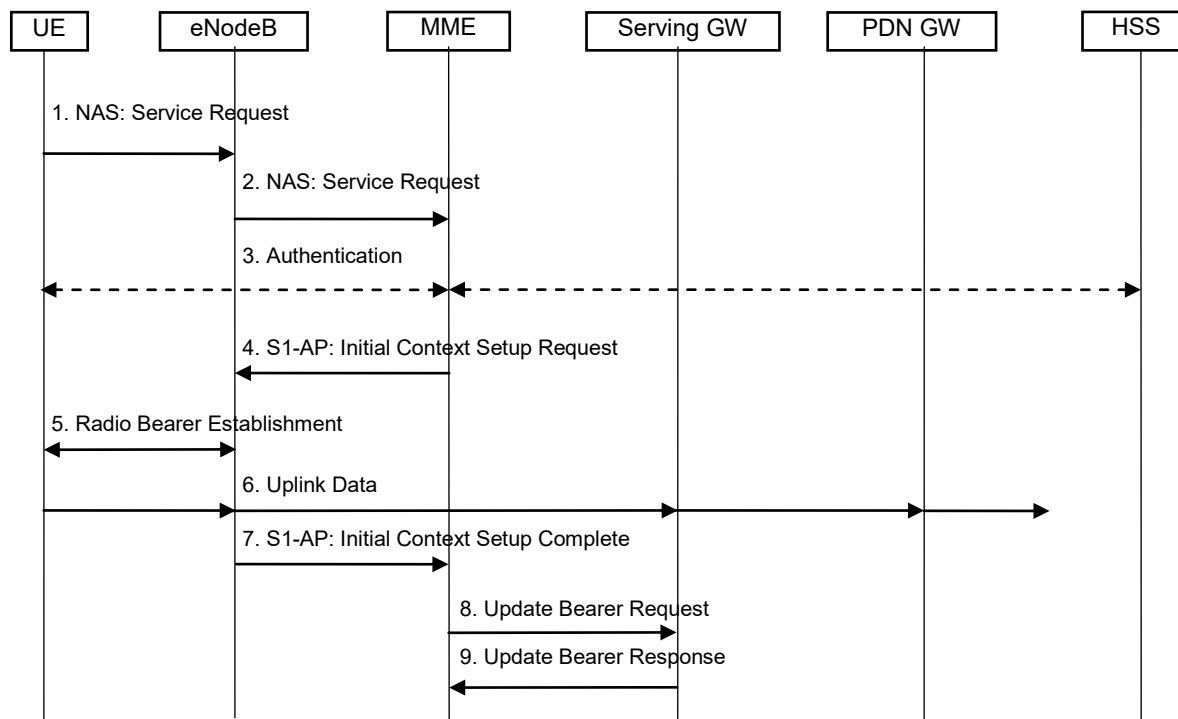


Figure 5.3.4-1: UE triggered Service Request procedure

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].

Whether TEID(s) of eNodeB could be allocated already in this step is FFS.

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

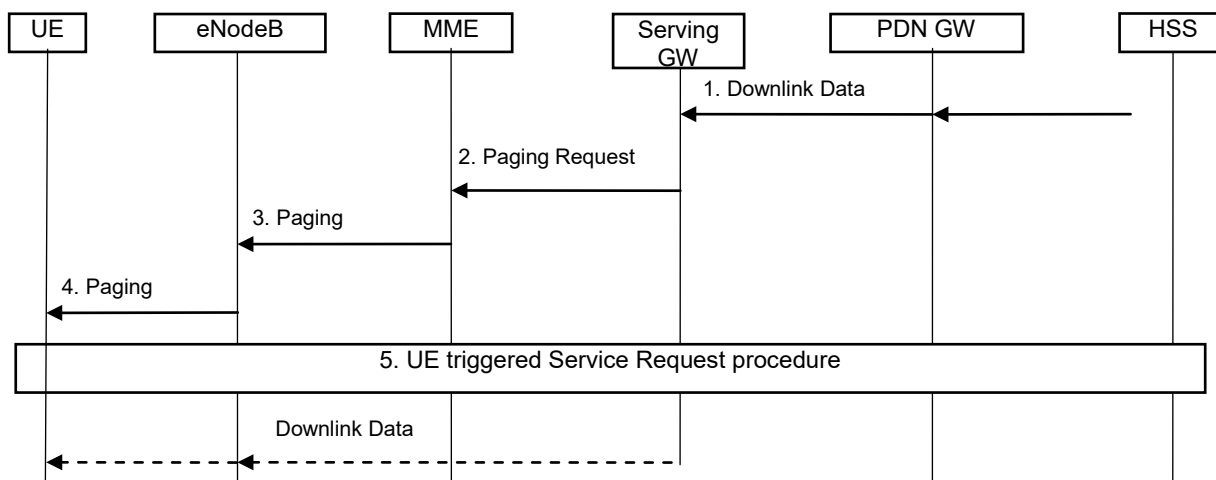


Figure 5.3.4-2: Network triggered Service Request procedure

- 1) The Serving GW receives a downlink data packet for a UE in IDLE state.
- 2) The Serving GW sends a Paging Request message 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].
- 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 ME identity check procedure

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

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.

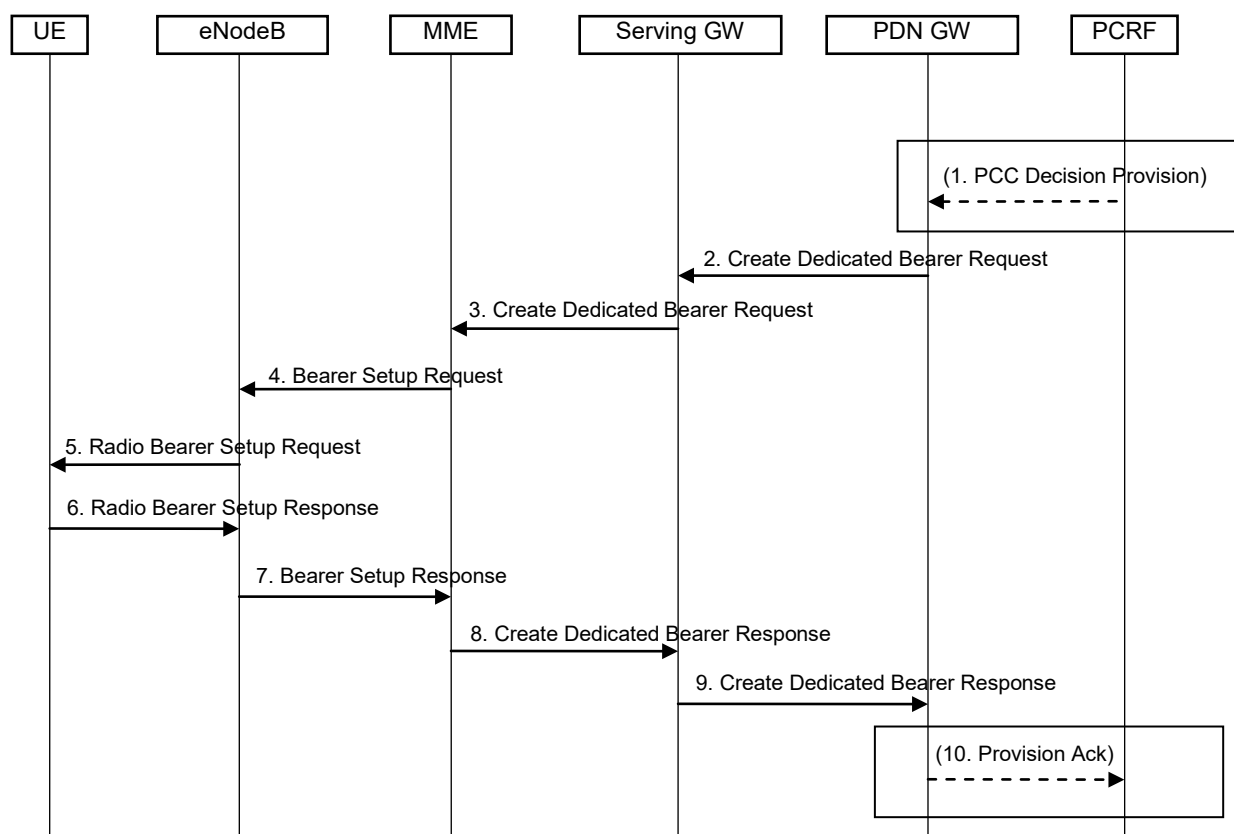


Figure 5.4.1-1: Dedicated Bearer Activation Procedure, UE in Active Mode

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.

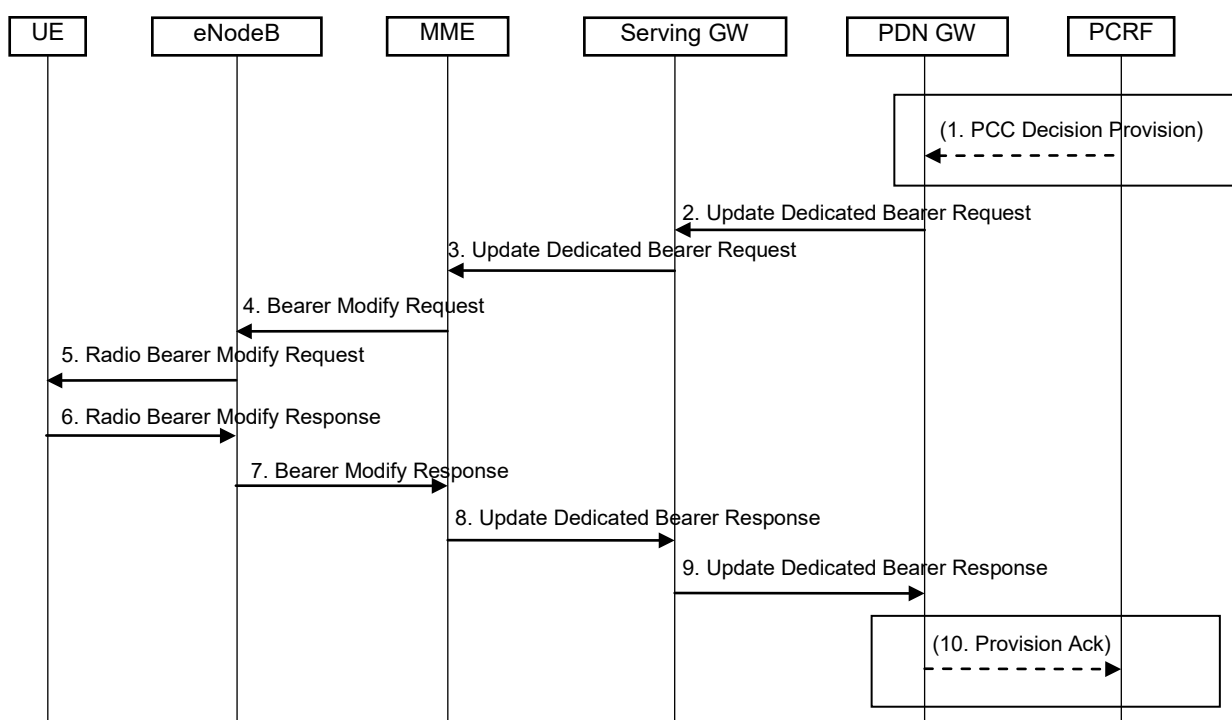


Figure 5.4.2-1: Dedicated Bearer Modification Procedure with Bearer QoS Update, UE in active mode

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.

- 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 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.

- The Serving GW sends the Update Dedicated Bearer Request (Bearer QoS, UL TFT) message to the MME.
- 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.

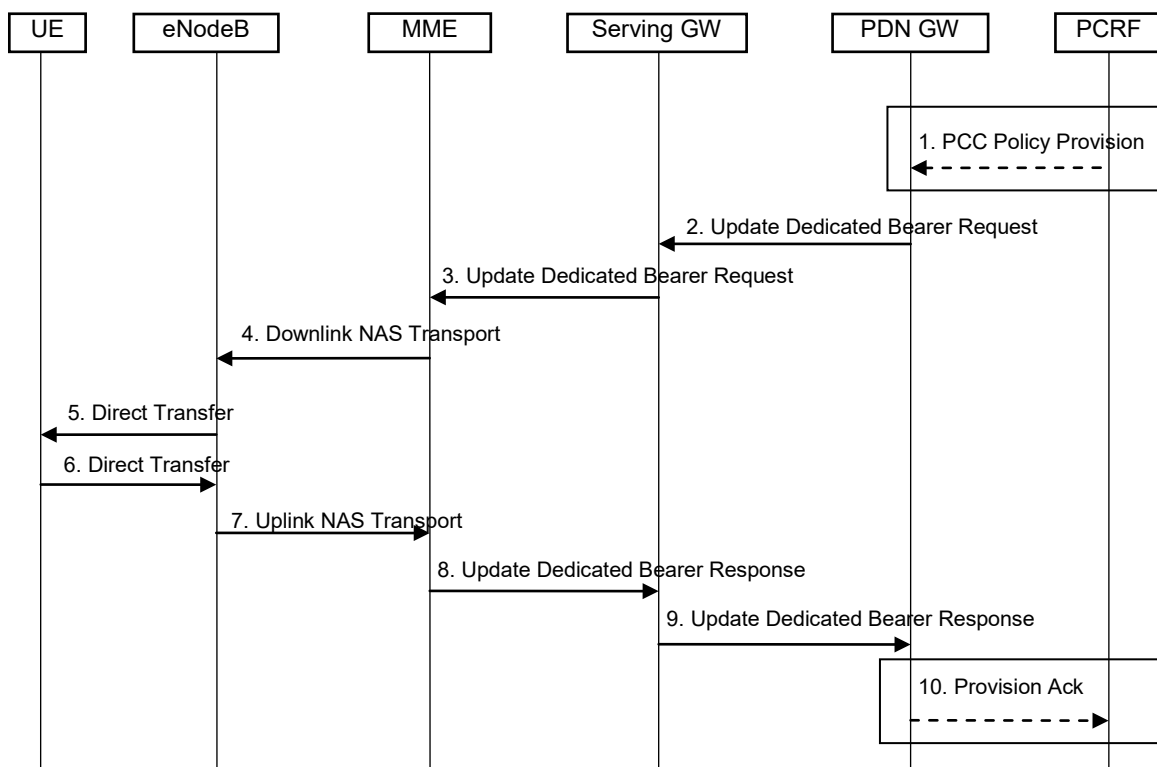


Figure 5.4.3-1: Dedicated Bearer Modification Procedure without Bearer QoS Update, UE in active mode

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.

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 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.

3. The Serving GW sends the Update Dedicated Bearer Request (UL TFT) message to the MME.
4. 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.
5. 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.

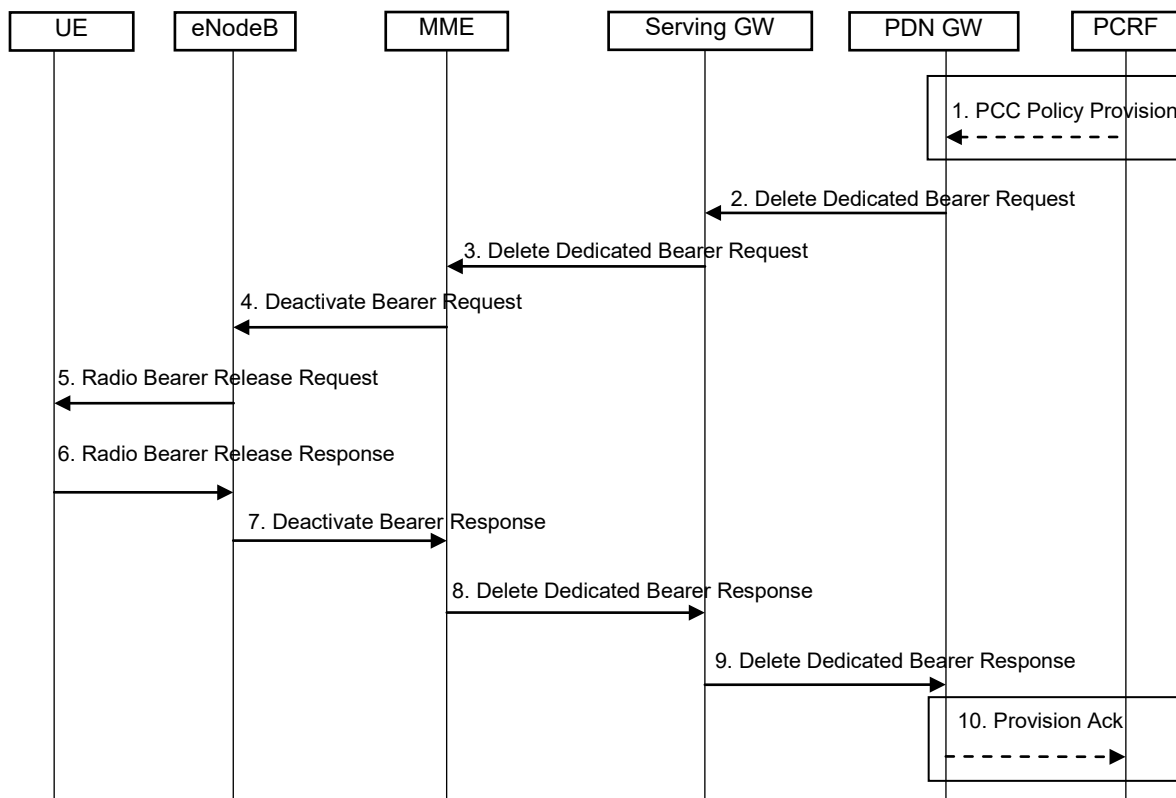


Figure 5.4.4-1: PDN GW Initiated Dedicated Bearer Deactivation, UE in active mode

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

This procedure shall be used for inter eNodeB handover in the following cases:

- There is no X2 connectivity between source eNodeB and target eNodeB (or it is not desired to be utilized); or
- There is no S1-MME connectivity between target eNodeB and source MME (or it is not desired to be utilized); or
- There is no S1-U connectivity between target eNodeB and source Serving GW (or it is not desired to be utilized).

To cover all the above scenarios and their combination this *Inter eNodeB handover with CN node relocation* procedure does not rely on:

- signalling on X2 between source eNodeB and target eNodeB,
- signalling on S1-MME between target eNodeB and source MME, nor
- signalling on S1-U between target eNodeB and source Serving GW, nor
- signalling on S1-MME between source eNodeB and target MME, nor
- signalling on S1-U between source eNodeB and target Serving GW

NOTE: Whether X2 is used to find out the non existence of S1-MME or S1-U connectivity is out of scope of this procedure.

This *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 X.y on Serving GW selection.

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.

5.5.2 Inter RAT handover

5.5.2.1 E-UTRAN to UMTS/GPRS Inter RAT handover

Editor's note: It is an open issue whether the final flow will be split into separate preparation phase and execution phase or combined into single comprehensive flow.

Editor's note: The case when the target Gb based system does not support PS handovers is FFS.

Editor's note: The eNodeB decides the list of EPS bearers that are subject to data forwarding in E-UTRAN to other 3GPP systems direction. Whether the need exists that the EPC may modify this list of EPS bearers that are subject to data forwarding is FFS

5.5.2.1.1 Preparation phase

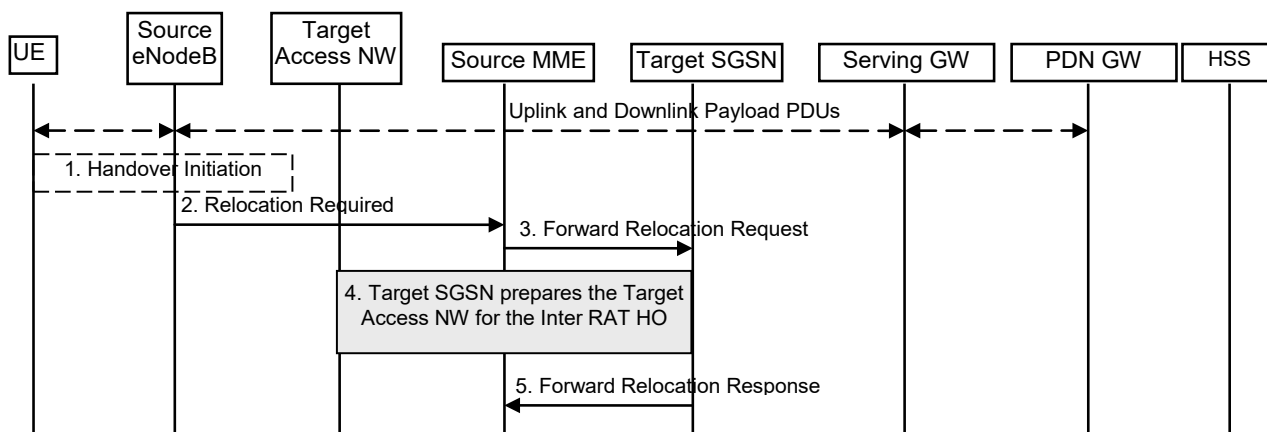


Figure 5.5.2-1: E-UTRAN to UMTS/GPRS Inter RAT HO, preparation phase

1. The source eNodeB decides to initiate a PS handover to the target access network within UMTS/GPRS. 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 message to the source MME to request the CN to establish resources in the target access network, target SGSN and the Serving GW.
3. The source MME will forward the request to the target SGSN using the message Forward Relocation Request. This message includes all (Release 8) PDP contexts corresponding to the bearers established in the source system and the uplink Tunnel endpoint parameters of the Serving GW.

Editor's Note: The actual tunnel endpoint parameters need to be defined.

4. The target SGSN will request the target access network to establish the necessary resources.

The target access network allocates the resources and returns the applicable parameters to the target SGSN. The details of this source access network specific signalling are described in 3GPP TS 23.060 [7] for Iu mode and in 3GPP TS 43.129 [8] for Gb mode.

Editor's note: The case when the Serving GW is changed is FFS.

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.

5. The target SGSN completes the preparation phase by sending the message Forward Relocation Response to the source MME.

5.5.2.1.2 Execution phase

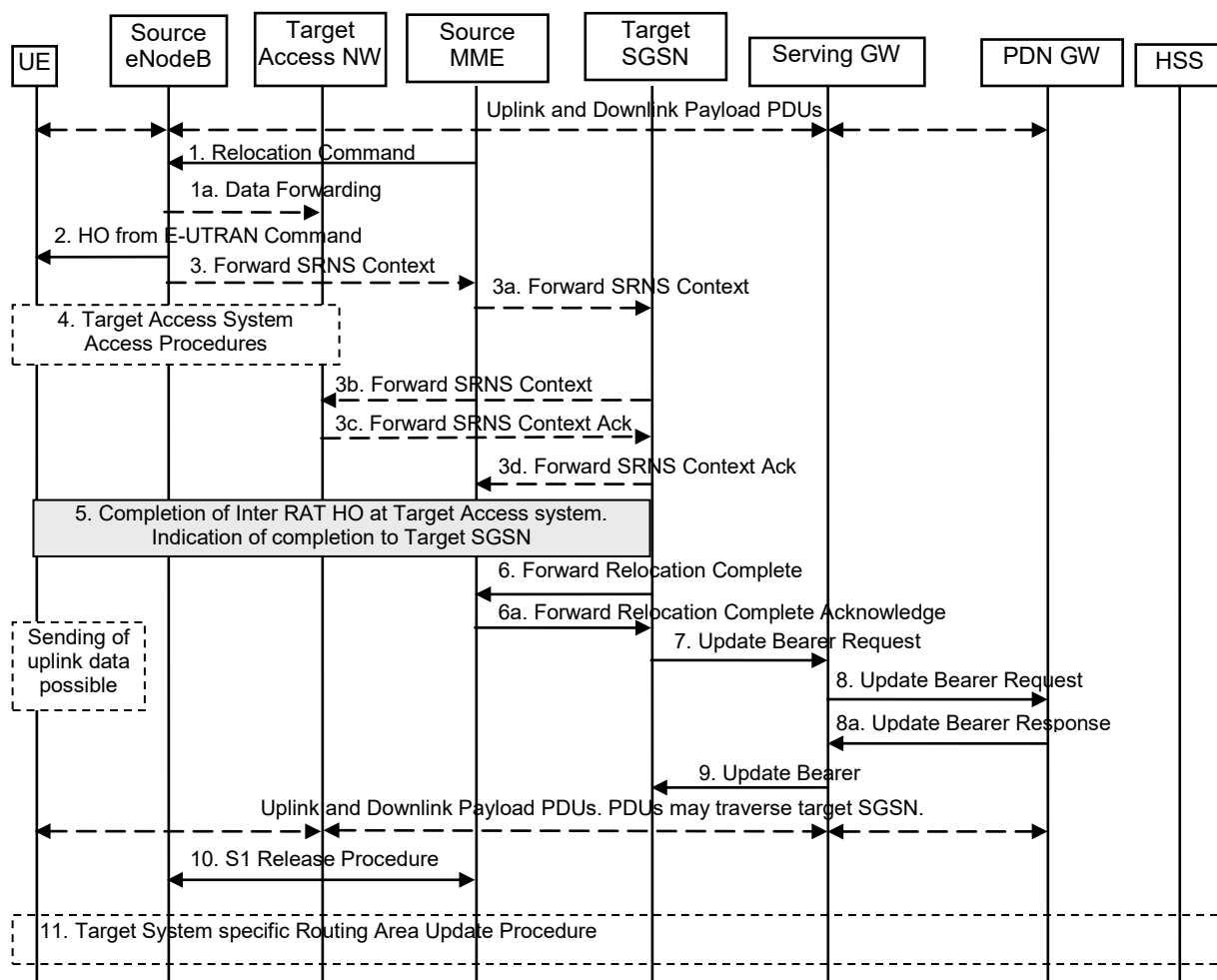


Figure 5.5.2-2: E-UTRAN to UMTS/GPRS Inter RAT HO, execution phase

1. The source MME completes the preparation phase towards source eNodeB by sending the message Relocation Command. This message includes bearer parameters for all PDP contexts that could be established on the target side. The details of this E-UTRAN specific signalling are described in 3GPP TS 36.300 [5].
- 1a. The source eNodeB initiates data forwarding for the indicated bearers. The data forwarding may go directly to target system (I.e. to target access network in case of Iu mode target system, to target SGSN in case of Gb mode target system). Data forwarding may alternatively go e.g. via Serving GW or/and target SGSN if so decided by source MME and/or target SGSN in Inter RAT HO preparation phase. **The indirect data forwarding is FFS.**
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 access network 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 if the Target Access Network is 3G network.

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

4. The UE moves to the target access network and performs access procedures toward target access network.

5. When the UE has successfully accessed the target access network, the target access network informs the target SGSN about the completion of the Inter RAT HO. The details of this target access network specific signalling are described in 3GPP TS 23.060 [7] for Iu mode and in 3GPP TS 43.129 [8] for Gb mode
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 11.
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.
8. 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.
9. The Serving GW acknowledges the user plane switch to the target SGSN via the message Update Bearer Response. 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.
10. After step 6, the source MME will clean-up all its resources towards source eNodeB by performing the S1 Release procedure.
11. The UE triggers a subset of Routing Area Update procedure as described in 3GPP TS 23.060 [7].

5.5.2.2 UMTS/GPRS to E-UTRAN Inter RAT HO

Editor's note: It is an open issue whether the final flow will be split into separate preparation phase and execution phase or combined into single comprehensive flow.

Editor's note: The case when the source Gb based system does not support PS handovers is FFS.

5.5.2.2.1 Preparation phase

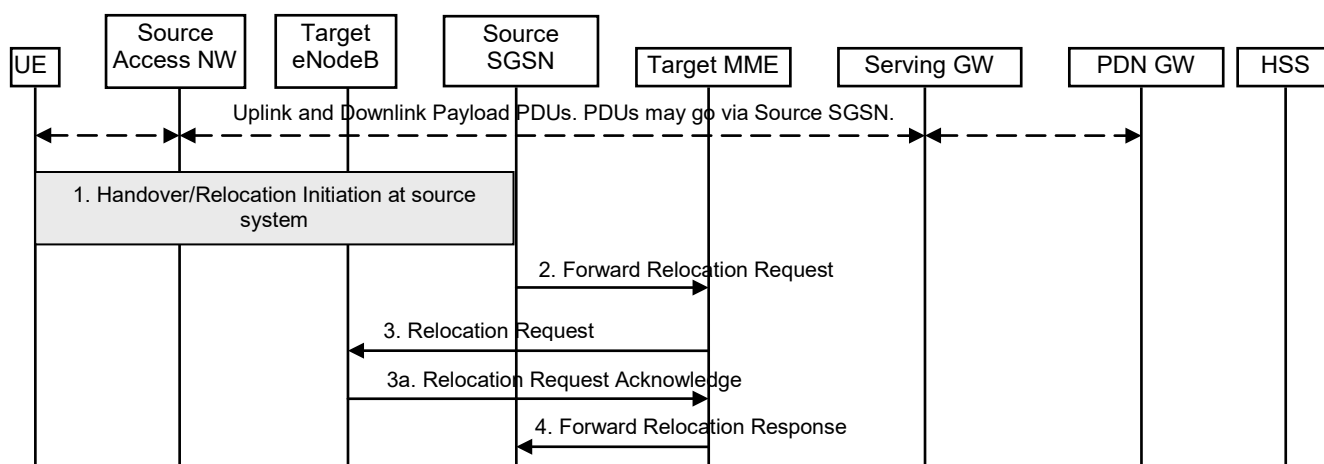


Figure 5.5.2-3: Inter RAT HO UMTS/GPRS to E-UTRAN, preparation phase

1. The source access network 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 access network, GTP tunnel(s) between source access network, Serving GW and PDN GW.

The source access network initiates PS handover/Relocation towards source SGSN to request the CN to establish resources in the target eNodeB, Target MME and the Serving GW. The details of this source access network specific signalling are described in 3GPP TS 23.060 [7] for Iu mode and in 3GPP TS 43.129 [8] for Gb mode.

2. The source SGSN will forward the request to the target MME using the message Forward Relocation Request. This message includes all (Rel-8) PDP contexts that are established in the source UMTS/GPRS system and the uplink Tunnel endpoint parameters of the Serving GW.

Editor's Note: The actual tunnel endpoint parameters need to be defined

3. The target MME will request the target eNodeB to establish the bearer(s) by sending the message Relocation Request. This request includes the uplink Tunnel endpoint parameters received in the previous step.
- 3a. The target eNodeB allocates the request resources and returns the applicable parameters to the target MME in the message Relocation Request Acknowledge.

Editor's Note: The case when the Serving GW is changed is FFS.

4. The target MME completes the preparation phase by sending the message Forward Relocation Response to the source SGSN.

5.5.2.2.2 Execution phase

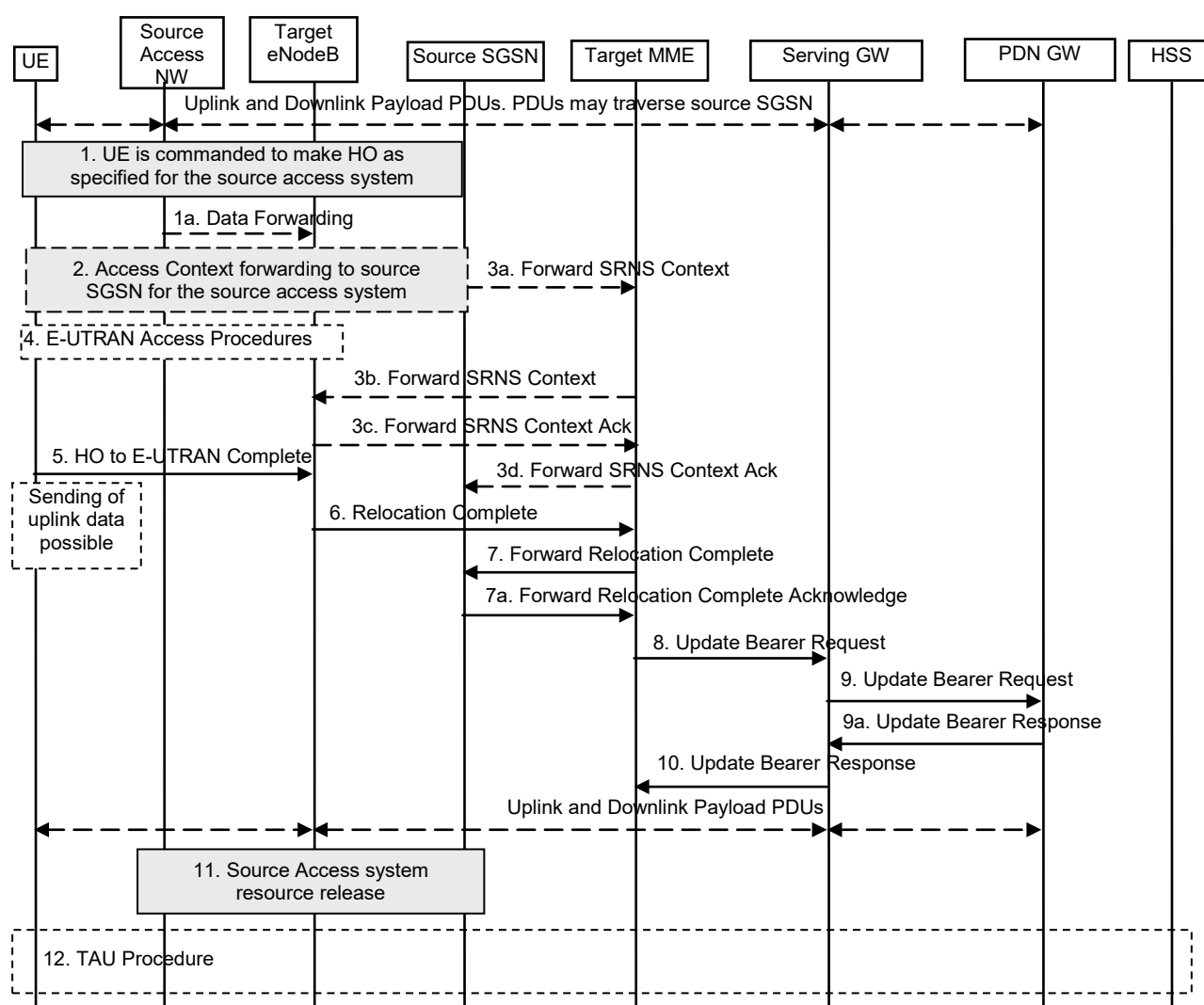


Figure 5.5.2-4: Inter RAT HO UMTS/GPRS to E-UTRAN, execution phase

1. The source SGSN completes the preparation phase towards source access network. The procedures for this are described in detail in 3GPP TS 23.060 [7] for Iu mode and in 3GPP TS 43.129 [8] for Gb mode.

The source access network 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 described in detail in 3GPP TS 23.060 [7] for Iu mode access networks and in 3GPP TS 43.129 [8] for Gb mode access networks.

- 1a. The source network (I.e. source access network in case of Iu mode source system or source SGSN in case of Gb mode source system) initiates data forwarding for the indicated RABs/PDP contexts. The data forwarding may go directly to target eNodeB. Data forwarding may alternatively go e.g. via source SGSN or/and Serving GW if so decided by source SGSN and/or target MME in Inter RAT HO preparation phase. **The indirect data forwarding is FFS.**
2. Depending on the source access network type, the Source access network may deliver source access network contexts to the source SGSN.
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 steps 2 & 3 are 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.
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.
10. The Serving GW acknowledges the user plane switch to the target MME via the message Update Bearer Response. At this stage the user plane path is established for all bearers between the UE, target eNodeB, Serving GW and PDN GW.
11. After step 7 the source SGSN will clean-up all its resources towards source access network by performing the necessary procedures. The procedures for this are described in detail in 3GPP TS 23.060 [7] for Iu mode access networks and in 3GPP TS 43.129 [8] for Gb mode access networks.
12. The UE triggers a subset of Tracking Area Update procedure (see clause 5.3.2).

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

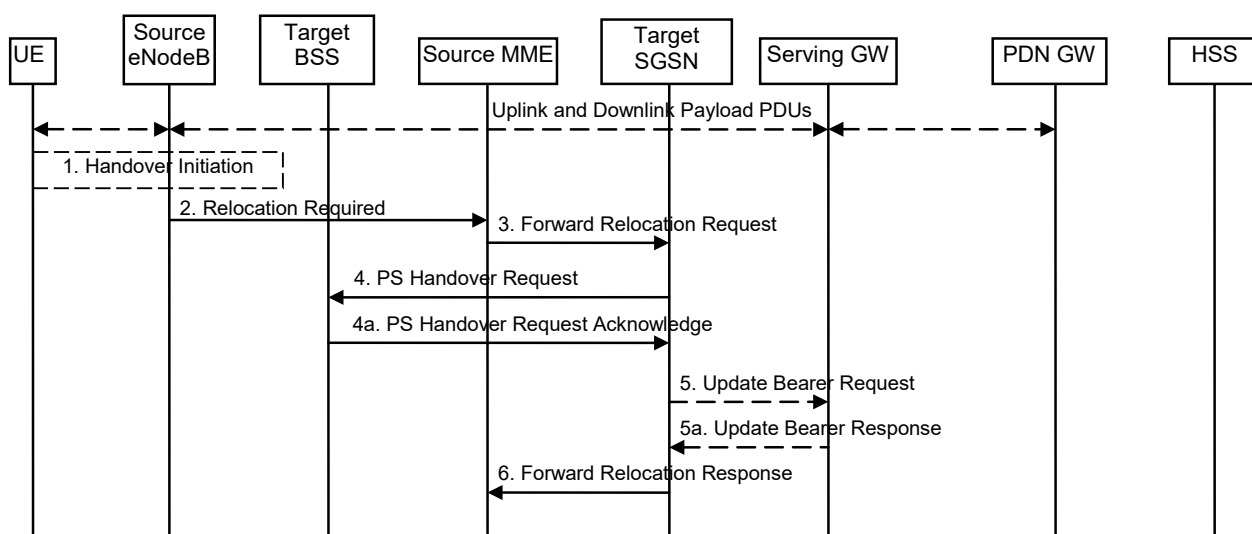


Figure 5.5.2.3.2-1: E-UTRAN to GERAN A/Gb Inter RAT HO, preparation phase

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 (Target Cell Identifier, Source eNodeB Identifier, Source to Target Transparent Container, and FFS) message to the Source MME to request the CN to establish resources in the Target BSS, Target SGSN and the Serving GW.
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, Packet Flow ID, XID parameters, and FFS). This message includes all (Release 8) PDP contexts corresponding to the bearers established in the source system and the uplink Tunnel endpoint parameters of the Serving GW.

The MM context contains security related information, e.g. supported ciphering algorithms. The relation between GSM and EPS security parameters is FFS.

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, and FFS).
- 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, and FFS).
5. The case when the Serving GW is changed is FFS.

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, SGSN Address for User Traffic, Target to Source Transparent Container, BSSGP Cause, and FFS) to the Source MME.

5.5.2.3.3 Execution phase

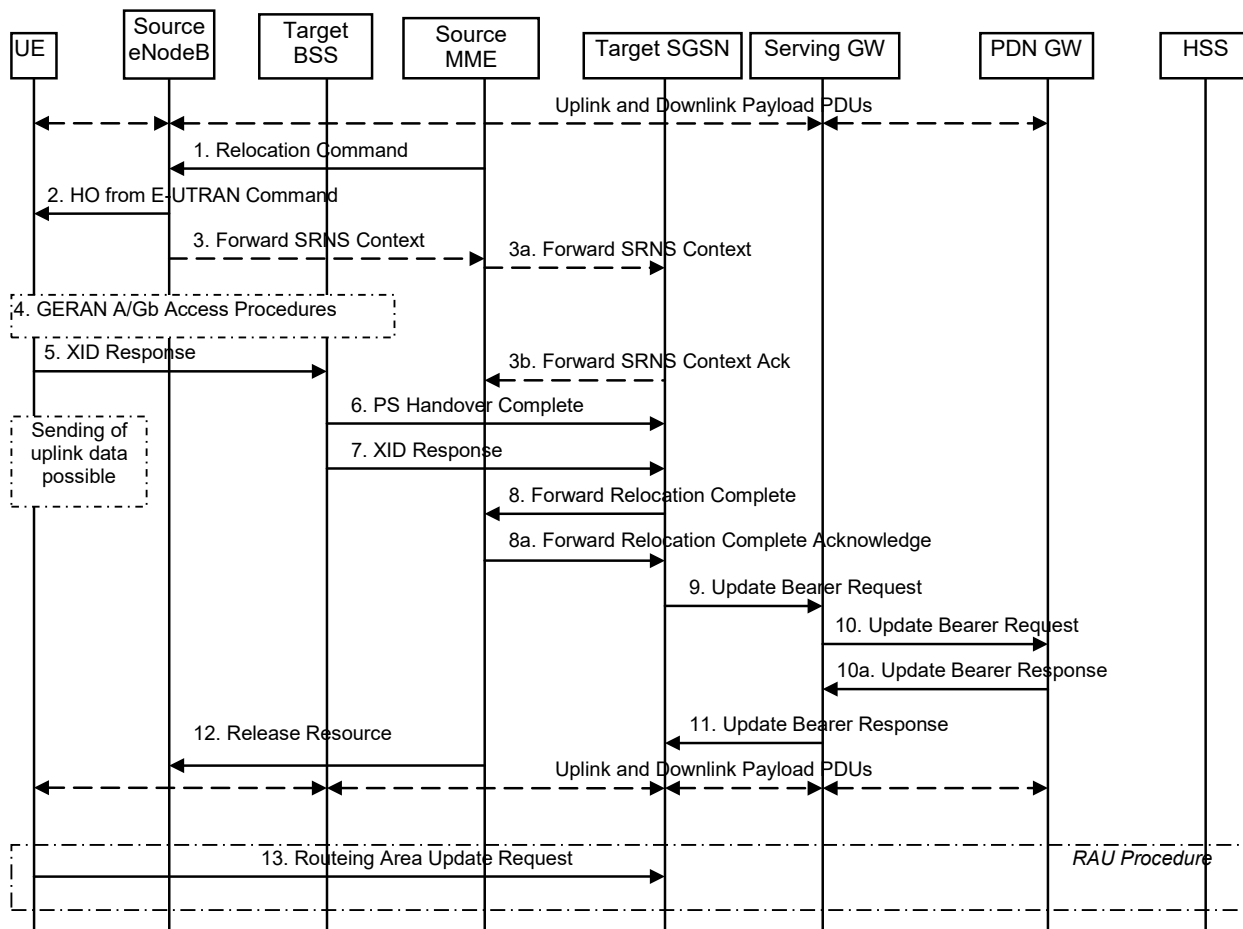


Figure 5.5.2.3.3-1: E-UTRAN to GERAN A/Gb Inter RAT HO, execution phase

1. The Source MME completes the preparation phase towards Source eNodeB by sending the message Relocation Command. This message includes bearer parameters for all PDP contexts that could be established on the Target side. It also includes NAS related parameters such as the XID parameters from the Target SGSN.

Source eNodeB initiate data forwarding for the bearers. 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. **The indirect data forwarding is FFS.**

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. **It is FFS if this message also includes the XID parameters.**
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 access procedures toward Target BSS.
5. When the UE has successfully accessed the Target BSS, it sends the message XID response.
6. When the UE has successfully accessed the Target BSS, the Target BSS informs the Target SGSN by sending the message PS Handover Complete (IMSI, TLLI, **and FFS**).

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 12.
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 (Tunnel Endpoint Identifier Data, Tunnel Endpoint Identifier Control Plane, NSAPI, Protocol Configuration Options, SGSN Address for Control Plane, and FFS).
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 Data, Tunnel Endpoint Identifier Control Plane, Charging ID, Protocol Configuration Options, GGSN Address for Control Plane, GGSN address for User traffic, and FFS). 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.
12. After the source MME has received the Forward Relocation Complete message, it sends a Release Resources message to the source eNodeB. The source eNodeB can the release resources in the source eNodeB. *The timing of this message and the timing of releasing the resources are FFS.*
13. 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].

5.5.2.4 GERAN A/Gb mode to E-UTRAN mode Inter RAT 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

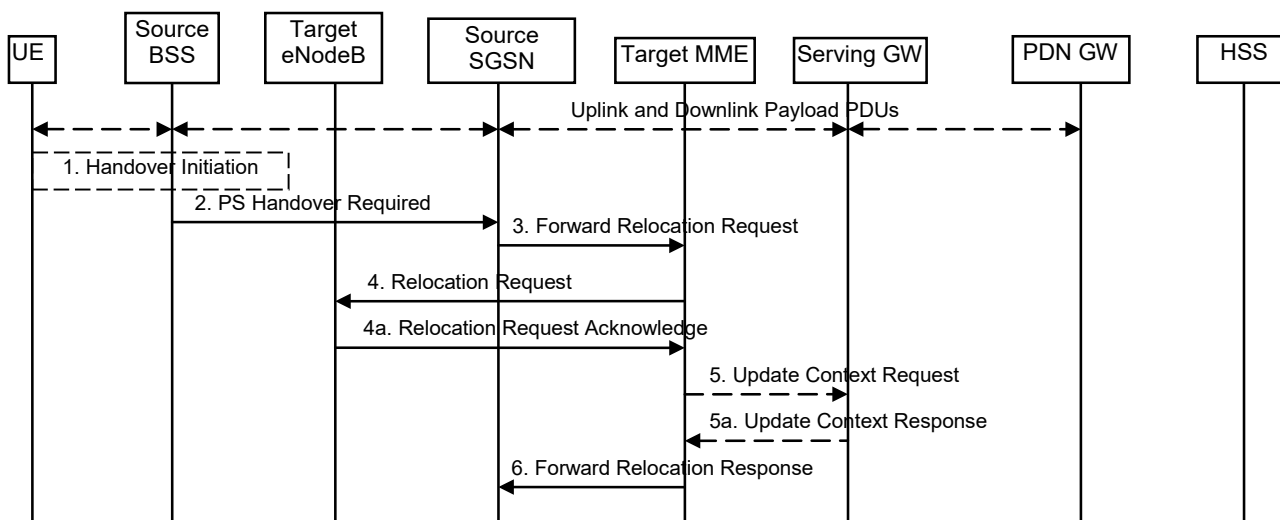


Figure 5.5.2.4.2-1: Inter RAT HO GERAN A/Gb (2G) to E-UTRAN, preparation phase

- 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 PS handover Required (TLLI, Cause, Source Cell Identifier, Target eNodeB Identifier, Source to Target Transparent Container, and FFS) 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 FFS). This message includes all (release 8) PDP contexts that are established in the source system and the uplink Tunnel endpoint parameters of the Serving GW.

The MM context contains security related information, e.g. supported ciphering algorithms. The relation between GSM and EPS security parameters is FFS.

- 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, Global CN-ID, and FFS). This request includes the uplink Tunnel endpoint parameters received in the previous step.
- 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, and FFS).

5) The case when the Serving GW is changed is FFS.

- 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, and FFS) to the Source SGSN.

5.5.2.4.3 Execution phase

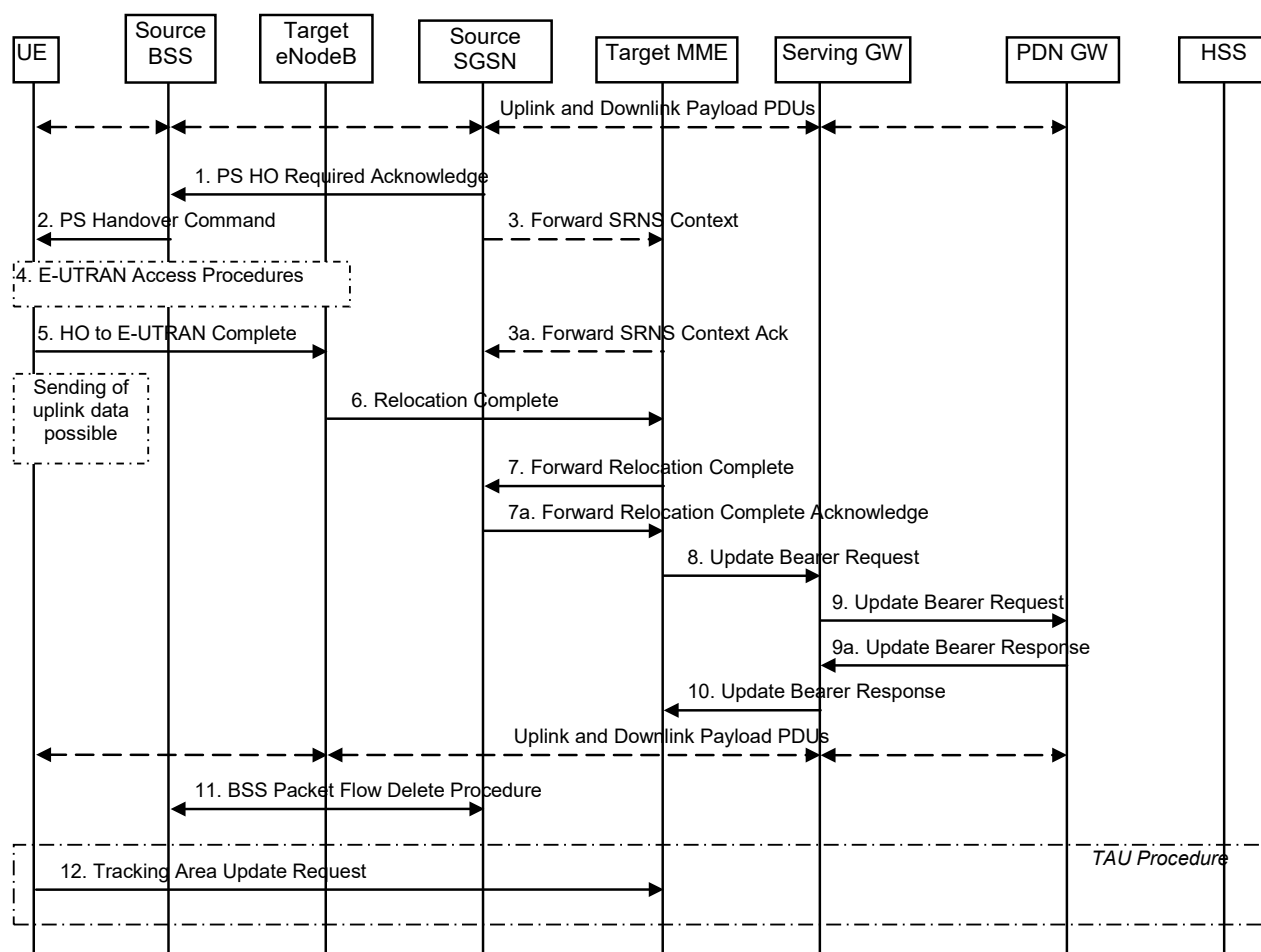


Figure 5.5.2.4.3-1: Inter RAT HO GERAN A/Gb (2G) to E-UTRAN, execution phase

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. **The indirect data forwarding is FFS.**
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. 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 (Tunnel Endpoint Identifier Data, Bearer Identity, and FFS).
9. 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.
10. The Serving GW acknowledges the user plane switch to the Target MME via the message Update Bearer Response (Parameter list is FFS). At this stage the user plane path is established for all bearers between the UE, Target eNodeB, Serving GW and PDN GW.
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).

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 Interactions with Other Services

< This section describes the interactions with other services/features, eg MBMS, 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 EPS shall support

- IPv4 only terminals,
- IPv6 only terminals, and
- dual stack terminals.

The HPLMN operator shall be able to control whether or not an IPv4 only or an IPv6 only terminal is allowed access to the network.

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

Table B-1 Standardized Label Characteristics

Name of Label Characteristic	Bearer Type	L2 Packet Delay Budget	L2 Packet Loss Rate	Example Services
NG-1	Non-GBR	Low (< 50 ms)	Low ($< 10^{-6}$)	NRT: SIP/SDP RT: Gaming
NG-2	Non-GBR	Medium (< 100 ms)	High ($< 10^{-3}$)	NRT: TCP interactive RT: Voice, Video (live)
NG-3	Non-GBR	High (< 300 ms)	Low ($< 10^{-6}$)	NRT: TCP bulk data RT: Video (playback)
G-1	GBR	Low (< 50 ms)	Low ($< 10^{-6}$)	NRT: RT: Gaming
G-2	GBR	Medium (< 100 ms)	High ($< 10^{-3}$)	NRT: RT: Voice, Video (live)
G-3	GBR	High (< 300 ms)	Low ($< 10^{-6}$)	NRT: RT: Video (playback)

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

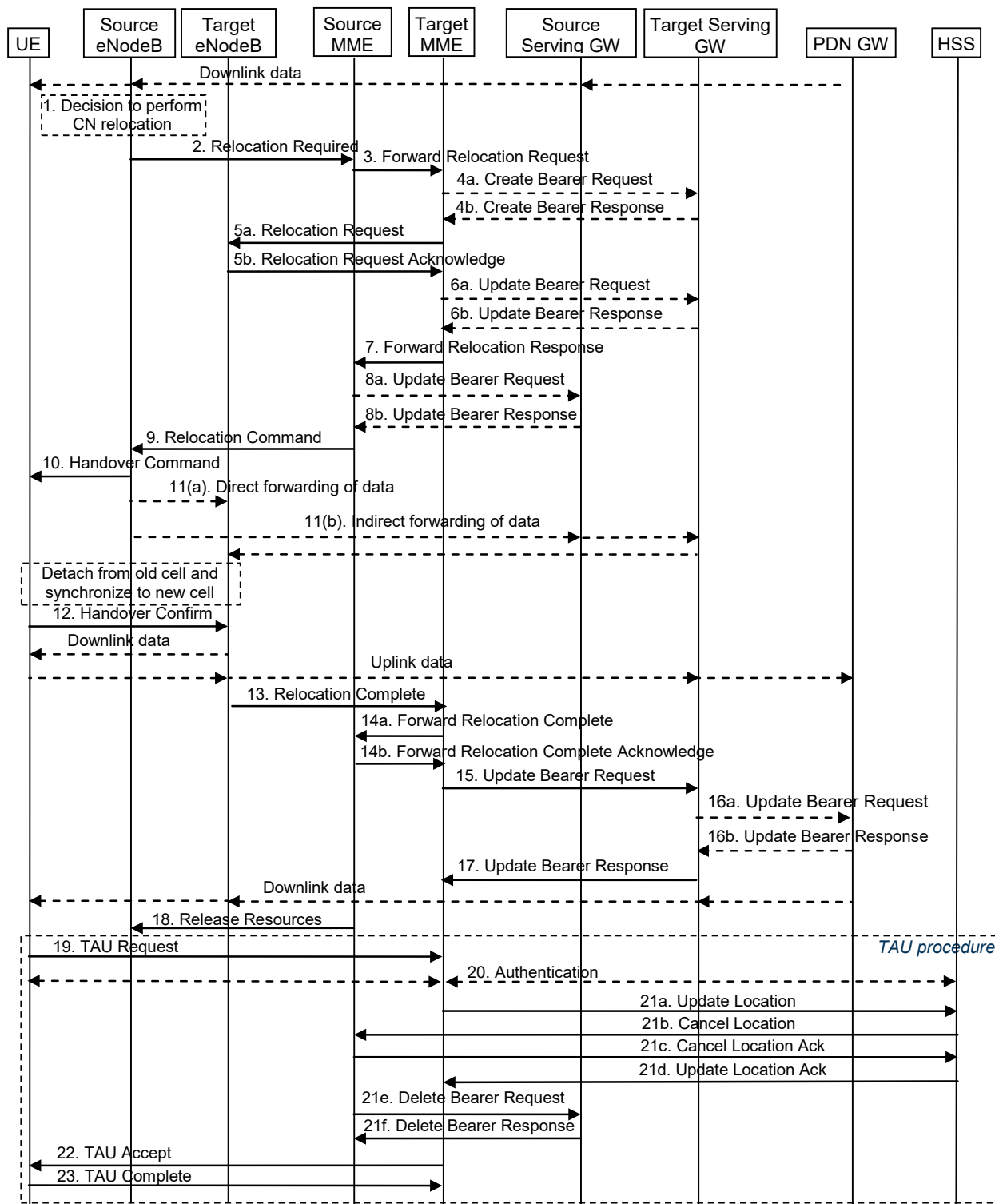
Editor's note: While Table B-1 is a first draft that will serve as the basis for future work, the ultimate goal is to specify a table of Label Characteristics that is normative.

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): Temporary location for Active Mode relocation flows

Editor's note: The following signalling flow is an example for section 5.5.1, Inter eNodeB handover with CN node relocation and it is not yet agreed. It can be used as a basis for further work. When a signalling flow in section 5.5.1 is agreed, this annex is to be removed.



1. The source eNodeB decides to perform a handover to the target eNodeB. This can be triggered e.g. by no X2 connectivity to the target eNodeB, or by configuration in the source eNodeB showing that the target eNodeB does not have S1_MME connectivity to the source MME, or by an error indication from the target eNodeB after an unsuccessful X2-based handover.
2. The source eNodeB sends Relocation Required to the source MME. This message contains a decision by the source eNodeB whether direct forwarding is applicable from the source eNodeB to the target eNodeB. This decision in the source eNodeB can be based on e.g., the presence of X2 or other configuration.
3. The source MME selects the target MME and sends a Forward Relocation Request message to it, which includes the UE context in the source MME, and the indication from the source eNodeB if direct forwarding to the target eNodeB is applicable. If direct forwarding is not applicable, it is FFS whether this message also contains an indication if indirect forwarding via the source Serving GW is applicable, based on source MME configuration.
4. It is FFS which node decides if the Serving GW needs to be relocated.
 - If the Serving GW is not relocated, no message is sent in this step. In this case, the target Serving GW is identical to the source Serving GW.
 - If the Serving GW is relocated, the target MME selects the target Serving GW and sends a Create Bearer Request message to the selected target Serving GW, including information about the established bearers of the UE and identity of the PDN GW and its TEIDs. The target Serving GW allocates TEIDs for the uplink traffic on S1_U reference point (one TEID per bearer). The target Serving GW sends an acknowledgement message back to the target MME, which include these newly allocated TEIDs.
5. The target MME sends Relocation Request message to the target eNodeB. This message creates the UE context in the target eNodeB, including information about the bearers, the target Serving GW identity, TEIDs, and the security context. The target eNodeB sends a Relocation Request Acknowledge message to the MME. This includes the TEIDs allocated at the target eNodeB for downlink traffic on S1_U reference point (one TEID per bearer), and the TEIDs to be used for packet forwarding to the target eNodeB.
6. The target MME determines the use of direct or indirect forwarding, which is FFS. One example behaviour is as follows:
 - If the source MME indicated in step 3 that the source eNodeB decided on the use of direct forwarding from the source eNodeB to the target eNodeB, then direct forwarding shall be used.
 - If the source MME indicated in step 3 that direct forwarding between the source and target eNodeBs is not available, and the source MME indicates that indirect forwarding via the source Serving GW is available, and the target MME determines (based on configuration) that indirect forwarding via the target Serving GW (which is identical to the source Serving GW if the Serving GW is not relocated) from the given source Serving GW is available, then indirect forwarding will be performed via the source Serving GW and target Serving GW (which are identical if the Serving GW is not relocated).

If indirect forwarding is used and the Serving GW is relocated, the target MME sets up forwarding parameters in the target Serving GW by sending the TEIDs allocated at the target eNodeB. The target Serving GW allocates TEIDs to be used for packet forwarding, and sends them to the target MME.

If indirect forwarding is not used, or the Serving GW is not relocated, no message is sent in this step.
7. The target MME sends a Forward Relocation Response message to the source MME. This message includes an indication if the target MME decided on direct or indirect forwarding, and an indication if the Serving GW is relocated. In the case of direct forwarding or indirect forwarding with no Serving GW relocation, the TEIDs allocated at the target eNodeB shall be included. In the case of indirect forwarding with the Serving GW relocation, the TEIDs allocated at the target Serving GW and the target Serving GW address shall be included.
8. If indirect forwarding is used, as indicated by the target MME in step 7, the source MME updates the source Serving GW about the forwarding parameters as follows:
 - If the target MME in step 7 indicated that the Serving GW is relocated, then the TEIDs to be used for indirect forwarding at the target Serving GW and the target Serving GW address, as indicated by the target MME in step 7, are sent to the source Serving GW, to be used as the destination for packet forwarding.
 - If the target MME in step 7 indicated that the Serving GW is not relocated, then the TEIDs allocated at the target eNodeB, and the target eNodeB address are sent to the Serving GW, to be used as the destination for packet forwarding.

The source Serving GW allocates TEIDs for indirect forwarding, and sends them to the source MME

9. The source MME sends a Relocation Command message to the source eNodeB. This message includes the destination (address and TEIDs) for packet forwarding. The destination is the target eNodeB in the case of direct forwarding, and the source Serving GW in the case of indirect forwarding.
10. The Handover Command is sent to the UE. The UE must be made aware that a CN relocation is being performed, since it will have to perform a Tracking Area Update (see below). The UE detaches from the old cell and synchronizes to the new cell.
11. The source eNodeB may start forwarding of downlink data from the source eNodeB to the target eNodeB, as configured in step 9. This may be either direct or indirect forwarding (FFS). Note that in the case of indirect forwarding, S1-U resources are also utilized from the source eNodeB to the source Serving GW and from the target Serving GW to the target eNodeB.
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 the PDN GW.
13. The target eNodeB sends a Relocation Complete message to the target MME. This includes TEIDs allocated at the target eNodeB for downlink traffic. This is FFS as it is FFS if the TEIDs used for forwarding are different from the TEIDs used for downlink packets.
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 to the target Serving GW. This includes the TEIDs allocated at the target eNodeB for downlink traffic.
16. If the Serving GW is relocated, the target Serving GW assigns TEIDs (one per bearer) for downlink traffic from the PDN GW. It sends an Update Bearer Request to the PDN GW, including the assigned TEIDs. The PDN GW starts sending downlink packets to the target Serving GW using the newly received TEIDs. These downlink packets will use the new downlink path via the target Serving GW and target eNodeB. An Update Bearer Response is sent back to the target Serving GW.
If the Serving GW is not relocated, no message is sent in this step.
17. The target Serving GW sends an Update Bearer Response to the target MME.
18. After the source MME has received the Forward Relocation Complete message, it sends a Release Resources message to the source eNodeB. The source eNodeB can release resources in the source eNodeB. The timing of this message and the timing of releasing the resources are FFS.
19. As soon as the handover to the target eNodeB is completed, the UE sends a Tracking Area Update Request message, which arrives to the target MME.
20. The target MME may optionally authenticate the UE
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.
 - e. The source MME releases the bearer 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 to the source MME.
22. The target MME sends a Tracking Area Update Accept to the UE, which include a new S-TMSI allocated by the target MME.

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

Annex D (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