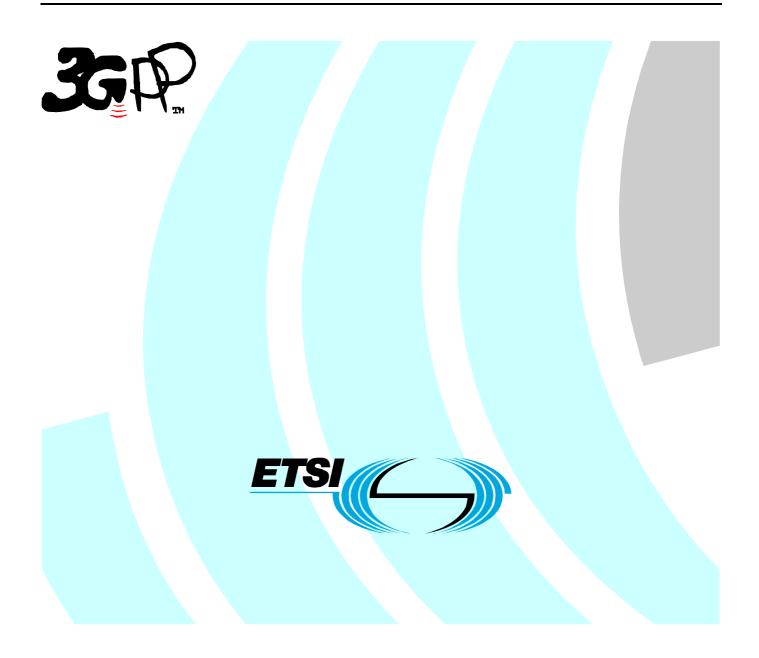# ETSI TS 123 401 V8.2.0 (2008-10)

Technical Specification

Universal Mobile Telecommunications System (UMTS); General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access (3GPP TS 23.401 version 8.2.0 Release 8)

Reference

DTS/TSGS-0223401v820

Keywords

access, GPRS, UMTS

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Foreword

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

The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

Contents

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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>
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>
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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. TS 36.300 [5] contains the overall description of the Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN).

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

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

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1]   3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2]   3GPP TS 23.402: "Architecture enhancements for non-3GPP accesses".

[3]   ITU-T Recommendation I.130: "Method for the characterization of telecommunication services supported by an ISDN and network capabilities of an ISDN".

[4]   ITU-T Recommendation Q.65: "The unified functional methodology for the characterization of services and network capabilities".

[5]   3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Overall description; Stage 2".

[6]   3GPP TS 23.203: "Policy and charging control architecture".

[7]   3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[8]   3GPP TS 43.129: "Packet-switched handover for GERAN A/Gb mode; Stage 2".

[9]   3GPP TS 23.003: "Numbering, addressing and identification".

[10]   3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station in idle mode".

[11]   3GPP TS 43.022: "Functions related to MS in idle mode and group receive mode".

[12]   3GPP TS 25.304: "UE procedures in idle mode and procedures for cell re-selection in connected mode".

[13]   3GPP TS 23.246: "Multimedia Broadcast/Multicast Service (MBMS); Architecture and functional description".

[14]   3GPP TS 29.060: "GPRS Tunnelling Protocol (GTP) across the Gn and Gp interface".

[15]   3GPP TS 43.051: "GERAN Overall description - Stage 2".

[16]   3GPP TS 25.401: "UTRAN overall description".

[17]   IETF RFC 1034 (1987): "Domain names – concepts and facilities" (STD 13).

[18]   IETF RFC 4862: "IPv6 Stateless Address Autoconfiguration".

[19]   IETF RFC 2131: "Dynamic Host Configuration Protocol".

[20]   IETF RFC 3736: "Stateless Dynamic Host Configuration Protocol (DHCP) Service for IPv6".

[21]   IETF RFC 3633: "IPv6 Prefix Options for Dynamic Host Configuration Protocol (DHCP) version 6".

[22]   3GPP TS 25.413: "UTRAN Iu interface Radio Access Network Application Part (RANAP) signalling".

[23]   3GPP TS 44.064: "Mobile Station - Serving GPRS Support Node (MS-SGSN); Logical Link Control (LLC) Layer Specification".

[24]   3GPP TS 23.251: "Network Sharing; Architecture and functional description".

[25]   IETF RFC 4039: "Rapid Commit Option for the Dynamic Host Configuration Protocol version 4 (DHCPv4)".

[26]   IETF RFC 768: "User Datagram Protocol".

[27]   3GPP TS 23.221: "Architectural requirements".

[28]   3GPP TS 23.008: "Organization of subscriber data".

[29]   3GPP TS 23.078: "Customized Applications for Mobile network Enhanced Logic (CAMEL) Phase X; Stage 2".

[30]   3GPP TS 23.236: "Intra-domain connection of Radio Access Network (RAN) nodes to multiple Core Network (CN) nodes".

[31]   IETF RFC 3588: "Diameter Base Protocol".

[32]   IETF RFC 4861: "Neighbor Discovery for IP Version 6 (IPv6)".

[33]   3GPP TS 25.331: "Radio Resource Control (RRC); Protocol Specification".

[34]   3GPP TS 36.304: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode".

[35]   IETF RFC 2960: "Stream Control Transmission Protocol".

[36]   3GPP TS 36.413: "Evolved Universal Terrestrial Access Network (E-UTRAN); S1 Application Protocol (S1AP)".

[37]   3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[38]   3GPP TS 29.061: "Interworking between the Public Land Mobile Network (PLMN) supporting packet based services and Packet Data Networks (PDN)".

[39]   IETF RFC 3041: "Privacy Extensions for Stateless Address Autoconfiguration in IPv6".

[40]   3GPP TS 33.102: "3G Security; Security architecture".

[41]   3GPP TS 33.401: "3GPP System Architecture Evolution: Security Architecture".

[42]   3GPP TS 48.018: "General Packet Radio Service (GPRS); Base Station System (BSS) - Serving GPRS Support Node (SGSN); BSS GPRS Protocol (BSSGP)".

[43]   3GPP TS 29.274: "General Packet Radio Service (GPRS); Evolved GPRS Tunnelling Protocol (eGTP) for EPS".

[44]   3GPP TS 32.251: "Telecommunication management; Charging management; Packet Switched (PS) domain charging".

[45]   3GPP TS 24.007: "Mobile radio interface signalling layer 3; General aspects".

[46]   3GPP TS 24.301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3".

[47]   3GPP TS 24.008: "Mobile Radio Interface Layer 3 specification; Core Network Protocols; Stage 3".

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.

Serving GW Service Area: A Serving GW Service Area is defined as an area within which a UE may be served without need to change the Serving GW. A Serving GW Service Area is served by one or more Serving GWs in parallel. Serving GW Service Areas are a collection of complete Tracking Areas. Serving GW Service Areas may overlap each other.

PDN Connection: The association between a UE represented by one IPv4 address and/or one IPv6 prefix/address, and a PDN represented by an APN.

Default APN: A Default APN is defined as the APN which is marked as default in the subscription data and used during the Attach procedure for PDN connection.

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
ECGI	Evolved Cell Global Identifier
ECM	EPS Connection Management
EMM	EPS Mobility Management
EPC	Evolved Packet Core
EPS	Evolved Packet System
GUMMEI	Globally Unique MME Identifier
GUTI	Globally Unique Temporary Identity
GW	Gateway
PDB	Packet Delay Budget
PLR	Packet Loss Rate
LBI	Linked EPS Bearer Id
MME	Mobility Management Entity
MMEC	MME Code
M-TMSI	M-Temporary Mobile Subscriber Identity
P-GW	PDN Gateway
PTI	Protocol Transaction Id

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
TIN	Temporary Identity used in Next update
UL TFT	UpLink Traffic Flow Template

4 Architecture model and concepts

4.1 General concepts

Local breakout of IP traffic via the visited PLMN is supported, when network policies and user subscription allow it. Local breakout may be combined with support for multiple simultaneous PDN connections, described in clause 5.10.

4.2 Architecture reference model

4.2.1 Non-roaming architecture
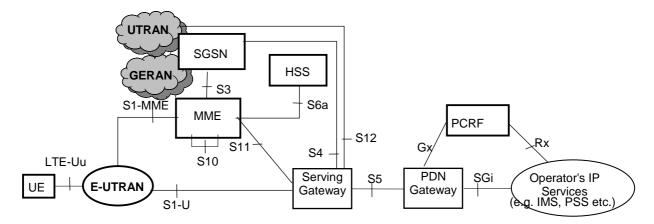
Figure 4.2.1-1: Non-roaming architecture for 3GPP accesses
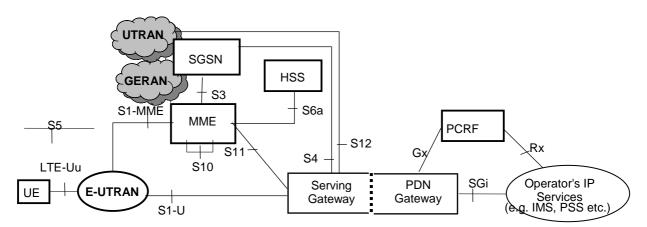
Figure 4.2.1-2: Non-roaming architecture for 3GPP accesses. Single gateway configuration option

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
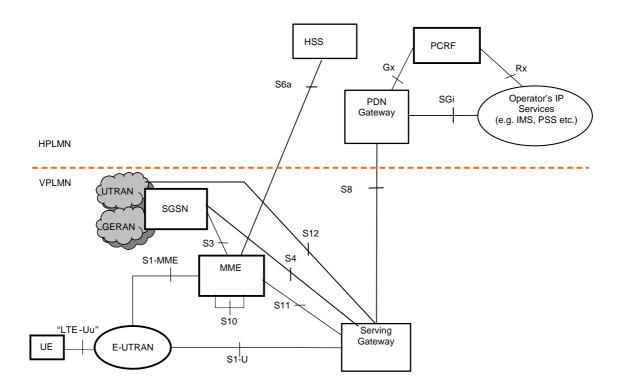
Figure 4.2.2-1: Roaming architecture for 3GPP accesses. Home routed traffic

NOTE 1: Additional interfaces/reference points for 2G/3G accesses are documented in TS 23.060 [7].

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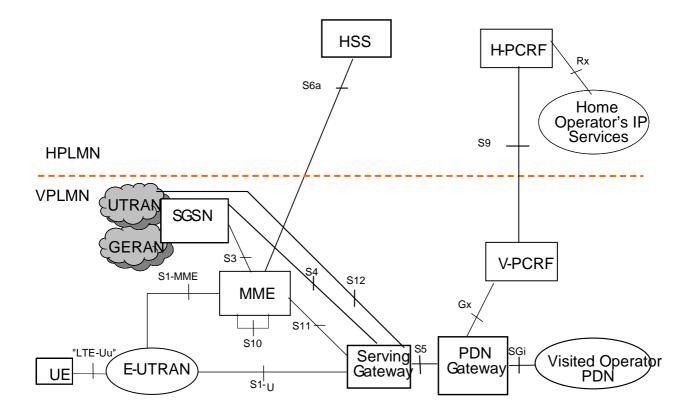
Figure 4.2.2-2: Roaming architecture for local breakout, with home operator's application functions only

NOTE 2: See TS 23.203 [6] for the role of and functions related to Home and Visited PCRF and S9/Rx reference points.

NOTE 3: In figure 4.2.2-2, the control plane signaling and the user plane for accessing to Home Operator's services traverse over the SGi reference point via the Visited Operator's PDN.
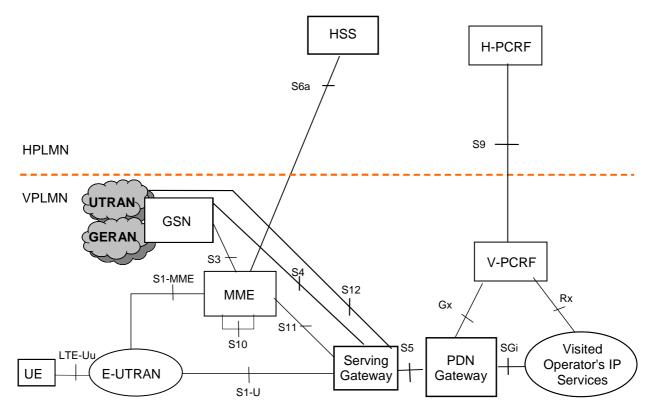
Figure 4.2.2-3: Roaming architecture for local breakout, with visited operator's application functions only

4.3 High level functions

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.

- Security Functions.

- Radio Resource Management Functions.

- Network Management Functions.

4.3.2 Network access control functions

4.3.2.1 General

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

4.3.2.2 Network/Access network selection

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

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

4.3.2.3 Authentication and authorisation function

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

4.3.2.4 Admission control function

The purpose of admission control is to determine if the requested resources are available, and then reserve those resources.

4.3.2.5 Policy and Charging Enforcement Function

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

4.3.2.6 Lawful Interception

Lawful interception is the action, performed by a network operator / access provider / service provider, of making available certain information and providing that information to a law enforcement monitoring facility.

4.3.3 Packet routeing 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 IP header compression function optimises use of radio capacity by IP header compression mechanisms.

4.3.3.3 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 Security functions

4.3.4.1 Ciphering function

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

4.3.4.2 Integrity protection function

The integrity protection function ensures the integrity of the signalling between the UE and the network.

4.3.5 Mobility management functions

4.3.5.1 General

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

4.3.5.2 Reachability Management for UE in ECM-IDLE state

The location of a UE in ECM-IDLE state is known by the network on a Tracking Area List granularity. A UE in ECM-IDLE state is paged in all cells of the Tracking Areas in which it is currently registered. The UE may be registered in multiple Tracking Areas.

A UE performs periodic Tracking Area Updates with the network after the expiry of the periodic TAU timer.

If the UE is out of E-UTRAN coverage (including the cases when the UE is camped on 2G/3G cells) when its periodic TAU update timer expires, then the UE should perform a Tracking Area Update when it next returns to E-UTRAN coverage. If the UE is camped on an E-UTRAN cell or is in ECM-CONNECTED state when the UE's periodic RAU or periodic LAU timer expires, the UE should perform a Routeing Area Update to the SGSN or a Location Area Update to the MSC when it next returns to 2G/3G coverage.

Expiry of the periodic TAU timer, or, the periodic RAU timer, or, the periodic LAU timer shall not cause the UE to change RAT.

The UE's periodic TAU timer is restarted from its initial value whenever the UE enters ECM-IDLE mode and when the UE leaves the E-UTRAN connection due to handover. UTRAN RRC state transitions and 2G GPRS STANDBY/READY state transitions shall have no other impact on the periodic TAU timer.

E-UTRAN RRC state transitions shall have no impact on the periodic RAU timer or periodic LAU timer except that handover from 2G/3G to E-UTRAN shall cause the periodic RAU timer to be started from its initial value.

Typically, the MME runs a timer with a similar value to the UE's periodic TAU timer. If this timer expires in the MME, the MME can deduce that the UE is 'out of coverage' at that moment. However, the MME does not know for how long the UE has been out of coverage, so, the MME shall not immediately delete the UE's bearers. Instead the MME should clear the PPF flag in the MME and start a second timer, with a relatively large value. With the PPF clear, the MME does not page the UE in EUTRAN coverage and shall send a Downlink Data Notification Reject message to the Serving GW when receiving a Downlink Data Notification message from the Serving GW. If this second timer expires before the UE contacts the network, then the MME can deduce that the UE has been 'out of coverage' for a long period of time:

- In the case of Idle Mode Signalling Reduction being active for the UE, after the second timer expires, the MME shall set its "Implicit detach permitted" flag. Any time after both MME and SGSN have set their "Implicit detach permitted" flags, the MME and SGSN implicitly detach the UE. If the UE enters ECM-CONNECTED mode, the MME shall clear the "Implicit detach permitted" flag and set the PPF flag.

  NOTE 1: If ISR is active, the SGSN has similar functionality.

- In case of Idle Mode Signalling Reduction is not activated for the UE, any time after the second timer expires, the MME implicitly detach the UE.

  NOTE 2: Alternative MME implementations are permitted, however, the externally visible MME behaviour should conform to the above description.

4.3.5.3 Tracking Area list management

Tracking Area list management comprises the functions to allocate and reallocate a Tracking Area Identity list to the UE.

4.3.5.4 Inter-eNodeB mobility anchor function

The Inter-eNodeB Mobility Anchor is the functional entity that anchors the user plane for E-UTRAN mobility.

4.3.5.5 Inter-3GPP mobility anchor function

The Inter-3GPP Mobility Anchor is the functional entity that anchors the user plane for mobility between 3GPP 2G/3G access systems and the E-UTRA access system.

4.3.5.6 Idle mode signalling reduction function

The Idle mode Signalling Reduction function provides a mechanism to limit signalling during inter-RAT cell-reselection in idle mode (ECM-IDLE, PMM-IDLE, GPRS STANDBY states).

4.3.5.7 Mobility Restrictions

Mobility Restrictions comprises the functions for restrictions to mobility handling of a UE in E-UTRAN access. The Mobility Restriction functionality is provided by the UE, the radio access network and the core network.

Mobility Restriction functionality in state ECM-IDLE is executed in UE based on information received from the core network. Mobility Restriction functionality in state ECM-CONNECTED is executed in the radio network and the core network.

In state ECM-CONNECTED, the core network provides the radio network with a Handover Restriction List. The Handover Restriction List specifies roaming, area and access restrictions.

4.3.6 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.

To support radio resource management in E-UTRAN the MME provides the parameter 'RAT/Frequency Selection Priority' (RFSP) to an eNB across S1. The RFSP is a 'per UE' parameter that is used by the E-UTRAN to derive UE specific cell reselection priorities to control idle mode camping. The RFSP may also be used by the E UTRAN to decide on redirecting active mode UEs to different frequency layers or RATs.

The MME receives the RFSP from the HSS (e.g., during the Attach procedure). For non-roaming subscribers the MME transparently forwards the RFSP to the eNB across S1. For roaming subscribers the MME may alternatively send an RFSP value to the eNB across S1 that is based on the visited network policy (e.g., an RFSP pre-configured per HPLMN, or a single RFSP values to be used for all roamers independent of the HPLMN).

Refer to TS 36.300 [5] for further information on E-UTRAN.

4.3.7 Network management functions

4.3.7.1 General

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 TS ss.xyz [qq]

4.3.7.2 Load balancing between MMEs

The MME Load Balancing functionality permits UEs that are entering into an MME Pool Area to be directed to an appropriate MME in a manner that achieves load balancing between MMEs. This is achieved by setting a Weight Factor for each MME, such that the probability of the eNodeB selecting an MME is proportional to its Weight Factor. The Weight Factor is typically set according to the capacity of an MME node relative to other MME nodes.

Editor's Note: It is FFS how the Weight Factor is provided to the eNodeB.

NOTE 1: An operator may decide to change the Weight Factor after the establishment of S1-MME connectivity as a result of changes in the MME capacities. E.g., a newly installed MME may be given a very much higher weight for an initial period of time making it faster to increase its load.

NOTE 2: It is intended that the Weight Factor is NOT changed frequently. e.g. in a mature network, changes on a monthly basis could be anticipated, e.g. due to the addition of RAN or CN nodes.

4.3.7.3   Load re-balancing between MMEs

The MME Load Re-balancing functionality permits UEs that are registered on an MME (within an MME Pool Area) to be moved to another MME.

NOTE 1: An example use for the MME Load Re-balancing function is for the O+M related removal of one MME from an MME Pool Area.

NOTE 2: Typically, this procedure should not be used when the MME becomes overloaded because the Load Balancing function should have ensured that the other MMEs in the pool area are similarly overloaded.

The eNodeBs may have their Load Balancing parameters adjusted beforehand (e.g. the Weight factor is set to zero if all subscribers are to be removed from the MME, which will route new entrant to the pool area into other MMEs).

The MME should off-load a cross section of its subscribers with minimal impacts on the network and users (e.g. the MME should avoid offloading only the low activity users while retaining the high activity subscribers. Gradual rather than sudden off-loading should be performed as a sudden re-balance of large number of subscribers could overload other MMEs in the pool.With minimal impact on network and the user's experience, the subscribers should be off-loaded as soon as possible). The load re-balancing can off-load part of or all the subscribers.

To off-load ECM-CONNECTED mode UEs for which there is no TAU, Attach, Detach or Service request procedure in progress, the inter eNodeB handover with MME relocation procedure (clause 5.5.1.2) is used with the source eNodeB being identical to the target eNodeB. The procedure is triggered by the MME sending a Handover Trigger message to the eNodeB to move a particular UE.

Editor's note: It is FFS whether other means of triggering handover need to be specified.

To off-load UEs who perform TA Updates or Attachs, it is FFS which mechanism is used to allow eNodeB to determine it has to transfer the UE to a new MME.

Editor's note: The following mechanisms have been proposed:
(1) The MME receives the Tracking Area Update request or Attach request and returns an indication in the accept message and releases the S1 connection. After receiving the indication, the UE will initiate a new TAU procedure with a new MME reselection indication in RRC part.
(2) The MME receives the Tracking Area Update or Attach request and retrns a Redirection indication (including the NAS part) to the eNodeB. After receiving the indication, the eNodeB forwards NAS message to a newly selected MME.
(3) The MME informs the eNodeB to move all subsequent TAU Request or Attach to a new MME node. In all secenarios, the eNodeB will treat the UE "as a new entrant to the pool area" and select another MME according to clause 4.3.8.3 on "MME selection function". The new MME will retrieve UE context from the old MME.

To off-load UEs in ECM-IDLE state without waiting for the UE to perform a TAU or perform Service request and become ECM-CONNECTED, the MME first pages UE to bring it to ECM-CONNECTED state.

4.3.7.4   MME control of overload

The MME shall contain mechanisms for handling overload situations. These can include the use of NAS signalling to reject NAS requests from UEs.

In addition, under unusual circumstances, the MME may need to restrict the load that its eNodeBs are generating on it. This can be achieved by the MME invoking the S1 interface overload procedure (see TS 36.300 [5] and TS 36.413 [36] to a proportion of the eNodeB's with which the MME has S1 interface connections. To reflect the amount of load that the MME wishes to reduce, the MME can adjust the proportion of eNodeBs which are sent S1 interface OVERLOAD START message, and the content of the OVERLOAD START message.

The MME should select the eNodeBs at random (so that if two MMEs within a pool area are overloaded, they do not both send OVERLOAD START messages to exactly the same set of eNodeBs).

Using the OVERLOAD START message, the MME can, for example, request the eNodeB to:

- reject all non-emergency Service Request messages for that MME; and/or

- reject all Service Request messages that are response to paging for that MME; and/or

- reject all new RRC connections for EPS Mobility Management signalling (e.g. for TA Updates) for that MME; and/or

- only permit RRC connection establishments for emergency sessions for that MME.

NOTE: The support for emergency sessions (and subsequent support within priority services) are not fully supported in this release.

When the MME has recovered and wishes to increase its load, the MME sends OVERLOAD STOP messages to the eNodeB(s).

Hardware and/or software failures within an MME may reduce the MME's load handling capability. Typically such failures should result in alarms which alert the operator/O+M system. Only if the operator/O+M system is sure that there is spare capacity in the rest of the pool, the operator/O+M system might use the load re-balancing procedure to move some load off this MME. However, extreme care is needed to ensure that this load re-balancing does not overload other MMEs within the pool area (or neighbouring SGSNs) as this might lead to a much wider system failure.

4.3.8 Selection functions

4.3.8.1 PDN GW selection function (3GPP accesses)

The PDN GW selection function allocates a PDN GW that shall provide the PDN connectivity for the 3GPP access. The function uses subscriber information provided by the HSS and possibly additional criteria. For each of the subscribed PDNs, the HSS provides one or more PDN subscription contexts each containing:

- the identity of a PDN GW and an APN (PDN subscription contexts with subscribed PDN GW address are not used when there is interoperation with pre Rel-8 2G/3G SGSN), or

- an APN and an indication for this APN whether the allocation of a PDN GW from the visited PLMN is allowed or whether a PDN GW from the home PLMN shall be allocated. Optionally an IP address of a PDN GW may be contained for handover with non-3GPP accesses.

In the case of static address allocation, a static PDN GW is selected by either having the APN configured to map to a given PDN GW, or the PDN GW identity provided by the HSS indicates the static PDN GW.

The HSS also indicates which of the PDN subscription contexts is the Default one for the UE.

To establish connectivity with a PDN when the UE is already connected to one or more PDNs, the UE provides the requested APN for the PDN GW selection function.

If the HSS provides the identity of a PDN GW, no further PDN GW selection functionality is performed. The PDN GW identity refers to a specific PDN GW. If the PDN GW identity includes the IP address of the PDN GW, that IP address shall be used as the PDN GW IP address; otherwise the PDN GW identity includes an FQDN which is used to derive the PDN GW IP address by using Domaind Name Service function, taking into account the protocol type on S5/S8 (PMIP or GTP).

NOTE: Provision of a PDN GW identity of a PDN GW as part of the subscriber information allows also for a PDN GW allocation by HSS.

If the HSS provides a PDN subscription context that allows for allocation of a PDN GW from the visited PLMN for this APN, the PDN GW selection function derives a PDN GW identity from the visited PLMN. If a visited PDN GW identity cannot be derived, or if the subscription does not allow for allocation of a PDN GW from the visited PLMN, then the APN is used to derive a PDN GW identity from the HPLMN. The PDN GW identity is derived from the APN, subscription data and additional information by using the Domain Name Service function. If the PDN GW identity is a logical name instead of an IP address, the PDN GW address is derived from the PDN GW identity, protocol type on S5/S8 (PMIP or GTP) by using the Domain Name Service function. The S8 protocol type (PMIP or GTP) is configured per HPLMN in MME/SGSN.

If the APN-OI Replacement field exists in the subscription data, the PDN GW domain name will be constructed by replacing the APN-OI with the value received in the APN-OI Replacement field. Otherwise, or when the resolution of

the above PDN GW domain name fails, the PDN GW domain name will be constructed by appending '.mnc<MNC>.mcc<MCC>.gprs' as specified in Annex A of TS 23.060 [7] and TS 23.003 [9]. If the Domain Name Service function provides a list of PDN GW addresses, one PDN GW address is selected from this list. If the selected PDN GW cannot be used, e.g. due to an error, then another PDN GW is selected from the list.

If the UE provides an APN for a PDN, this APN is then used to derive the PDN GW identity as specified for the case of HSS provided APN if one of the subscription contexts allows for this APN.

If there is an existing PDN connection to the same APN used to derive the PDN GW address, the same PDN GW shall be selected.

As part of PDN GW selection, an IP address of the assigned PDN GW may be provided to the UE for use with host based mobility as defined in TS 23.402 [2], if the PDN GW supports host-based mobility for inter-access mobility towards accesses where host-based mobility can be used. If a UE explicity requests the address of the PDN GW and the PDN GW supports host based mobility then the PDN GW address shall be returned to the UE.

4.3.8.2 Serving GW selection function

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

If a subscriber of a GTP only network roams into a PMIP network, the PDN GWs selected for local breakout support the PMIP protocol, while PDN GWs for home routed traffic use GTP. This means the Serving GW selected for such subscribers may need to support both GTP and PMIP, so that it is possible to set up both local breakout and home routed sessions for these subscribers. For a Serving GW supporting both GTP and PMIP, the MME/SGSN should indicate the Serving GW which protocol should be used over S5/S8 interface. The MME/SGSN is configured with the S8 variant(s) on a per HPLMN granularity.

If a subscriber of a GTP only network roams into a PMIP network, the PDN GWs selected for local breakout may support GTP or the subscriber may not be allowed to use PDN GWs of the visited network. In both cases a GTP only based Serving GW may be selected. These cases are considered as roaming between GTP based operators.

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

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

For handover from non-3GPP accesses in roaming scenario, the Serving GW selection function for local anchoring is described in TS 23.402 [2].

4.3.8.3 MME selection function

The MME selection function selects an available MME for serving a UE. The selection is based on network topology, i.e. the selected MME serves the UE's location and in case of overlapping MME service areas, the selection may prefer MMEs with service areas that reduce the probability of changing the MME. When an eNodeB selects an MME, the selection shall achieve load balancing as specified in clause 4.3.6.2.

4.3.8.4 SGSN selection function

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

4.3.8.5 Selection of PCRF

The PDN-GW and AF may be served by one or more PCRF nodes in the HPLMN and, in roaming with local breakout scenarios, one or more PCRF nodes in the VPLMN.

The selection of PCRF and linking of the different UE's PCC sessions over the multiple PCRF interfaces (e.g. Rx session, Gx session, S9 session etc.) for a UE IP CAN session is described in TS 23.203 [6].

4.3.9 IP network related functions

4.3.9.1 Domain Name Service function

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

4.3.9.2 DHCP function

The Dynamic Host Configuration Function allows to deliver IP configuration information for UEs. This function is standard Internet functionality according to RFC 2131 [19], RFC 3736 [20], RFC 3633 [21] and RFC 4039 [25].

4.3.10 Functionality for Connection of eNodeBs to Multiple MMEs

An eNodeB may connect to several MMEs. This implies that an eNodeB must be able to determine which of the MMEs, covering the area where an UE is located, should receive the signalling sent from a UE. To avoid unnecessary signalling in the core network, a UE that has attached to one MME should generally continue to be served by this MME as long as the UE is in the radio coverage of the pool area to which the MME is associated. The concept of pool area is a RAN based definition that comprises one or more TA(s) that, from a RAN perspective, are served by a certain group of MMEs. This does not exclude that one or more of the MMEs in this group serve TAs outside the pool area. This group of MMEs is also referred to as an MME pool.

To enable the eNodeB to determine which MME to select when forwarding messages from an UE, this functionality defines a routing mechanism (and other related mechanism). A routing mechanism (and other related mechanism) is defined for the MMEs. The routing mechanism is required to find the correct old MME (from the multiple MMEs that are associated with a pool area). When a UE roams out of the pool area and into the area of one or more MMEs that do not know about the internal structure of the pool area where the UE roamed from, the new MME will send the Identification Request message or the Context Request message to the old MME using the GUTI. The routing mechanism in both the MMEs and the eNodeB utilises the fact that every MME that serves a pool area must have its own unique value range of the GUTI parameter within the pool area.

4.4 Network elements

4.4.1 E-UTRAN

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

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

- Header compression and user plane ciphering;

- MME selection when no routeing to an MME can be determined from the information provided by the UE;

- UL bearer level rate enforcement based on UE-AMBR via means of uplink scheduling and MBR
  (e.g. by limiting the amount of UL resources granted per UE over time);

- UL and DL bearer level admission control;

- Transport level packet marking in the uplink, e.g. setting the DiffServ Code Point, based on the QCI of the associated EPS bearer.

4.4.2 MME

MME functions include:

- NAS signalling;

- NAS signalling security;

- Inter CN node signalling for mobility between 3GPP access networks (terminating S3);

- UE Reachability in ECM-IDLE state (including control and execution of paging retransmission);

- Tracking Area list management;

- PDN GW and Serving GW selection;

- MME selection for handovers with MME change;

- SGSN selection for handovers to 2G or 3G 3GPP access networks;

- Roaming (S6a towards home HSS);

- Authentication;

- Bearer management functions including dedicated bearer establishment.

- Lawful Interception of signalling traffic.

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).

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.

The functions of the Serving GW, for both the GTP-based and the PMIP-based S5/S8, include:

- the local Mobility Anchor point for inter-eNodeB handover;

- assist the eNodeB reordering function during inter-eNodeB handover by sending one or more "end marker" packets to the source eNodeB immediately after switching the path.

- Mobility anchoring for inter-3GPP mobility (terminating S4 and relaying the traffic between 2G/3G system and PDN GW);

- ECM-IDLE mode downlink packet buffering and initiation of network triggered service request procedure;

- Lawful Interception;

- Packet routeing and forwarding;

- Transport level packet marking in the uplink and the downlink, e.g. setting the DiffServ Code Point, based on the QCI of the associated EPS bearer;

- Accounting on user and QCI granularity for inter-operator charging;

- UL and DL charging per UE, PDN, and QCI
  (e.g. for roaming with home routed traffic).

Additional Serving GW functions for the PMIP-based S5/S8 are captured in TS 23.402 [2].

Connectivity to a GGSN is not supported.

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, however a mix of S5/S8 connectivity and Gn/Gp connectivity is not supported for that UE simultaneously.

PDN GW functions include for both the GTP-based and the PMIP-based S5/S8:

- Per-user based packet filtering (by e.g. deep packet inspection);

- Lawful Interception;

- UE IP address allocation;

- Transport level packet marking in the uplink and downlink, e.g. setting the DiffServ Code Point, based on the QCI of the associated EPS bearer;

- UL and DL service level charging as defined in TS 23.203 [6]
  (e.g. based on SDFs defined by the PCRF, or based on deep packet inspection defined by local policy);

- UL and DL service level gating control as defined in TS 23.203 [6];

- UL and DL service level rate enforcement as defined in TS 23.203 [6]
  (e.g. by rate policing/shaping per SDF);

- UL and DL rate enforcement based on APN-AMBR
  (e.g. by rate policing/shaping per aggregate of traffic of all SDFs of the same APN that are associated with Non-GBR QCIs);

- DL rate enforcement based on the accumulated MBRs of the aggregate of SDFs with the same GBR QCI
  (e.g. by rate policing/shaping);

- DHCPv4 (server and client) and DHCPv6 (client, relay and server) functions;

- The network does not support PPP bearer type in this version of the specification. Pre-Release 8 PPP functionality of a GGSN may be implemented in the PDN GW.

Additionally the PDN GW includes the following functions for the GTP-based S5/S8:

- UL and DL bearer binding as defined in TS 23.203 [6];

- UL bearer binding verification;

  Editor's Note: This is to verify that the UE applies the UL packet filters correctly and does not misbehave, e.g., by sending packets on a "premium bearer" even though the packets do not match the UE's UL packet filters associated with that "premium bearer". Once the term 'UL bearer binding verification' has been defined in TS 23.203 this editor's note can be replaced with a corresponding reference.

- Functionality as defined in RFC 4861 [32].

The P-GW provides PDN connectivity to both GERAN/UTRAN only UEs and E-UTRAN capable UEs using any of E-UTRAN, GERAN or UTRAN. The P-GW provides PDN connectivity to E-UTRAN capable UEs using E-UTRAN only over the S5/S8 interface.

4.4.4 SGSN

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

- Inter EPC node signalling for mobility between 2G/3G and E-UTRAN 3GPP access networks;

- PDN and Serving GW selection: the selection of S-GW/P-GW by the SGSN is as specified for the MME;

- MME selection for handovers to E-UTRAN 3GPP access network.

4.4.5 GERAN

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

4.4.6 UTRAN

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

4.4.7 PCRF

4.4.7.1 General

PCRF is the policy and charging control element. PCRF functions are described in more detail in TS 23.203 [6].

In non-roaming scenario, there is only a single PCRF in the HPLMN associated with one UE's IP-CAN sessionThe PCRF terminates the Rx interface and the Gx interface.

In a roaming scenario with local breakout of traffic there may be two PCRFs associated with one UE's IP-CAN session:

- H-PCRF that resides within the H-PLMN;

- V-PCRF that resides within the V-PLMN.

4.4.7.2 Home PCRF (H-PCRF)

The functions of the H-PCRF include:

- terminates the Rx reference point for home network services;

- terminates the S9 reference point for roaming with local breakout;

- associates the sessions established over the multiple reference points (S9, Rx), for the same UE's IP-CAN session (PCC session binding).

The functionality of H-PCRF is described in TS 23.203 [6].

4.4.7.3 Visited PCRF (V-PCRF)

The functions of the V-PCRF include:

- terminates the Gx and S9 reference points for roaming with local breakout;

- terminates Rx for roaming with local breakout and visited operator's Application Function.

The functionality of V-PCRF is described in TS 23.203 [6].

4.4.8 PDN GW's associated AAA Server

The PDN Gateway may interact with a AAA server over the SGi interface. This AAA Server may maintain information associated with UE access to the EPC and provide authorization and other network services. This AAA Server could be a RADIUS or Diameter Server in an external PDN network, as defined in TS 29.061 [38]. This AAA Server is logically separate from the HSS and the 3GPP AAA Server.

4.5 Reference points

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

S1-U: Reference point between E-UTRAN and Serving GW for the per bearer user plane tunnelling 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.

S4: It provides related control and mobility support between GPRS Core and the 3GPP Anchor function of Serving GW. In addition, if Direct Tunnel is not established, it provides the user plane tunnelling.

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

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

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

S8: Inter-PLMN reference point providing user and control plane between the Serving GW in the VPLMN and the PDN GW in the HPLMN. S8 is the inter PLMN variant of S5.

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

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

S11: Reference point between MME and Serving GW.

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

S13: It enables UE identity check procedure between MME and EIR.

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 TS 23.203 [6].

When data forwarding is used as part of mobility procedures different user plane routes may be used based on the network configuration (e.g. direct or indirect data forwarding). These routes can be between eNodeB and RNC, eNodeB and SGSN, RNC and S-GW or between S-GW and SGSN. Explicit reference points are not defined for these routes.

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. PMIP variant of S5 is described in TS 23.402 [2];

- The S8 is based on GTP protocol. PMIP variant of S8 is described in TS 23.402 [2].

- S3, S4, S5, S8, S10 and S11 interfaces are designed to manage EPS bearers as defined in clause 4.7.2.

NOTE: Redundancy support on reference points S5 and S8 should be taken into account.

4.6 EPS Mobility Management and Connection Management states

Editor's note: The relationship and impact of the inter-system mobility to the EMM/ECM states are FFS. The current definitions of ECM-IDLE and ECM-CONNECTED states roughly correspond to PMM-IDLE and PMM-CONNECTED 3G-SGSN/UTRAN states.

4.6.1 General

The EPS Mobility Management (EMM) states describe the Mobility Management states that result from the mobility management procedures e.g. Attach and Tracking Area Update procedures.

The EPS Connection Management (ECM) states describe the signalling connectivity between the UE and the EPC.

The ECM and EMM states are independent of each other.

NOTE: For example, the UE has to be in the ECM-CONNECTED state in order for the network to send a Tracking Area Update Reject message to the UE.

4.6.2 Definition of main EPS Mobility Management states

4.6.2.1 EMM-DEREGISTERED

In the EMM-DEREGISTERED state, the EMM context in MME holds no valid location or routeing information for the UE. The UE is not reachable by a MME, as the UE location is not known.

In the EMM-DEREGISTERED state, some UE context can still be stored in the UE and MME, e.g. to avoid running an AKA procedure during every Attach procedure.

4.6.2.2 EMM-REGISTERED

The UE enters the EMM-REGISTERED state by a successful registration procedure which is either an Attach procedure or a Tracking Area Update procedure. In the EMM-REGISTERED state, the UE can receive services that require registration in the EPS.

The UE location is known in the MME to at least an accuracy of the tracking area list allocated to that UE (excluding some abnormal cases).

In the EMM-REGISTERED state, the UE shall:

- always have at least one active PDN connection;

- setup the EPS security context.

After performing the Detach procedure, the state is changed to EMM-DEREGISTERED in the UE and in the MME. Upon receiving the TAU Reject and Attach Reject messages the actions of the UE and MME depend upon the 'cause value' in the reject message, but, in many cases the state is changed to EMM-DEREGISTERED in the UE and in the MME.

If all the bearers belonging to a UE are released (e.g., after handover from EUTRAN to non-3GPP access), the MME shall change the MM state of the UE to EMM-DEREGISTERED. If the UE detects that all of its bearers are released, the UE shall change the MM state to EMM-DEREGISTERED. If the UE switches off its EUTRAN interface when performing handover to non-3GPP access, the UE shall automatically change its MM state to EMM-DEREGISTERED.

The MME may perform an implicit detach any time after the UE reachable timer expires.

4.6.3 Definition of EPS Connection Management states

4.6.3.1 ECM-IDLE

A UE is in ECM-IDLE state when no NAS signalling connection between UE and network exists. In ECM-IDLE state, a UE performs cell selection/reselection according to TS 36.304 [34] and PLMN selection according to TS 23.122 [10].

There exists no UE context in E-UTRAN for the UE in the ECM-IDLE state. There is no S1_MME and no S1_U connection for the UE in the ECM-IDLE state.

In the EMM-REGISTERED and ECM-IDLE state, the UE shall:

- perform a tracking area update if the current TA is not in the list of TAs that the UE has received from the network in order to maintain the registration and enable the MME to page the UE;

- perform the periodic tracking area updating procedure to notify the EPC that the UE is available;

- answer to paging from the MME by performing a service request procedure;

- perform the service request procedure in order to establish the radio bearers when uplink user data is to be sent.

The UE and the MME shall enter the ECM-CONNECTED state when the signalling connection is established between the UE and the MME. Initial NAS messages that initiate a transition from ECM-IDLE to ECM-CONNECTED state are Attach Request, Tracking Area Update Request, Service Request or Detach Request.

The UE in the ECM-IDLE state performs the tracking area update procedure when TAI in the EMM system information is not in the list of TA's that the UE is registered with the network.

When the UE is in ECM-IDLE state, the UE and the network may be unsynchronized, i.e. the UE and the network may have different sets of established EPS bearers. When the UE and the MME enter the ECM-CONNECTED state, the set of EPS Bearers is synchronized between the UE and network.

4.6.3.2 ECM-CONNECTED

The UE location is known in the MME with an accuracy of a serving eNodeB ID. The mobility of UE is handled by the handover procedure.

The UE performs the tracking area update procedure only when explicitly triggered by the eNodeB. The eNodeB shall trigger the tracking area update procedure after a handover with the change of MME, which may happen due to UE mobility or due to load rebalancing. It is up to RAN configuration whether the eNodeB triggers the tracking area update procedure after handover without MME change on condition that the current TAI is not in the list of TA's that the UE has registered with the network.

For a UE in the ECM-CONNECTED state, there exists a signalling connection between the UE and the MME. The signalling connection is made up of two parts: an RRC connection and an S1_MME connection.

The S1 release procedure changes the state at both UE and MME from ECM-CONNECTED to ECM-IDLE.

> NOTE: The UE may not receive the indication for the S1 release, e.g. due to radio link error or out of coverage. In this case, there can be temporal mismatch between the ECM-state in the UE and the ECM-state in the MME.

After a signalling procedure, the MME may decide to release the signalling connection to the UE, after which the state at both the UE and the MME is changed to ECM-IDLE.

Editor's note: There are some error cases where the UE also changes to EMM-IDLE. The details are FFS.

When a UE changes to ECM-CONNECTED state and if a radio bearer cannot be established, the corresponding EPS bearer is deactivated.

4.6.4 State transition and functions

Detach,
Attach Reject,
TAU reject,
EUTRAN interface switched off due to Non-3GPP handover,
All bearers deactivated,

EMM-DEREGISTERED   EMM-REGISTERED

Attach accept,
TAU accept

Figure 4.6.4-1: EMM state model in UE

Detach,
Attach Reject,
TAU reject
All bearers deactivated

EMM-DEREGISTERED   EMM-REGISTERED

Attach accept,
TAU accept

Figure 4.6.4-2: EMM state model in MME

RRC connection
released

ECM-IDLE   ECM-CONNECTED

RRC connection
established

Figure 4.6.4-3: ECM state model in UE

S1 connection
released

ECM-IDLE   ECM-CONNECTED

S1 connection
established

Figure 4.6.4-4: ECM state model in MME

4.7 Overall QoS concept

4.7.1 PDN connectivity service

The Evolved Packet System provides IP connectivity between a UE and a PLMN external packet data network. This is referred to as PDN Connectivity Service.

The PDN Connectivity Service supports the transport of one or more Service Data Flows (SDFs) defined in TS 23.203 [6].

4.7.2 The EPS bearer

4.7.2.1 The EPS bearer in general

For E-UTRAN access to the EPC the PDN connectivity service is provided by an EPS bearer in case of GTP-based S5/S8, and by an EPS bearer concatenated with IP connectivity between Serving GW and PDN GW in case of PMIP-based S5/S8.

An EPS bearer uniquely identifies an SDF aggregate between a UE and a PDN GW in case of GTP-based S5/S8, and between UE and Serving GW in case of PMIP-based S5/S8.

The term 'SDF aggregate' is defined in TS 23.203 [6].

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 1: 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 mapping of SDFs to EPS bearers.

One EPS bearer is established when the UE connects to a PDN, and that remains established throughout the lifetime of the PDN connection to provide the UE with always-on IP connectivity to that PDN. That bearer is referred to as the default bearer. Any additional EPS bearer that is established to the same PDN is referred to as a dedicated bearer. The distinction between default and dedicated bearers should be transparent to the access network (e.g. E-UTRAN).

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

> NOTE 2: The evaluation precedence order of the filters associated with the default bearer, in relation to those associated with the dedicated bearers, is up to operator configuration. It is possible to "force" certain SDFs onto the default bearer by setting the evaluation precedence order of the corresponding filters to a value that is lower than the values used for filters associated with the dedicated bearers. It is also possible use the default bearer for traffic that does not match any of the filters associated with the dedicated bearers. In this case, the evaluation precedence order of the corresponding filter(s) (e.g., a "match all filter") need to be set to a value that is higher than the values used for filters associated with dedicated bearers.

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

The decision to establish or modify a dedicated bearer can only be taken by the EPC, and the bearer level QoS parameter values are always assigned by the EPC. Therefore, the MME shall not modify the bearer level QoS parameter values received on the S11 reference point during establishment or modification of a dedicated bearer. Instead, the MME shall only transparently forwards those values to the E-UTRAN. Consequently, "QoS negotiation" between the E-UTRAN and the EPC during dedicated bearer establishment / modification is not supported. The MME may, however, reject the establishment or modification of a dedicated bearer (e.g. in case the bearer level QoS parameter values sent by the PCEF over a GTP based S8 roaming interface do not comply with a roaming agreement).

Editor's Note: It is FFS in case of GTP based roaming how an MME in the VPLMN can enforce roaming restrictions on an 'EPS subscribed QoS profile' received from the HSS in the HPLMN during the Attach procedure.

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

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

NOTE 3: Admission control can be performed at establishment / modification of a Non-GBR bearer even though a Non-GBR bearer is not associated with a GBR value.

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

NOTE 4: A default bearer remains permanently established to provide the UE with always-on IP connectivity to a certain PDN. That motivates the restriction of a default bearer to bearer type Non-GBR.

4.7.2.2 The EPS bearer with GTP-based S5/S8
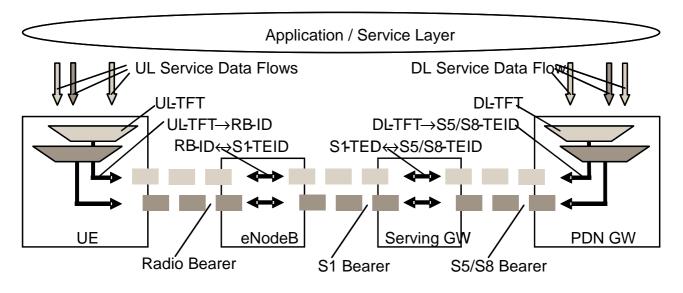
Figure 4.7.2.2-1: Two unicast EPS bearers (GTP-u based S5/S8)

An EPS bearer is realized by the following elements:

- An UL TFT in the UE maps 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 maps an SDF to an EPS bearer in the downlink direction. Multiple SDFs can be multiplexed onto the same EPS bearer by including multiple downlink packet filters in the DL TFT;

- A radio bearer (defined in TS 36.300 [5]) transports the packets of an EPS bearer between a UE and an eNodeB. There is a one-to-one mapping between an EPS bearer and a radio bearer;

- An S1 bearer transports the packets of an EPS bearer between an eNodeB and a Serving GW;

- An S5/S8 bearer transports the packets of an EPS bearer between a Serving GW and a PDN GW;

- A UE stores a mapping between an uplink packet filter and a radio to create the mapping between an SDF and a radio bearer in the uplink;

- A PDN GW stores a mapping between a downlink packet filter and an S5/S8 bearer to create the mapping between an SDF and an S5/S8 bearer in the downlink;

- An eNodeB stores a one-to-one mapping between a radio bearer and an S1 to create the mapping between a radio bearer and an S1 bearer in both the uplink and downlink;

- A Serving GW stores a one-to-one mapping between an S1 bearer and an S5/S8 bearer to create the mapping between an S1 bearer and an S5/S8 bearer in both the uplink and downlink.

4.7.2.3 The EPS bearer with PMIP-based S5/S8

See clause 4.6 in TS 23.402 [2].

4.7.3 Bearer level QoS parameters

The bearer level (i.e. per bearer or per bearer aggregate) QoS parameters are QCI, ARP, GBR, MBR, and AMBR described in this section.

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

- QoS Class Identifier (QCI);

- Allocation and Retention Priority (ARP).

A QCI 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 QCI values to standardized characteristics is captured TS 23.203 [6].

NOTE 1: On the radio interface and on S1, each PDU (e.g. RLC PDU or GTP-u PDU) is indirectly associated with one QCI 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: QCI, GBR, MBR, and AMBR.

NOTE 2: The ARP should be understood as "Priority of Allocation and Retention"; not as "Allocation, Retention, and Priority".

NOTE 3: Video telephony is one use case where it may be beneficial to use EPS bearers with different ARP values for the same UE. In this use case an operator could map voice to one bearer with a higher ARP, and video to another bearer with a lower ARP. In a congestion situation (e.g. cell edge) the eNB can then drop the "video bearer" without affecting the "voice bearer". This would improve service continuity.

NOTE 4: The ARP may also be used to free up capacity in exceptional situations, e.g. a disaster situation. In such a case the eNB may drop "low ARP bearers" to free up capacity.

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). See clause 4.7.4 for further details on GBR and MBR.

Each APN is associated with the following IP-CAN session level QoS parameter:

- per APN Aggregate Maximum Bit Rate (APN-AMBR).

The APN-AMBR is a subscription parameter stored per APN in the HSS. It limits the aggregate bit rate that can be expected to be provided across all Non-GBR bearers and across all PDN connections of the same APN (e.g. excess traffic may get discarded by a rate shaping function). Each of those Non-GBR bearers could potentially utilize the entire APN-AMBR, e.g. when the other Non-GBR bearers do not carry any traffic. GBR bearers are outside the scope of

APN-AMBR. The P-GW enforces the APN-AMBR in downlink. Enforcement of APN-AMBR in uplink is done in the UE and additionally in the P-GW.

NOTE 5: All simultaneous active PDN connections of a UE that are associated with the same APN shall be provided by the same PGW (see clause 5.10.1).

Each UE is associated with the following bearer level QoS parameter:

- per UE Aggregate Maximum Bit Rate (UE-AMBR).

The UE-AMBR is limited by a subscription parameter stored in the HSS. The MME shall set the used UE-AMBR to the sum of the APN-AMBR of all active APNs up to the value of the subscribed UE-AMBR. The UE-AMBR limits the aggregate bit rate that can be expected to be provided across all Non-GBR bearers of a UE (e.g. excess traffic may get discarded by a rate shaping function). Each of those Non-GBR bearers could potentially utilize the entire UE-AMBR, e.g. when the other Non-GBR bearers do not carry any traffic. GBR bearers are outside the scope of UE AMBR. The E-UTRAN enforces the UE-AMBR in uplink and downlink.

The GBR and MBR denote bit rates of traffic per bearer while UE-AMBR/APN-AMBR denote bit rates of traffic per group of bearers. Each of those 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/IP header overhead of the tunnel on S1_U.

One 'EPS subscribed QoS profile' is defined for each APN permitted for the subscriber. It contains the bearer level QoS parameter values for that APN's default bearer (QCI and ARP) and the APN-AMBR.

NOTE: Subscription data related to bearer level QoS parameter values for dedicated bearers is specified in TS 23.203 [6].

4.7.4 Support for Application / Service Layer Rate Adaptation

Neither the EPC nor the E-UTRAN supports any explicit feedback to trigger a rate adaptation scheme at the application / service / transport layer.

The MBR of a particular GBR bearer shall be set equal to the GBR.

NOTE: Support for "MBR > GBR" bearers may be introduced in a future release.

The EPC does not support E-UTRAN-initiated "QoS re-negotiation". That is, the EPC does not support an eNodeB initiated bearer modification procedure. If an eNodeB can no longer sustain the GBR of an active GBR bearer then the eNodeB should simply trigger a deactivation of that bearer.

4.7.5 Application of PCC in the Evolved Packet System

The Evolved Packet System applies the PCC framework as defined in TS 23.203 [6] for QoS policy and charging control. PCC functionality is present in the AF, PCEF and PCRF.

An EPS needs to support both PCEF and PCRF functionality to enable dynamic policy and charging control by means of installation of PCC rules based on user and service dimensions. However, an EPS may only support PCEF functionality in which case it shall support static policy and charging control.

NOTE: The local configuration of PCEF static policy and charging control functionality is not subject to standardization. The PCEF static policy and control functionality is not based on subscription information.

The following applies to the use of dynamic policy and charging control in EPS:

- The service level (per SDF) QoS parameters are conveyed in PCC rules (one PCC rule per SDF) over the S7 reference point. The service level QoS parameters consist of a QoS Class Identifier (QCI) Allocation and Retention Priority (ARP) and authorised Guaranteed and Maximum Bit Rate values for uplink and downlink. The QCI is a scalar that represents the QoS characteristics that the EPS is expected to provide for the SDF. ARP is an indicator of the priority of allocation and retention for the SDF. The service level ARP assigned by PCRF in a PCC rule may be different from the bearer level ARP stored in subscription data;

- The set of standardized QCIs and their characteristics that the PCRF in an EPS can select from is provided in TS 23.203 [6]. It is expected that the PCRF selects a QCI in such a way that the IP-CAN receiving it can support it;

- It is not required that an IP-CAN supports all standardized QCIs;

- In the case of IP address configuration subsequent to initial attachment, the PDN GW/PCEF shall notify the PCRF of the UE's IP address when it is assigned. If the PCRF response leads to an EPS bearer modification the PDN GW should initiate a bearer update procedure;

- For local breakout, the visited network has the capability to reject the QoS authorized by the home network based on operator policies.

The following applies regardless of whether dynamic or static policy and charging control is used in EPS:

- For E-UTRAN the value of the ARP of an EPS bearer is identical to the value of the ARP of the SDF(s) mapped to that EPS bearer;

- For the same UE/PDN connection: SDFs associated with different QCIs or with the same service-level QCI but different ARP shall not be mapped to the same EPS bearer;

- The bearer level QCI of an EPS bearer is identical to the value of the QCI of the SDF(s) mapped to that EPS bearer.

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

Editor's note: The inclusion in TS 23.203 of ARP and the associated description of the information that the PCRF takes into account to take a policy decision on ARP is FFS.

5 Functional description and information flows

5.1 Control and user planes

NOTE:

- Refer to TS 23.402 [2] for the corresponding protocol stack for PMIP based S5/S8.

- Refer to TS 23.203 [6] for the corresponding protocol stack for Policy Control and Charging (PCC) function related reference points.

5.1.1 Control Plane
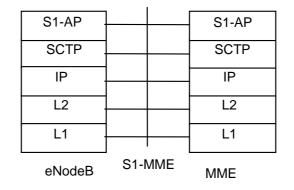
5.1.1.1 General

The control plane consists of protocols for control and support of the user plane functions:

- controlling the E-UTRA network access connections, such as attaching to and detaching from E-UTRAN;

- controlling the attributes of an established network access connection, such as activation of an IP address;

- controlling the routeing path of an established network connection in order to support user mobility; and

- controlling the assignment of network resources to meet changing user demands.

The following control planes are used in E-UTRAN mode.

5.1.1.2   eNodeB - MME

Legend:
- **S1 Application Protocol (S1-AP):** Application Layer Protocol between the eNodeB and the MME.
- **SCTP for the control plane (SCTP):** This protocol guarantees delivery of signalling messages between MME and eNodeB (S1). SCTP is defined in RFC 2960 [35].

Figure 5.1.1.2-1: Control Plane for S1-MME Interface

5.1.1.3   UE - MME

Legend:
- **NAS:** The NAS protocol supports mobility management functionality and user plane bearer activation, modification and deactivation. It is also responsible of ciphering and integrity protection of NAS signalling.
- **LTE-Uu:** The radio protocol of E-UTRAN between the UE and the eNodeB is specified in TS 36.300 [5].

Figure 5.1.1.3-1: Control Plane UE - MME

5.1.1.4 SGSN - MME

Legend:
- **GPRS Tunnelling Protocol for the control plane (GTP-C):** This protocol tunnels signalling messages between SGSN and MME (S3).
- **User Datagram Protocol (UDP):** This protocol transfers signalling messages. UDP is defined in RFC 768 [26].

Figure 5.1.1.4-1: Control Plane for S3 Interface

5.1.1.5 SGSN - S-GW

Legend:
- **GPRS Tunnelling Protocol for the control plane (GTP-C):** This protocol tunnels signalling messages between SGSN and S-GW (S4).
- **User Datagram Protocol (UDP):** This protocol transfers signalling messages. UDP is defined in RFC 768 [26].

Figure 5.1.1.5-1: Control Plane for S4 interface

5.1.1.6   S-GW - P-GW
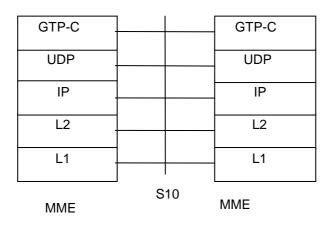
Figure 5.1.1.6-1: Control Plane for S5 and S8 interfaces

Legend:
- **GPRS Tunnelling Protocol for the control plane (GTP-C):** This protocol tunnels signalling messages between S-GW and P-GW (S5 or S8).
- **User Datagram Protocol (UDP):** This protocol transfers signalling messages between S-GW and P-GW. UDP is defined in RFC 768 [26].

5.1.1.7   MME - MME

Legend:
- **GPRS Tunnelling Protocol for the control plane (GTP-C):** This protocol tunnels signalling messages between MMEs (S10).
- **User Datagram Protocol (UDP):** This protocol transfers signalling messages between MMEs. UDP is defined in RFC 768 [26].

Figure 5.1.1.7-1: Control Plane for S10 interface

5.1.1.8 MME - S-GW

Legend:
- **GPRS Tunnelling Protocol for the control plane (GTP-C):** This protocol tunnels signalling messages between MME and S-GW (S11).
- **User Datagram Protocol (UDP):** This protocol transfers signalling messages. UDP is defined in RFC 768 [26].

Figure 5.1.1.8-1: Control Plane for S11 interface

5.1.1.9 MME - HSS
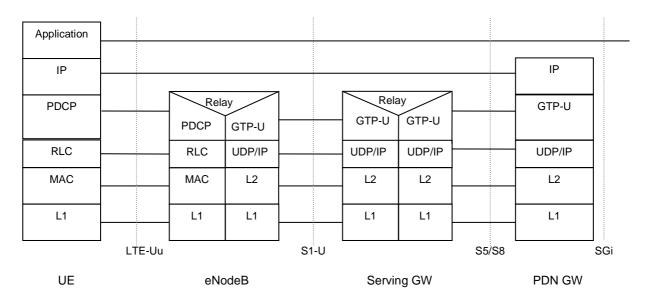
Editor's note: This section shall specify the protocol stack on the control plane of the S6a interface.

5.1.1.10 MME - EIR

Editor's note: This section shall specify the protocol stack on the control plane of the S13 reference point.

5.1.2 User Plane

5.1.2.1 UE - P-GW user plane with E-UTRAN

Legend:
- **GPRS Tunnelling Protocol for the user plane (GTP-U):** This protocol tunnels user data between eNodeB and the S-GW as well as between the S-GW and the P-GW in the backbone network. GTP shall encapsulate all end user IP packets.
- **MME** controls the user plane tunnel establishment and establishes User Plane Bearers between eNodeB and S-GW.
- **UDP/IP:** These are the backbone network protocols used for routeing user data and control signalling.
- **LTE-Uu:** The radio protocols of E-UTRAN between the UE and the eNodeB are specified in TS 36.300 [5].

Figure 5.1.2.1-1: User Plane
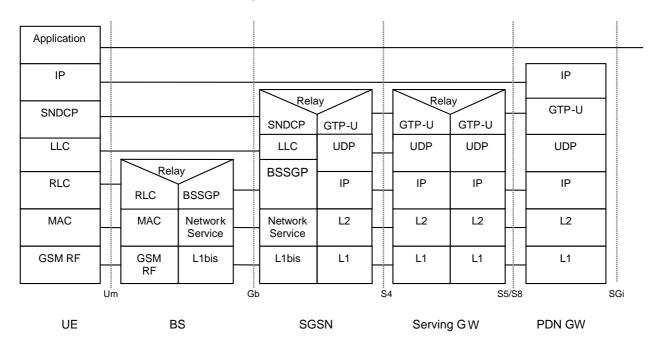
5.1.2.2 eNodeB - S-GW

Legend:
- **GPRS Tunnelling Protocol for the user plane (GTP-U):** This protocol tunnels user data between eNodeB and S-GW.
- **User Datagram Protocol (UDP):** This protocol transfers user data. UDP is defined in RFC 768 [26].

Figure 5.1.2.2-1: User Plane for eNodeB – S-GW
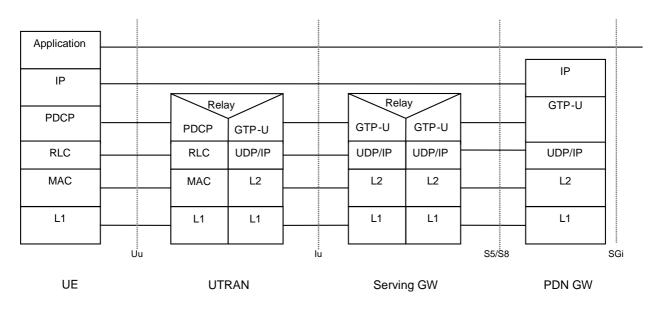
5.1.2.3 UE - PDN GW user plane with 2G access via the S4 interface

Legend:
- **GPRS Tunnelling Protocol for the user plane (GTP-U):** This protocol tunnels user data between SGSN and the S-GW as well as between the S-GW and the P-GW in the backbone network. GTP shall encapsulate all end user IP packets.
- **UDP/IP:** These are the backbone network protocols used for routeing user data and control signalling.
- Protocols on the Um and the Gb interfaces are described in TS 23.060 [7].

Figure 5.1.2.3-1: User Plane for A/Gb mode
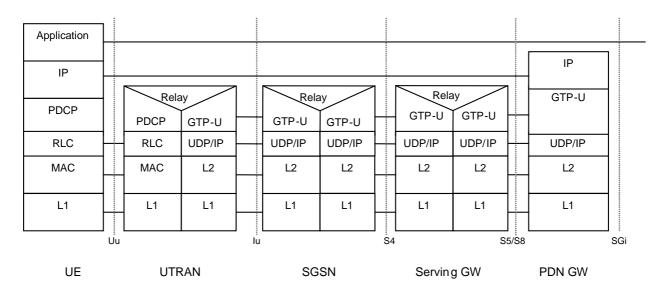
5.1.2.4 UE - PDN GW user plane with 3G access via the S12 interface

Figure 5.1.2.4-1: User Plane for UTRAN mode and Direct Tunnel on S12

Legend:
- **GPRS Tunnelling Protocol for the user plane (GTP-U):** This protocol tunnels user data between UTRAN and the S-GW as well as between the S-GW and the P-GW in the backbone network. GTP shall encapsulate all end user IP packets.
- **UDP/IP:** These are the backbone network protocols used for routeing user data and control signalling.
- Protocols on the Uu interface are described in TS 23.060 [7].
- SGSN controls the user plane tunnel establishment and establish a Direct Tunnel between UTRAN and S-GW as shown in Figure 5.1.2.4-1.

5.1.2.5 UE - PDN GW user plane with 3G access via the S4 interface

NOTE: Please refer to TS 23.402 [2] for the corresponding stack for PMIP based S5/S8.

Legend:
-       **GPRS Tunnelling Protocol for the user plane (GTP-U):** This protocol tunnels user data between
        UTRAN and the SGSN, between SGSN and S-GW as well as between the S-GW and the P-GW in the
        backbone network. GTP shall encapsulate all end user IP packets.
-       **UDP/IP:** These are the backbone network protocols used for routeing user data and control signalling.
-       Protocols on the Uu and the Iu interfaces are described in TS 23.060 [7].
-       **SGSN** controls the user plane tunnel establishment and establishes a tunnel between SGSN and S-GW. If
        Direct Tunnel is established between UTRAN and S-GW, see Figure 5.1.2.4-1.

Figure 5.1.2.5-1: User Plane for Iu mode

5.2 Identities

5.2.1 EPS bearer identity

An EPS bearer identity uniquely identifies an EPS bearer for one UE accessing via E-UTRAN. The EPS Bearer Identity
is allocated by the MME. There is one to one mapping between EPS RB and EPS Bearer, and the mapping between
EPS RB Identity and EPS Bearer Identity is made by E-UTRAN.

When there is a mapping between an EPS bearer and a PDP context, the same identity value is used for the EPS bearer
ID and the NSAPI/RAB ID.

5.2.2 Globally Unique Temporary UE Identity

The MME shall allocate a Globally Unique Temporary Identity (GUTI) to the UE.

The GUTI has two main components:

-   one that uniquely identifies the MME which allocated the GUTI; and

-   one that uniquely identifies the UE within the MME that allocated the GUTI.

Within the MME, the mobile is identified by the M-TMSI.

The Globally Unique MME Identifier (GUMMEI) is constructed from MCC, MNC and MME Identifier (MMEI).

In turn the MMEI is constructed from an MME Group ID (MMEGI) and an MME Code (MMEC).

The GUTI is constructed from the GUMMEI and the M-TMSI.

For paging, the mobile is paged with the S-TMSI. The S-TMSI is constructed from the MMEC and the M-TMSI.

The operator needs to ensure that the MMEC is unique within the MME pool area and, if overlapping pool areas are in use, unique within the area of overlapping MME pools.

The GUTI is used to support subscriber identity confidentiality, and, in the shortened S-TMSI form, to enable more efficient radio signalling procedures (e.g. paging and Service Request).

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

5.3.1 IP address allocation

5.3.1.1 General

A UE shall perform the address allocation procedures for at least one IP address (either IPv4 or IPv6) after the default bearer activation if no IPv4 address is allocated during the default bearer activation.

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 or static 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 (dynamic or static) IP address to the UE when the default bearer is activated (External PDN Address Allocation).

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 handled with the same set of mechanisms as Attach.

PDN types IPv4, IPv6 and IPv4v6 are supported. An EPS Bearer of PDN type IPv4v6 may be associated with one IPv4 address only, with one IPv6 address/prefix only or with both one IPv4 and one IPv6 address/prefix. PDN type IPv4 is associated with an IPv4 address. PDN type IPv6 is associated with an IPv6 address/prefix. PDN types IPv4 and IPv6 are utilised in case the UE and/or the PDN GW support IPv4 addressing only or IPv6 addressing/prefix only; or operator preferences dictate the use of a single IP version only, or the subscription is limited to IPv4 only or IPv6 only. In addition, PDN type IPv4 and IPv6 are utilised for interworking with nodes of earlier releases.

The UE sets the PDN type during the Attach procedure based on its IP stack configuration as follows:

- A UE, which is IPv6 and IPv4 capable, shall request for PDN type IPv4v6.

- A UE, which is only IPv4 capable, shall always request for PDN type IPv4.

- A UE, which is only IPv6 capable, shall always request for PDN type IPv6.

- When the IP version capability of the UE is unknown in the UE (as in the case when the MT and TE are separated and the capability of the TE is not known in the MT), the UE shall request for PDN type IPv4v6.

In case the UE requests PDN type IPv4v6, but the operator preferences dictate the use of a single IP version only, the PDN type may be changed to a single address PDP type (IPv4 or IPv6) and a reason cause of "network preference" returned to the UE. In this case the UE should not request another PDN connection for the other IP version. In case the UE requests PDN type IPv4v6, but the operator uses single addressing per bearer due to interworking with nodes of earlier releases, the PDN type may be changed to a single IP version only and a reason cause of "single address bearers only" returned to the UE. In this case the UE can request another PDN connection for the other IP version using the UE requested PDN connectivity procedure to the same APN with a single address PDN type (IPv4 or IPv6) other than the one already activated.

During inter-RAT mobility between EUTRAN and UTRAN/GERAN, an EPS bearer with PDN type IPv4v6 shall be mapped one-to-one to PDP type IPv4v6.

During inter-RAT mobility between E-UTRAN and UTRAN/GERAN, an EPS bearer with PDN type IPv4 shall be mapped one-to-one to a PDP context of PDP type IPv4. An EPS bearer with PDN type IPv6 shall be mapped one-to-one to a PDP context of PDP type IPv6.

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

The EPS UE may indicate to the network within the Protocol Configuration Options element that the UE wants to obtain the IPv4 address with DHCPv4:

- the UE may indicate that it prefers to obtain an IPv4 address as part of the default bearer activation procedure. In such a case, the UE relies on the EPS network to provide IPv4 address to the UE as part of the default bearer activation procedure.

- the UE may indicate that it prefers to obtain the IPv4 address after the default bearer setup by DHCPv4. That is, when the EPS network supports DHCPv4 and allows that, it does not provide the IPv4 address for the UE as part of the default bearer activation procedures. The network may respond to the UE by setting the relevant field to 0.0.0.0. After the default bearer establishment procedure is completed, the UE uses the connectivity with the EPS and initiates the IPv4 address allocation on its own using DHCPv4. The UE sends DHCPv4 Discover message (see details in sub-clause 5.3.1.2.4). However, if the EPS network provides IPv4 address to the UE as part of the default bearer activation procedure, the UE should accept the IPv4 address indicated in the default bearer activation procedure.

- if the UE sends no Address Allocation Preference, the PDN GW determines whether to use DHCPv4 or not based on per APN configuration

Both EPS network elements and UE shall support the following mechanisms:

a. IPv4 address allocation via default bearer activation, if IPv4 is supported.

b. /64 IPv6 prefix allocation via IPv6 Stateless Address autoconfiguration according to RFC 4862 [18], if IPv6 is supported;

Furthermore, the Protocol Configuration Options may be used during bearer activation to configure parameters which are needed for IP address allocation.

Both EPS network elements and UE may optionally support the following mechanisms:

a. IPv4 address allocation and IPv4 parameter configuration after the attach procedure via DHCPv4 according to RFC 2131 [19] and RFC 4039 [25];

b. IPv6 parameter configuration via Stateless DHCPv6 according to RFC 3736 [20];

c. Allocation of a static Ipv4 address and/or a static IPv6 prefix based on subscription data in the HSS.

If the static IP address/prefix is not stored in the HSS subscription record, it may be configured on a per-user per-APN basis in the DHCP/Radius/Diameter server and the PDN GW retrieves the IP address/prefix for the UE from the

DHCP/Radius/Diameter server. In this case, static IP address/prefix is allocated by the same procedures as the dynamic IP address/prefix allocation.

The following clauses describe how the above listed IP address allocation mechanisms work when GTP based S5/S8 is used. The way of working of the IP address allocation mechanisms for PMIP based S5/S8 can be found in TS 23.402 [2].The procedures can be used both for PLMN (VPLMN/HPLMN) or external PDN based IP address allocation. Note it is transparent to the UE whether the PLMN or the external PDN allocates the IP address.

In order to support DHCP based IP address configuration, the PDN GW shall act as the the DHCP server for HPLMN assigned dynamic and static and VPLMN assigned dynamic IP addressing. When DHCP is used for external PDN assigned addressing and parameter configuration, the PDN GW shall act as the DHCP server towards the UE and it shall act as the DHCP client towards the external DHCP server. The Serving GW does not have any DHCP functionality. It forwards all packets to and from the UE including DHCP packets as normal.

> Editor's note: It is FFS if additional security measures need to be taken in the case of DHCPv4 and DHCPv6.

IPv6 Stateless Address autoconfiguration [18] is the basic mechanism to allocate /64 IPv6 prefix to the UE. Additionally, shorter than /64 IPv6 prefix delegation via DHCPv6, RFC 3633 [21] may be provided, if it is supported by the PDN-GW.

During the attach procedure and default bearer establishment, the PDN GW sends the IPv6 prefix and Interface Identifier to the SGW, and then the S-GW forwards the IPv6 prefix and Interface Identifier to the MME or to the SGSN. The MME or the SGSN forwards the IPv6 Interface Identifier to the UE. Even if the UE receives the IPv6 prefix in the Attach Accept message, it shall ignore it.

> Editor's note: It is a stage 3 matter if the MME or the Rel-8 SGSN forwards the whole IPv6 address or only the Interface Identifier to the UE.

5.3.1.2 IP address allocation mechanisms for GTP based S5/S8

5.3.1.2.1 IPv4 address allocation via default bearer activation

In this case the IP address is provided to the UE as part of the default bearer activation.

When the PLMN allocates the IP address, it is the PDN-GW's responsibility to allocate and release the IP address. The PDN GW may use an internal address pool in this case. The PDN GW allocates an IPv4 address upon default bearer activation and it releases the IPv4 address upon default bearer de-activation for a given UE.

When the IP address is allocated from the external PDN, it is the PDN GW's responsibility to obtain the IP address from the external PDN, allocate and release the IP address. The PDN GW may use DHCPv4 to obtain the IP address from the external PDN. If RADIUS or Diameter is used towards the external PDN as described in TS 29.061 [38], the IP address can be fetched as part of these procedures. If DHCPv4 is used, the PDN GW functions as the DHCPv4 Client. If RADIUS is used, the PDN GW functions as the RADIUS Client. If Diameter is used, the PDN GW functions as the Diameter Client.

5.3.1.2.2 IPv6 prefix allocation via IPv6 stateless address autoconfiguration

When the PLMN allocates the IPv6 prefix then it is the PDN GW responsibility to allocate and release the IPv6 prefix. The PDN GW may use an internal prefix pool in this case. The PDN GW allocates a globally unique /64 IPv6 prefix via Router Advertisement to a given UE.

When the IPv6 prefix is allocated from the external PDN, it is the PDN GW's responsibility to obtain the IPv6 prefix for external PDN, allocate and release the IPv6 prefix. The PDN GW may use DHCPv6 to obtain the IPv6 prefix from the external PDN. In this context, the PDN GW shall act as a DHCP client rather than a requesting router as defined in prefix delegation. If RADIUS or Diameter is used towards the external PDN as described in TS 29.061 [38], the IPv6 prefix can be fetched as part of these procedures. If DHCPv6 is used, the PDN-GW functions as the DHCPv6 Client. If RADIUS is used, the PDN GW functions as the RADIUS Client. If Diameter is used, the PDN GW functions as the Diameter Client.

The procedure of the stateless IPv6 address autoconfiguration is the following: After the attach procedure and default bearer establishment, the UE may send a Router Solicitation message to the PDN GW to solicit a Router Advertisement message. The PDN-GW sends a Router Advertisement message (solicited or unsolicited) to the UE. The Router Advertisement messages shall contain the same prefix as the one provided during the attach procedure (if it was

provided). During the attach procedure if the UE receives the IPv6 prefix it shall ignore the prefix included in the Attach Accept message.

> Editor's note: It is FFS if the PDN GW needs to send the IPv6 prefix to the MME/SGSN via S-GWin the Create Default Bearer Response and to the UE in the Attach Accept message. This is used to inform the MME/SGSN of the IPv6 prefix allocated to the UE.

After the UE has received the Router Advertisement message, it constructs its full IPv6 address via IPv6 Stateless Address autoconfiguration in accordance with RFC 4862 [18]. For privacy, RFC 3041 [39], the UE may change the interface identifier used to generate full IPv6 addresses, without involving the network.

Any prefix that the PDN GW advertises to the UE is globally unique. The PDN GW shall also record the relationship between the UE identities and the allocated IPv6 prefix. Because any prefix that the PDN GW advertises to the UE is globally unique, there is no need for the UE to perform Duplicate Address Detection for any IPv6 address configured from the allocated IPv6 prefix. The PDN GW shall respond back with a Neighbor Advertisement upon receiving a Neighbor Solicitation message from the UE. For example, it is possible for the UE to perform Neighbor Unreachability Detection towards the PDN GW, as defined in RFC 4861 [32].

5.3.1.2.3 IPv6 parameter configuration via stateless DHCPv6

The UE may use stateless DHCPv6 for additional parameter configuration. The PDN GW acts as the DHCP server. When PLMN based parameter configuration is used, the PDN GW provides the requested parameters from locally provisioned database. When external PDN based parameter configuration is used, the PDN GW obtains the requested configuration parameters from the external PDN as described in the previous sections. When the PDN GW acts as a DHCPv6 server towards the UE, the PDN GW may act as DHCPv6 client towards the external PDN to request the configuration parameters for the UE. If RADIUS or Diameter is used towards the external PDN as described in TS 29.061 [38], the the requested configuratation paramters can be fetched as part of these procedures.

5.3.1.2.4 IPv4 address allocation and IPv4 parameter configuration via DHCPv4

When the PLMN allocates the IPv4 address then the PDN GW responsibility is to allocate and release the IPv4 address (as it is in the previous case).

When external PDN allocation is used the PDN GW shall act as a DHCPv4 server towards the UE. The PDN GW acts as DHCP Client and it interacts with the DHCP server in the external PDN to obtain the IP address and the configuration parameters. If RADIUS or Diameter is used towards the external PDN as described in TS 29.061 [38], the IP address and the requested configuration parameters can be fetched as part of these procedures.

> Editor's Note: It is FFS how the PDN GW releases the IP address that is assigned to the UE.

5.3.1.2.5 IPv6 prefix delegation via DHCPv6

When the PLMN allocates the IPv6 prefix then the PDN GW responsibility is to allocate and release the IPv6 prefixes (as it is in the previous case) and the PDN GW shall act as DHCPv6 server and shall create and send the DHCPv6 responses to the UE.

When external PDN allocation is used the PDN GW shall act as a DHCPv6 server towards the UE. The PDN GW acts as DHCP Client and it interacts with the DHCP server in the external PDN to obtain IPv6 prefix and other parameters for the UE. If RADIUS or Diameter is used towards the external PDN as described in TS 29.061 [38], the IPv6 prefix can be fetched as part of these procedures.

> Editor's Note: It is FFS how the PDN GW releases the IPv6 prefix that is assigned to the UE.

5.3.2 Attach procedure

5.3.2.1 E-UTRAN Initial Attach

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

procedure, the UE may request for an IP address allocation. Terminals utilising only IETF based mechanisms for IP address allocation are also supported.

During the Initial Attach procedure the Mobile Equipment Identity may be obtained from the UE. The MME operator may check the ME Identity with an EIR. At least in roaming situations, the MME should pass the ME Identity to the HSS, and, if a PDN-GW outside of the VPLMN, should pass the ME Identity to the PDN-GW.
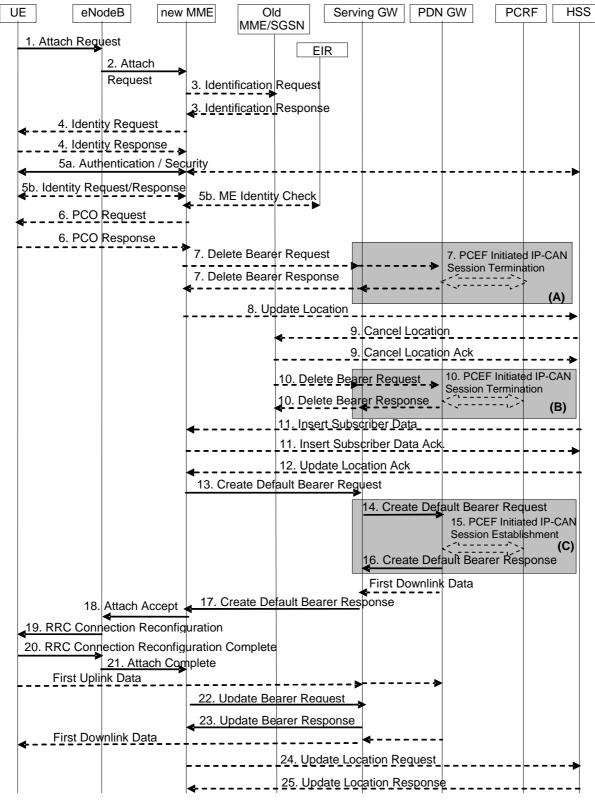
Figure 5.3.2.1-1: Attach procedure

NOTE 1:   For a PMIP-based S5/S8, procedure steps (A), (B), and (C) are defined in TS 23.402 [2]. Steps 7, 10, 14, 15 and 16 concern GTP based S5/S8.

NOTE 2:   The Serving GWs and PDN GWs involved in steps 7 and/or 10 may be to different to those in steps 13-17.

1. The UE initiates the Attach procedure by the transmission of an Attach Request (IMSI or old GUTI, last visited TAI (if available), UE Network Capability, PDN Type, Protocol Configuration Options, Ciphered Protocol Configuration Options Transfer, Attach Type, KSI, NAS sequence number, NAS-MAC) message together with an indication of the Selected Network to the eNodeB. IMSI shall be included if the UE does not have a valid GUTI available. If the UE has a valid GUTI, it shall be included. If available, the last visited TAI shall be included in order to help the MME produce a good list of TAIs for any subsequent Attach Accept message. Selected Network indicates the PLMN that is selected for network sharing purposes. UE Network Capability is described in clause "UE capabilities". If the UE has valid security parameters, the Attach Request message shall be integrity protected by the NAS-MAC in order to allow validation of the UE by the MME. KSI is included if the UE has valid security parameters. NAS sequence number indicates the sequential number of the NAS message. Furthermore, the UE may cipher the parts of the Attach Request message that require ciphering (it is FFS whether there are any such parts). If the UE does not have a valid NAS security association, then the Attach Request message is neither integrity protected nor ciphered. In this case the security association is established in step 5a. The UE network capabilities indicate also the supported NAS and AS security algorithms. PDN type indicates the requested IP version (IPv4, IPv4/IPv6, IPv6). Protocol Configuration Options (PCO) are used to transfer parameters between the UE and the PDN GW, and are sent transparently through the MME and the Serving GW. The Protocol Configuration Options may include the Address Allocation Preference indicating that the UE prefers to obtain an IPv4 address only after the default bearer activation by means of DHCPv4. If the UE intends to send PCOs, which require ciphering (e.g., PAP/CHAP usernames and passwords), the UE shall set the Ciphered Protocol Configuration Options Transfer (Ciphered PCO Transfer) flag and shall send all PCOs only after authentication and NAS security setup have been completed (see below). Attach Type indicates "Handover" when the UE has already an activated PDN GW/HA due to mobility with non-3GPP accesses.

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

2. The eNodeB derives the MME from the GUTI and from the indicated Selected Network. If that MME is not associated with the eNodeB, the eNodeB selects an MME as described in clause 4.3.8.3 on "MME selection function". The eNodeB forwards the Attach Request message to the new MME contained in a S1-MME control message (Initial UE message) together with the Selected Network and an indication of the E-UTRAN Area identity, a globally unique E-UTRAN ID of the cell from where it received the message to the new MME.

3. If the UE identifies itself with GUTI and the MME has changed since detach, the new MME sends an Identification Request (old GUTI, complete Attach Request message) to the old MME to request the IMSI. If the S-TMSI and old TAI identifies an SGSN, the message shall be sent to the old SGSN. The old MME responds with Identification Response (IMSI, unused EPS Authentication Vectors, KSI$_{ASME}$, K$_{ASME}$) and if request is sent to the old SGSN, then the old SGSN responds with Identification Response(IMSI, Unused Authentication Quintets, CK, IK and KSI). If the UE is not known in the old MME/SGSN or if the integrity check for the Attach Request message fails, the old MME/SGSN responds with an appropriate error cause.

NOTE: A Pre-Rel-8 SGSN always responds with the UMTS security parameters and the MME may cache it for later use.

4. If the UE is unknown in both the old MME/SGSN and new MME, the new MME sends an Identity Request to the UE to request the IMSI. The UE responds with Identity Response (IMSI).

5a If no UE context for the UE exists anywhere in the network, if the Attach Request (sent in step 1) was not integrity protected, or if the check of the integrity failed, then authentication and NAS security setup are mandatory. Otherwise it is optional. The authentication and NAS security setup functions are defined in clause 5.3.10 on "Security Function".

5b. The ME Identity shall be retrieved from the UE at Initial Attach when Attach Type does not indicate handover. Otherwise it is optional. The ME identity shall be transferred encrypted. The MME may send the ME Identity Check Request (ME Identity, IMSI) to the EIR. The EIR shall respond with ME Identity Check Ack (Result). Dependent upon the Result, the MME decides whether to continue with this Attach procedure or to reject the UE.

Editor's note: It is FFS whether NAS security setup and ME identity retrieval can be combined in the case when both procedures are to be performed.

6. If the UE has set the Ciphered PCO Transfer flag in the Attach Request message, the Protocol Configuration Options shall now be retrieved from the UE.

7. If there are active bearer contexts in the new MME for this particular UE (i.e. the UE re-attaches to the same MME without having properly detached before), the new MME deletes these bearer contexts by sending Delete Bearer Request (TEIDs) messages to the GWs involved. The GWs acknowledge with Delete Bearer Response (TEIDs) message. If a PCRF is deployed, the PDN GW employs an IP-CAN Session Termination procedure to indicate that resources have been released.

8. If the MME has changed since the last detach, or if there is no valid subscription context for the UE in the MME, or if the ME identity has changed, the MMEsends an Update Location (MME Identity, IMSI, ME Identity) to the HSS.

9. 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.

10. If there are active bearer contexts in the old MME for this particular UE, the old MME deletes these bearer contexts by sending Delete Bearer Request (TEIDs) messages to the GWs involved. The GWs return Delete Bearer Response (TEIDs) message to the old MME. If a PCRF is deployed, the PDN GW employs an IP-CAN Session Termination procedure as defined in TS 23.203 [6] to indicate that resources have been released.

11. The HSS sends Insert Subscriber Data (IMSI, Subscription Data) message to the new MME. The Subscription Data contain one or more PDN subscription contexts. Each PDN subscription context contains an'EPS subscribed QoS profile' (see clause 4.7.3). The MME adopts the PDN subscription context that is marked as default for the default bearer activation, which is performed during this attach procedure. This results in the usage of the Default APN for this procedure. The new MME validates the UE's presence in the (new) TA. If due to regional subscription restrictions or access restrictions the UE is not allowed to attach in the TA, the new MME rejects the Attach Request with an appropriate cause, and may return an Insert Subscriber Data Ack message to the HSS. If subscription checking fails for other reasons, the new MME rejects the Attach Request with an appropriate cause and returns an Insert Subscriber Data Ack message to the HSS including an error cause. If all checks are successful then the new MME constructs a context for the UE and returns an Insert Subscriber Data Ack message to the HSS.

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

13. If a subscribed PDN address is allocated for the UE for this APN, the PDN subscription context contains the UE's IPv4 address and/or the IPv6 prefix and optionally the PDN GW identity. In case the PDN subscription context contains a subscribed IPv4 address and/or IPv6 prefix, the MME indicates it in the PDN address. If the PDN subscription context contains no PDN GW identity the new MME selects a PDN GW as described in clause 4.3.8.1 on PDN GW selection function (3GPP accesses). If the PDN subscription context contains a dynamically allocated PDN GW identity and the Attach Type does not indicate "Handover" the MME may select a new PDN GW as described in clause PDN GW selection function, e.g. to allocate a PDN GW that allows for more efficient routing. If the PDN subscription profile contains no PDN GW address for the default PDN and the Attach Type indicates "Handover" the MME select a new PDN GW as described in clause PDN GW selection function. The new MME selects a Serving GW as described in clause 4.3.8.2 on Serving GW selection function and allocates an EPS Bearer Identity for the Default Bearer associated with the UE. Then it sends a Create Default Bearer Request (IMSI, MSISDN, MME TEID for control plane, PDN GW address, PDN Address, APN, RAT type, Default Bearer QoS, PDN Type, APN-AMBR, EPS Bearer Identity, Protocol Configuration Options, ME Identity, User Location Information (ECGI), Selection Mode, Charging Characteristics, Trace Reference, Trace Type, Trigger Id, OMC Identity, Maximum APN Restriction, Dual Address Bearer Flag, the Protocol Type over S5/S8) message to the selected Serving GW.

The RAT type is provided in this message for the later PCC decision. The AMBR applied to the relevant PDN access is also provided in this message. The MSISDN is included if provided in the subscription data from the HSS. Selection Mode indicates whether a subscribed APN was selected, or whether a non-subscribed APN chosen by the MME was selected. Selection Mode is set according to Annex A of TS 23.060 [7]. The P-GW may use Selection Mode when deciding whether to accept or reject the default bearer activation. For example, if an APN requires subscription, the P-GW is configured to accept only the default bearer activation that requests a

subscribed APN as indicated by Selection Mode. Charging Characteristics indicates which kind of charging the bearer context is liable for. The Dual Address Bearer Flag shall be set when the UE requests PDN type IPv4v6 and all SGSNs which the UE may be handed over to are Release 8 or above supporting dual addressing, which is determined based on node pre-configuration by the operator. The Protocol Type over S5/S8 is provided to Serving GW which protocol should be used over S5/S8 interface.

The charging characteristics for the PS subscription and individually subscribed APNs as well as the way of handling Charging Characteristics and whether to send them or not to the P-GW is defined in TS 32.251 [44]. The MME shall include Trace Reference, Trace Type, Trigger Id, and OMC Identity if S-GW and/or P-GW trace is activated. The MME shall copy Trace Reference, Trace Type, and OMC Identity from the trace information received from the HLR or OMC.

The Maximum APN Restriction denotes the most stringent restriction as required by any already active bearer context. If there are no already active bearer contexts, this value is set to the least restrictive type (see clause 15.4 of TS 23.060 [7]). If the P-GW receives the Maximum APN Restriction, then the P-GW shall check if the Maximum APN Restriction value does not conflict with the APN Restriction value associated with this bearer context request. If there is no conflict the request shall be allowed, otherwise the request shall be rejected with sending an appropriate error cause to the UE.

14. The Serving GW creates a new entry in its EPS Bearer table and sends a Create Default Bearer Request (IMSI, MSISDN, APN, Serving GW Address for the user plane, Serving GW TEID of the user plane, Serving GW TEID of the control plane, RAT type, Default Bearer QoS, PDN Type, PDN Address, APN-AMBR, EPS Bearer Identity, Protocol Configuration Options, ME Identity, User Location Information (ECGI), Selection Mode, Charging Characteristics, Trace Reference, Trace Type, Trigger Id, OMC Identity, Maximum APN Restriction, Dual Address Bearer Flag) message to the PDN GW indicated by the PDN GW address received in the previous step. After this step, the Serving GW buffers any downlink packets it may receive from the PDN GW until receives the message in step 21 below. The MSISDN is included if received from the MME.

15. If dynamic PCC is deployed, the PDN GW performs an IP-CAN Session Establishment procedure as defined in TS 23.203 [6], and thereby obtains the default PCC rules for the UE. This may lead to the establishment of a number of dedicated bearers following the procedures defined in clause 5.4.1 in association with the establishment of the default bearer, which is described in Annex F.

    The IMSI, UE IP address, User Location Information (ECGI), Serving Network, RAT type, APN-AMBR, Default Bearer QoS are provided to the PCRF by the PDN GW if received by the previous message. The User Location Information is used for location based charging.

NOTE: While the PDN GW/PCEF may be configured to activate predefined PCC rules for the default bearer, the interaction with the PCRF is still required to provide e.g. the UE IP address information to the PCRF.

    If dynamic PCC is not deployed, the PDN GW may apply local QoS policy.

Editor's note: It is FFS if the AMBR shall be sent to the PCRF, and if the PCRF is allowed to change the value of the AMBR.

Editor's note: The parameters used for User Location Information are FFS.

16. The P-GW creates a new entry in its EPS bearer context table and generates a Charging Id. The new entry allows the P-GW to route user plane PDUs between the S-GW and the packet data network, and to start charging. The way the P-GW handles Charging Characteristics that it may have received is defined in TS 32.251 [44].

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 Type, PDN Address, EPS Bearer Identity, Protocol Configuration Options, UL TFT, Charging Id, Prohibit Payload Compression, APN Restriction, Cause, CGI/SAI/RAI change report required, BCM) message to the Serving GW. The PDN GW takes into account the PDN type sent by the UE , the Dual Address Bearer Flag and the policies of operator when the PDN GW selects the PDN type to be used as follows. If the UE has requested PDN type IPv4v6 and both IPv4 and IPv6 addressing is possible in the PDN but the Dual Address Bearer Flag is not set, or only single IP version addressing is possible in the PDN, the PDN GW selects a single IP version (either IPv4 or IPv6). If the UE has requested PDN type IPv4 or IPv6, the PDN GW uses the PDN type supplied by the UE in case it is supported in the PDN, otherwise an appropriate error cause will be returned. The PDN GW allocates a PDN Address according to the selected PDN type. In case the PDN GW has selected a PDN type different from the one sent by the UE, the PDN GW indicates together with the PDN type IE a reason cause (network preference, single address bearers only) to the UE why the PDN type has been modified. PDN Address may contain an IPv4 address for IPv4 and/or an IPv6 prefix and an Interface Identifier. If the PDN has been configured by the operator so that the PDN addresses for the requested APN shall be allocated by usage of DHCPv4 only, or if the PDN GW allows the UE to use DHCPv4 for address allocation according to the Address Allocation Preference received from the UE, the PDN Address shall be set to 0.0.0.0, indicating that the IPv4 PDN address shall be negotiated by the UE with DHCPv4 after completion of the Default Bearer Activation procedure. In case of external PDN addressing for IPv6, the PDN GW obtains the IPv6 prefix from the external PDN using either RADIUS or Diameter client function. In the PDN Address field of the Create Default Bearer Response, the PDN GW includes the Interface Identifer and IPv6 prefix. The PDN GW sends Router Advertisement to the UE after default bearer establishment with the IPv6 prefix information for all cases.

If the PDN address is contained in the Create Default Bearer Request, the PDN GW shall allocate the IPv4 addresss and/or IP6 prefix contained in the PDN address to the UE. The IP address allocation details are described in clause 5.3.1 on "IP Address Allocation". Protocol Configuration Options contains the BCM as well as optional PDN parameters that the P-GW may transfer to the UE. BCM shall also be sent as a separate IE. These optional PDN parameters may be requested by the UE, or may be sent unsolicited by the P-GW. Protocol Configuration Options are sent transparently through the MME. According to the used RAT BCM is set to "UE/network".

17. If the CGI/SAI/RAI change report required is received for this bearer context, then the S-GW shall store this for the bearer context and the S-GW shall report to that P-GW whenever a CGI/SAI/RAI change occurs that meets the P-GW request, as described in clause 15.1.1a of TS 23.060 [7].

    The Serving GW returns a Create Default Bearer Response (PDN Type, PDN Address, Serving GW address for User Plane, Serving GW TEID for User Plane, Serving GW TEID for control plane, EPS Bearer Identity, PDN GW addresses and TEIDs (GTP-based S5/S8) or GRE keys (PMIP-based S5/S8) at the PDN GW(s) for uplink traffic, Protocol Configuration Options, UL TFT, DL TFT (for PMIP-based S5/S8), Charging Id, Prohibit Payload Compression, APN Restriction, Cause, CGI/SAI/RAI change report required, BCM) message to the new MME. The DL TFT for PMIP-based S5/S8 is obtained from interaction between the Serving GW and the PCRF as described in clause 5.2 of TS 23.402 [2], when PCC is deployed; otherwise, the DL TFT IE is wildcarded, matching any downlink traffic.

18. If an APN Restriction is received, then the MME shall store this value for the Bearer Context and the MME shall check this received value with the stored value for the Maximum APN Restriction to ensure there are no conflicts between values. If the Bearer Context is accepted, the MME shall determine a (new) value for the Maximum APN Restriction. If there is no previously stored value for Maximum APN Restriction, then the Maximum APN Restriction shall be set to the value of the received APN Restriction.

    If the CGI/SAI/RAI change report required is received for this bearer context, then the MME shall store this for the bearer context and the MME shall report whenever a CGI/SAI/RAI change occurs that meets the request, as described in clause 15.1.1a of TS 23.060 [7].

    The new MME sends an Attach Accept (APN, GUTI, PDN Type, PDN Address, TAI List, EPS Bearer Identity, Session Management Configuration IE, Protocol Configuration Options, KSI, NAS sequence number, NAS-MAC, NAS security algorithm) message to the eNodeB. GUTI is included if the new MME allocates a new GUTI. This message is contained in an S1_MME control message Initial Context Setup Request. This S1 control message also includes the AS security context information for the UE, the Handover Restriction List, the EPS Bearer QoS, the UE-AMBR, EPS Bearer Identity, as well as the TEID at the Serving GW used for user plane and the address of the Serving GW for user plane. The MME includes the UL TFT and the EPS Bearer QoS parameter QCI into the Session Management Configuration IE. Furthermore, if the UE has UTRAN or GERAN capabilities, the MME uses the EPS bearer QoS information to derive the corresponding PDP context parameters

QoS Negotiated (R99 QoS profile), Radio Priority and Packet Flow Id and includes them in the Session Management Configuration. If the UE indicated in the UE Network Capability it does not support BSS packet flow procedures, then the MME shall not include the Packet Flow Id. Handover Restriction List is described in clause 4.3.5.7 "Mobility Restrictions".

NAS security algorithm indicates the NAS algorithm selected by the MME. This information element shall not be ciphered. The MME starts using the indicated NAS security algorithm with this NAS message.

19. The eNodeB sends the RRC Connection Reconfiguration message including the EPS Radio Bearer Identity to the UE, and the Attach Accept message will be sent along to the UE. The UE shall store the QoS Negotiated, Radio Priority, Packet Flow Id, which it received in the Session Management Configuration, for use when accessing via GERAN or UTRAN. The UE shall ignore the IPv6 prefix information in PDN Address. The APN is provided to the UE to notify it of the APN for which the activated default bearer is associated. The UE uses the uplink packet filter (UL TFT) to determine the mapping of uplink packets to the radio bearer. For further details, see TS 36.331 [37]. The UE may provide EPS Bearer QoS information to the application handling the service data flow. The application usage of the EPS Bearer QoS is implementation dependent. The UE shall not reject the RRC Connection Reconfiguration on the basis of the EPS Bearer QoS information contained in the Session Management Configuration IE.

When receiving the Attach Accept message the UE sets its TIN to "GUTI" as no ISR is indicated. And the UE's internal update status for any stored P-TMSI is set to "update-needed".

NOTE: The IP address allocation details are described in clause 5.3.1 on "IP Address Allocation".

20. The UE sends the RRC Connection Reconfiguration Complete message to the eNodeB. This message includes the Attach Complete (EPS Bearer Identity, NAS sequence number, NAS-MAC) message. For further details, see TS 36.331 [37]. With the Attach Complete message the UE starts using the NAS security algorithm indicated by the MME, i.e. the Attach Complete message shall be protected by the NAS security algorithm indicated by the MME.

21. The eNodeB forwards the Attach Complete message to the new MME in an S1 control message. This S1 control message includes the TEID of the eNodeB and the address of the eNodeB used for downlink traffic on the S1_U reference point.

After the Attach Accept message and once the UE has obtained a PDN Address, the UE can then send uplink packets towards the eNodeB which will then be tunnelled to the Serving GW and PDN GW. If the UE requested for a dual address PDN type (IPv4v6) to a given APN and was granted a single address PDN type (IPv4 or IPv6) by the network with a reason cause "single address bearers only" sent together with the PDN type, the UE may request for the activation of a parallel PDN connection to the same APN with a single address PDN type (IPv4 or IPv6) other than the one already activated. If the UE receives no reason cause in step 18 in response to an IPv4v6 PDN type and it receives an IPv6 prefix and Interface Identifier apart from the IPv4 address or 0.0.0.0 in the PDN Address field, it considers that the request for a dual address PDN was successful. It can wait for the Router Advertisement from the network with the IPv6 prefix information or it may send Router Solicitation if necessary.

22. The new MME sends an Update Bearer Request (eNodeB address, eNodeB TEID) message to the Serving GW.

23. The Serving GW acknowledges by sending Update Bearer Response (EPS Bearer Identity) message to the new MME. The Serving GW can then send its buffered downlink packets.

24. After the MME receives Update Bearer Response (EPS Bearer Identity) message, if an EPS bearer was established and the subscription data indicates that the user is allowed to perform handover to non-3GPP accesses, and if the MME selected a PDN GW that is different from the PDN GW identity which was indicated by the HSS in the PDN subscription context, the MME shall send an Update Location Request including the APN and PDN GW identity to the HSS for mobility with non-3GPP accesses.

25. The HSS stores the APN and PDN GW identity pair and sends an Update Location Response to the MME.

5.3.2.2 UTRAN/GERAN Initial Attach

When a UE attaches to UTRAN/GERAN, it executes the normal attach procedure as defined in TS 23.060 [7]. When the UE needs an IP address, it initiates PDP context activation procedure as defined in TS 23.060 [7].

Editor's note: It is FFS how to handle the case when the UE changes to E-UTRAN access when it only has a PDP context over GERAN/UTRAN which maps to a GBR bearer over E-UTRAN.

5.3.3 Tracking Area Update procedures

5.3.3.1 Tracking Area Update procedure with Serving GW change
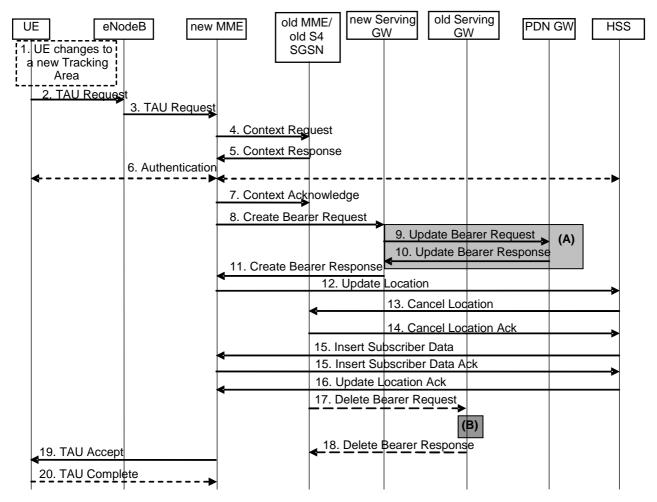
Figure 5.3.3.1-1: Tracking Area Update procedure with Serving GW change

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Steps 9 and 10 concern GTP based S5/S8.

1. The UE detects a change to a new TA by discovering that its current TAI is not in the list of TAIs that the UE registered with the network, or the UE reselects an E-UTRAN cell and is not registered or updated with the MME (e.g. periodic TAU timer expired while camping on GERAN or UTRAN) or the UE was in PMM_Connected state (e.g. URA_PCH) when it reselects an E-UTRAN cell.

2. The UE initiates the TAU procedure by sending a TAU Request (old GUTI, last visited TAI, active flag, EPS bearer status, P-TMSI Signature, additional GUTI, KSI, NAS sequence number, NAS-MAC) message together with an indication of the Selected Network to the eNodeB.

   If the UE's TIN indicates "GUTI" or "RAT-related TMSI" and the UE holds a valid GUTI then the old GUTI indicates this valid GUTI. If the UE's TIN indicates "P-TMSI" and the UE holds a valid P-TMSI and related RAI then these two elements are indicated as the old GUTI. Mapping a P-TMSI and RAI to a GUTI is specified in Annex H.

   If the UE holds a valid GUTI then the UE indicates the GUTI as additional GUTI, regardless whether the old GUTI also indicates this GUTI or a GUTI mapped from a P-TMSI.

The routing parameter that is signalled in the RRC signalling to the eNB for routing to the MME is derived from the identifier that is signalled as the old GUTI according to the rules above. For a combined MME/SGSN the eNB is configured to route the MME-code(s) of this combined node to the same combined node. This eNB is also configured to route MME-code(s) of GUTIs that are generated by the UE's mapping of the P-TMSIs allocated by the combined node. Such an eNB configuration may also be used for separate nodes to avoid changing nodes in the pool caused by inter RAT mobility.

The last visited TAI shall be included in order to help the MME produce a good list of TAIs for any subsequent TAU Accept message. Selected Network indicates the network that is selected. Active flag is a request by UE to activate the radio and S1 bearers for all the active EPS Bearers by the TAU procedure when the UE is in ECM-IDLE state. The EPS bearer status that indicates each EPS bearer that is active in the UE. If the UE has valid security parameters, the TAU Request message shall be integrity protected by the NAS-MAC in order to allow validation of the UE by the MME. KSI is included if the UE has valid security parameters. NAS sequence number indicates the sequential number of the NAS message.

3. The eNodeB derives the MME from the GUTI and from the indicated Selected Network. If that MME is not associated with that eNodeB,the eNodeB selects an MME as described in clause 4.3.8.3 on "MME Selection Function".

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

4. The new MME sends a Context Request (old GUTI, complete TAU Request message) message to the old MME/old S4 SGSN to retrieve user information. The new MME/old S4 SGSN derives the old MME from the old GUTI. If the new MME indicates that it has authenticated the UE or if the old MME correctly validates the UE, then the old MME starts a timer.

5. The old MME/old S4 SGSN responds with a Context Response (MME context (e.g. IMSI, MSISDN, unused EPS Authentication Vectors, KSI_{ASME}, K_{ASME}, bearer contexts, Serving GW signalling Address and TEID(s), ISR) message. The PDN GW Address and TEID(s) (for GTP-based S5/S8) or GRE Keys (PMIP-based S5/S8 at the PDN GW(s) for uplink traffic) is part of the Bearer Context. If the UE is not known in the old MME or if the integrity check for the TAU Request message fails, the old MME responds with an appropriate error cause. The MSISDN is included if the old MME has it stored for that UE.

6. If the integrity check of TAU Request message (sent in step 2) failed, then authentication is mandatory. The authentication functions are defined in clause 5.3.10 on "Security Function". Ciphering procedures are described in clause 5.3.10 on "Security Function". If GUTI allocation is going to be done and the network supports ciphering, the NAS messages shall be ciphered.

7. The new MME determines whether to relocate the Serving GW or not. The Serving GW is relocated when the old Serving GW cannot continue to serve the UE. The new MME may also decide to relocate the Serving GW in case a new Serving GW is expected to serve the UE longer and/or with a more optimal UE to PDN GW path, or in case a new Serving GW can be co-located with the PDN GW. Selection of a new Serving GW is performed according to clause 4.3.8.2 on "Serving GW selection function".

   The new MME sends a Context Acknowledge (Serving GW change indication) message to the old MME/old S4 SGSN. Serving GW change indication indicates a new Serving GW has been selected. The old MME/old S4 SGSN marks in its context that the information in the GWs and the HSS are invalid. This ensures that the old MME/old S4 SGSN updates the GWs and the HSS if the UE initiates a TAU procedure back to the old MME/old S4 SGSN before completing the ongoing TAU procedure. If the security functions do not authenticate the UE correctly, then the TAU shall be rejected, and the new MME shall send a reject indication to the old MME/old S4 SGSN. The old MME/old S4 SGSN shall continue as if the Identification and Context Request was never received.

   ISR is not indicated in the Context Acknowledge as ISR is not activated due to the S-GW change.

8. The MME constructs an MM context for the UE. The MME verifies the EPS bearer status received from the UE with the bearer contexts received from the old MME/old S4 SGSN and releases any network resources related to EPS bearers that are not active in the UE. If there is no bearer context suitable for default bearer or no bearer context at all, the MME rejects the TAU Request. If the new MME selected a new Serving GW it sends a Create Bearer Request (IMSI, bearer contexts, MME Context ID, Type, the Protocol Type over S5/S8) message to the selected new Serving GW. The PDN GW address and DL TFT (for PMIP-based S5/S8) are indicated in the

bearer Contexts. Type indicates to the Serving GW to send the Update Bearer Request the PDN GW. The Protocol Type over S5/S8 is provided to Serving GW which protocol should be used over S5/S8 interface.

Editor's note: It is FFS whether a TAU Accept can be done instead with an indication that default bearer is not established.

9. The new Serving GW sends the message Update Bearer Request (Serving GW Address, Serving GW Tunnel Endpoint Identifier) to the PDN GW concerned.

10. The PDN GW updates its bearer contexts and returns an Update Bearer Response (MSISDN, PDN GW address and TEID(s)) message. The MSISDN is included if the PDN GW has it stored in its UE context.

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 verifies whether it holds subscription data for the UE identified by the GUTI, the additional GUTI or by the IMSI received with the context data from the old CN node. If there are no subscription data in the new MME for this UE then the new MME sends an Update Location (MME Identity, IMSI, Update Type) message to the HSS. Update Type indicates that only the MME registration shall be updated in HSS. Update Type indicates whether HSS should cancel location to the other RAT as well.

13. The HSS sends the message Cancel Location (IMSI, Cancellation Type) to the old MME with Cancellation Type set to Update Procedure.

14. If the timer started in step 4 is not running, the old MME removes the MM context. Otherwise, the contexts are removed when the timer expires. It also ensures that the MM context is kept in the old MME for the case the UE initiates another TAU procedure before completing the ongoing TAU procedure to the new MME. The old MME acknowledges with the message Cancel Location Ack (IMSI).

15. The HSS sends Insert Subscriber Data (IMSI, Subscription Data) 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 be attached in the TA, the MME rejects the Tracking Area Update Request with an appropriate cause to the UE, and may return an Insert Subscriber Data Ack (IMSI, MME Area Restricted) message to the HSS. If all checks are successful, the MME constructs an MM context for the UE and returns an Insert Subscriber Data Ack (IMSI) message to the HSS.

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

17. When the timer started in step 4 expires the old MME/old S4 SGSN releases any local MME or SGSN bearer resources and if it received the Serving GW change indication in the Context Acknowledge message, the old MME/old S4 SGSN deletes the EPS bearer resources by sending Delete Bearer Request (Cause, TEID) messages to the Serving GW. Cause indicates to the old Serving GW that the old Serving GW shall not initiate a delete procedure towards the PDN GW. If ISR is established on the S-GW then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that CN node. If the MME has not changed, step 11 triggers the release of EPS bearer resources when a new Serving GW is allocated.

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

19. The MME sends a TAU Accept (GUTI, TAI list, EPS bearer status, KSI, NAS sequence number, NAS-MAC, NAS security algorithm) message to the UE. If the active flag is set the MME may provide the eNodeB with Handover Restriction List. GUTI is included if the MME allocates a new GUTI. If the "active flag" is set in the TAU Request message the user plane setup procedure can be activated in conjunction with the TAU Accept message. The procedure is described in detail in TS 36.300 [5]. The message sequence should be the same as for the UE triggered Service Request procedure specified in clause 5.3.4.1 from the step when MME establishes the bearer(s). The MME indicates the EPS bearer status IE to the UE. The UE removes any internal resources related to bearers that are not marked active in the received EPS bearer status. Handover Restriction List is described in clause 4.3.5.7 "Mobility Restrictions".

    NAS security algorithm indicates the NAS algorithm selected by the MME. This information element shall not be ciphered. The MME starts using the indicated NAS security algorithm with this NAS message

When receiving the TAU Accept message and there is no ISR indication the UE sets its TIN to "GUTI". When ISR is not indicated the UE clears any internal ISR status by setting its internal update status for the P-TMSI to "update-needed".

For a S-GW change, ISR is never indicated by the MME as it needs a RAU with the same S-GW first to activate ISR. In case of an MME change ISR is not activated by the new MME to avoid context transfer procedures with two old CN nodes.

20. If GUTI or NAS security algorithm was included in the TAU Accept, the UE acknowledges the received message by returning a TAU Complete message to the MME. If NAS security algorithm was included in the TAU Accept, the NAS sequence number and NAS-MAC message shall be included in the TAU Complete. With the TAU Complete message the UE starts using the NAS security algorithm indicated by the MME, i.e. the TAU Complete message shall be protected by the NAS security algorithm indicated by the MME.

When the "Active flag" is not set in the TAU Request message and the Tracking Area Update was not initiated as the part of the handover, the new MME releases the signalling connection with UE, according to clause 5.3.5.

NOTE 2: The new MME may initiate RAB establishment after execution of the security functions, or wait until completion of the TA update procedure. For the UE, RAB establishment may occur anytime after the TA update request is sent.

In the case of a rejected tracking area update operation, due to regional subscription, roaming restrictions, or access restrictions (see TS 23.221 [27] and TS 23.008 [28]) the new MME shall not construct a bearer context. A reject shall be returned to the UE with an appropriate cause and the S1 connection shall be released. Upon return to idle, the UE shall act according to TS 23.122 [10].

The new MME shall determine the Maximum APN restriction based on the received APN Restriction of each bearer context from the P-GW and then store the new Maximum APN restriction value.

If the new MME is unable to support the same number of active bearer contexts as received from old SGSN, the new MME should use the prioritisation sent by the old SGSN as input when deciding which bearer contexts to maintain active and which ones to delete. In any case, the new MME shall first update all contexts in one or more P-GWs and then deactivate the context(s) that it cannot maintain as described in the clause "MME Initiated Dedicated Bearer Deactivation Procedure". This shall not cause the MME to reject the tracking area update.

NOTE 3: In case MS (UE) was in PMM-CONNECTED state the bearer contexts are sent already in the Forward Relocation Request message as described in the clause "Serving RNS relocation procedures" of TS 23.060 [7].
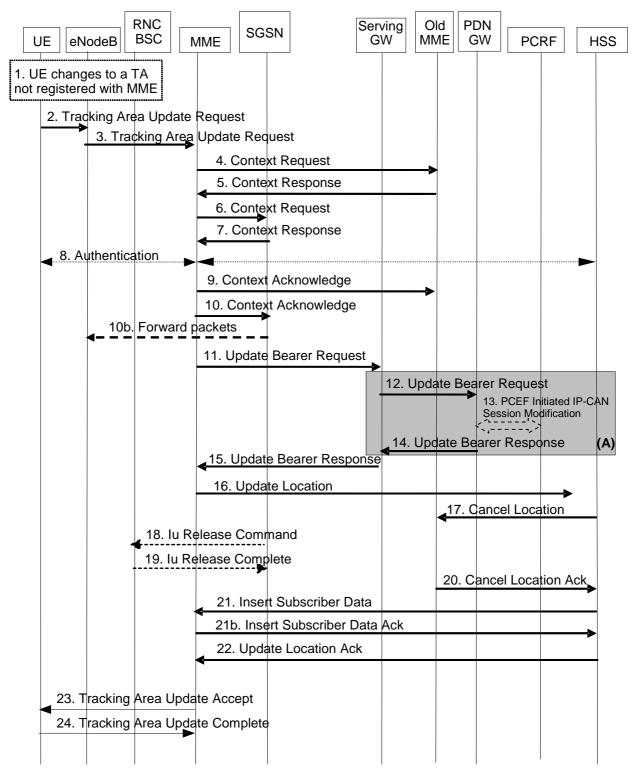
If the tracking area update procedure fails a maximum allowable number of times, or if the MME returns a Tracking Area Update Reject (Cause) message, the UE shall enter EMM DEREGISTERED state.
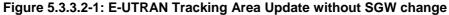
5.3.3.2 E-UTRAN Tracking Area Update without SGW Change

The Tracking Area Update procedure takes place when a UE that is registered with an MME and/or a SGSN selects an E-UTRAN cell. The procedure is initiated by the UE if the UE changes thereby to a Tracking Area that the UE has not yet registered with the network or if the P-TMSI update status is "not updated" due to bearer configuration modifications performed between UE and SGSN when ISR is activated. This procedure is initiated by an ECM-IDLE state UE and may also be initiated if the UE is in ECM-CONNECTED state. The procedure also takes place when a UE registered with a 3G-SGSN in PMM_CONNECTED state selects an E-UTRAN cell regardless whether ISR is activated. The cell selection for UTRAN is described in TS 25.304 [12] and TS 25.331 [33].

Editor's note: The URA-PCH handling needs to be shown in the steps below.

This TA update case is illustrated in Figure 5.3.3.2-1.

Figure 5.3.3.2-1: E-UTRAN Tracking Area Update without SGW change

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) are defined in TS 23.402 [2]. Steps 12 and 14 concern GTP based S5/S8.

1. The UE selects an E-UTRAN cell of a Tracking Area which is not in the UE's list of TAI's that the UE registered with the network, or the UE reselects an E-UTRAN cell and is not registered or updated with the MME (e.g. periodic TAU timer expired while camping on GERAN or UTRAN) or the UE was in PMM_Connected state (e.g. URA_PCH) when it reselects an E-UTRAN cell.

2. The UE initiates a TAU procedure by sending a Tracking Area Update Request (UE Network Capability, active flag, EPS bearer status, old GUTI, last visited TAI, P-TMSI signature, additional GUTI) message together with an indication of the Selected Network to the eNodeB.

   If the UE's TIN indicates "GUTI" or "RAT-related TMSI" and the UE holds a valid GUTI then the old GUTI indicates this valid GUTI. If the UE's TIN indicates "P-TMSI" and the UE holds a valid P-TMSI and related RAI then these two elements are indicated as the old GUTI. Mapping a P-TMSI and RAI to a GUTI is specified in Annex H.

   If the UE holds a valid GUTI then the UE indicates the GUTI as additional GUTI, regardless whether the old GUTI also indicates this GUTI or a GUTI mapped from a P-TMSI.

   The routeing parameter that is signalled in the RRC signalling to the eNB for routing to the MME is derived from the identifier that is signalled as the old GUTI according to the rules above. For a combined MME/SGSN the eNB is configured to route the MME-code(s) of this combined node to the same combined node. This eNB is also configured to route MME-code(s) of GUTIs that are generated the UE's mapping of the P-TMSIs allocated by the combined node. Such an eNB configuration may also be used for separate nodes to avoid changing nodes in the pool caused by inter RAT mobility.

   The last visited TAI shall be included in order to help the MME produce a good list of TAIs for any subsequent TAU Accept message. Selected Network indicates the network that is selected. Active flag is a request by the UE to activate the radio and S1 bearers for all the active EPS Bearers by the TAU procedure. The UE's ISR capability is included in the UE Network Capability element.

3. The eNodeB derives the MME from the old GUMMEI (contained within the old GUTI) and the indicated Selected Network. If that GUMMEI is not associated with the eNodeB, or the GUMMEI is not available, the eNodeB selects the MME as described in clause 4.3.8.3 on "MME Selection Function". The eNodeB forwards the TAU Request message together with the ECGI of the cell from where it received the message and with the Selected Network to the MME.

Editor's Note: It is FFS how the S-TMSI and P-TMSI handling is performed to let RAN select the same CN node for GERAN/UTRAN access as for E-UTRAN access, this to support co-location of the MME function and the SGSN function in one node.

Editor's Note: It is FFS whether and how an S-TMSI is derived from the P-TMSI. It is also FFS whether this facilitates the collocated MME/SGSN or whether additional information is used for this.

4. If the UE provided an old GUTI, that identifies an old MME, the new MME sends a Context Request (old GUTI, MME Address, UE Validated, complete TAU Request message) message to the old MME to retrieve the user information. The MME derives the old MME from the old GUTI. If the new MME indicates that it has authenticated the UE or if the old MME authenticates the UE, the old MME starts a timer.

5. The old MME responds with a Context Response (Context) message. Bearer contexts, PDN GW Address, and Serving GW Address are part of the Context. The Bearer contexts shall be sent in a prioritized order, i.e. the most important Bearer context first. The prioritization method is implementation dependent, but should be based on the current activity.

NOTE 2: Assigning the highest priority to the Bearer context without TFT could be done to get service continuity for all ongoing services regardless of the number of supported EPS bearers in the UE and network.

   The new MME shall ignore the UE Network Capability contained in the Context of Context Response only when it has previously received an UE Network Capability in the Tracking Area Update Request. If the UE is not known in the old MME or if the integrity check for the TAU request message fails, the old MME responds with an appropriate error cause.

6. If the UE provided an old GUTI that identifies an old SGSN, or the UE provided an old GUTI that identifies an old SGSN, then the new MME sends a Context Request (old GUTI, UE Validated, MME Address, P-TMSI signature) message to the old SGSN to retrieve the user information. The new MME derives the old SGSN from the old GUTI. The new MME always supports the related functionality for Intra Domain Connection of RAN Nodes to Multiple CN Nodes. P-TMSI Signature is used by the SGSN for integrity check. UE Validated indicates that the new MME has authenticated the UE. If the new MME indicates that it has authenticated the UE or if the old SGSN authenticates the UE, the old SGSN starts a timer.

7. The old SGSN responds with a Context Response (MM context (e.g. IMSI, unused Authentication Quintets, CK, IK, KSI, bearer contexts, Serving GW signalling Address and TEID(s), ISR) message. PDN GW Address and Serving GW Address are part of the bearer contexts. If the UE is not known in the old SGSN, the old SGSN responds with an appropriate error cause. ISR indicates that the old SGSN is capable to establish ISR for the UE. The bearer contexts shall be sent in a prioritized order, i.e. the most important bearer context first. The prioritization method is implementation dependent, but should be based on the current activity. The new MME shall ignore the UE Network Capability contained in MM Context of Context Response when it has previously received an UE Network Capability in the Tracking Area Request.

NOTE 3: Assigning the highest priority to the bearer context without TFT could be done to get service continuity for all ongoing services regardless of the number of supported EPS bearers in the UE and network.

8. Security functions may be executed. Procedures are defined in clause 5.3.10 on "Security Function".

9. The MME sends a Context Acknowledge message to the old MME. The old MME marks in its context that the information in the GWs and the HSS are invalid. This ensures that the MME updates the GWs and the HSS if the UE initiates a TAU procedure back to the 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 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.

10. The MME sends a Context Acknowledge (ISR) message to the old SGSN. Unless ISR is indicated by the MME the old SGSN marks in its context that the information in the GWs and the HSS are invalid. This ensures that the SGSN updates the GWs and the HSS if the UE initiates a RAU procedure back to the SGSN before completing the ongoing TAU procedure. ISR indicates to the old SGSN that it shall maintain the UE's contexts and the SGSN stops the timer started in step 6. When ISR is not indicated and this timer expires the old SGSN deletes all bearer resources of that UE. As the Context Acknowledge from the MME does not include any S-GW change the SGSN does not send any Delete Bearer Request message to the S-GW.

   If the security functions do not authenticate the UE correctly, then the TAU shall be rejected, and the MME shall send a reject indication to the old SGSN. The old SGSN shall continue as if the Identification and Context Request was never received.

10b. Forwarding occurs if applicable.

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

11. The new MME adopts the bearer contexts received from the old MME/SGSN as the UE's EPS bearer contexts to be maintained by the new MME. If necessary, the new MME maps PDP contexts to the EPS bearers 1-to-1 and maps the pre-Rel-8 QoS parameter values of a PDP context to the EPS QoS parameter values of an EPS bearer as defined in Annex E. The MME establishes the EPS bearer(s) in the indicated order. The MME deactivates the EPS bearers which cannot be established.

   The new MME verifies the EPS bearer status received from the UE with the EPS bearer contexts it maintains and releases any network resources related to EPS bearers that are not active in the UE. If there is no bearer context suitable for default bearer or no bearer context at all, the MME rejects the TAU Request. The new MME sends an Update Bearer Request (new MME address and TEID, QoS Negotiated, Serving network identity, ISR) message to the Serving GW. The PDN GW address is indicated in the bearer contexts. The information element ISR indicates whether ISR is established.

   When the Update Bearer Request does not indicate ISR the S-GW deletes any ISR resources by sending a Delete Bearer Request to the other CN node that has bearer resources on the S-GW reserved.

Editor's note: It is FFS whether a TAU Accept can be done instead with an indication that default bearer is not established.

12. The Serving GW informs the PDN GW(s) about the change of for example the RAT type that e.g. can be used for charging, by sending the message Update Bearer Request (Serving GW Address and TEID, RAT type) to the PDN GW(s) concerned.

13. If dynamic PCC is deployed, and RAT type information needs to be conveyed from the PDN GW to the PCRF, then the PDN GW shall send RAT type information to the PCRF by means of an IP-CAN Session Modification procedure as defined in TS 23.203 [6].

NOTE 4:	The PDN GW does not need to wait for the PCRF response, but continues in the next step. If the PCRF response leads to an EPS bearer modification the PDN GW should initiate a bearer update procedure.

14. The PDN GW updates its context field to allow DL PDUs to be routed to the correct Serving GW. PDN GW returns an Update Bearer Response (PDN GW address and TEID, MSISDN) to the Serving GW. The MSISDN is included if the PDN GW has it stored in its UE context.

15. The Serving GW updates its bearer context. This allows the Serving GW to route Bearer PDUs to the PDN GW when received from eNodeB. The Serving GW returns an Update Bearer Response (Serving GW address and TEID and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic) message to the new MME.

Editor's note: It is FFS whether the same SGW address and TEIDs are used for S4 and S1 or whether separate parameters are needed.

16. The new MME verifies whether it holds subscription data for the UE identified by the GUTI, the additional GUTI or by the IMSI received with the context data from the old CN node. If there are no subscription data in the new MME for this UE then the new MME informs the HSS of the change of MME by sending an Update Location (MME Id, IMSI, Update Type) message to the HSS. Update Type indicates that only the MME registration shall be updated in HSS.

17. The HSS sends a Cancel Location (IMSI, Cancellation type) message to the old MME with a Cancellation Type set to Update Procedure.

18. When receiving the Context Acknowledge message and if the UE is Iu Connected, the old SGSN sends an Iu Release Command message to the RNC.

19. The RNC responds with an Iu Release Complete message.

20. When receiving a Cancel Location message and the timer started in step 4 is not running, the old MME removes the MM and bearer contexts. Otherwise, the contexts are removed when the timer expires. It also ensures that the MM context is kept in the old MME for the case the UE initiates another TAU procedure before completing the ongoing TAU procedure to the new MME. The old MME acknowledges with a Cancel Location Ack (IMSI) message.

NOTE 5:	ISR is never indicated from new to old MME.

So an old MME deletes all bearer resources of an UE in any case when the timer started in step 4 expires, which is independent from receiving a Cancel Location message.

21. The HSS sends Insert Subscriber Data (IMSI, Subscription Data) 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 be attached in the TA, the MME rejects the Tracking Area Update Request with an appropriate cause to the UE, and may return an Insert Subscriber Data Ack (IMSI, MME Area Restricted) message to the HSS. If all checks are successful, the MME constructs an MM context for the UE and returns an Insert Subscriber Data Ack (IMSI) message to the HSS.

22. The HSS acknowledges the Update Location by returning an Update Location Ack (IMSI) message to the new MME after the cancelling of the old MME context is finished. If the Update Location is rejected by the HSS, the MME rejects the TAU Request from the UE with an appropriate cause sent in the TAU Reject message to the UE.

23. The new MME responds to the UE with a Tracking Area Update Accept (GUTI, TAI-list, EPS bearer status, ISR) message. If the active flag is set the Handover Restriction List may be sent to eNodeB as eNodeB handles the roaming restrictions and access restrictions in the Intra E-UTRAN case. If the "active flag" is set in the TAU Request message the user plane setup procedure is activated in conjunction with the TAU Accept message. The procedure is described in detail in TS 36.300 [5]. The message sequence should be the same as for the UE triggered Service Request procedure specified in clause 5.3.4.1 from the step when MME establish the bearers(s). The EPS bearer status indicates the active bearers in the network. The UE removes any internal resources related to bearers not marked active in the received EPS bearer status. ISR indicates to the UE that its P-TMSI and RAI remain registered with the network and remain valid in the UE. If ISR is not indicated the UE sets in its internal data the update status of the P-TMSI to "update-needed". Handover Restriction List is described in clause 4.3.5.7 "Mobility Restrictions".

When receiving the TAU Accept message and there is no ISR indication the UE sets its TIN to "GUTI". When ISR is indicated and the UE's TIN indicates "GUTI" the UE's TIN is not changed. When ISR is indicated and the Next Update is "P-TMSI" or "RAT-related TMSI" the UE sets its TIN to "RAT-related TMSI".

In case of an MME change ISR is not activated by the new MME to avoid context transfer procedures with two old CN nodes.

24. If the GUTI was changed the UE acknowledges the new GUTI by returning a Tracking Area Update Complete message to the MME.

NOTE 6: The new MME may initiate RAB establishment after execution of the security functions, or wait until completion of the TA update procedure. For the UE, RAB establishment may occur anytime after the TA update request is sent.

In the case of a rejected tracking area update operation, due to regional subscription, roaming restrictions, or access restrictions (see TS 23.221 [27] and TS 23.008 [28]) the new MME shall not construct a bearer context. A reject shall be returned to the UE with an appropriate cause and the S1 connection shall be released. Upon return to idle, the UE shall act according to TS 23.122 [10].

If the new MME is unable to update the bearer context in one or more P-GWs, the new MME shall deactivate the corresponding bearer contexts as described in subclause "MME Initiated Dedicated Bearer Deactivation Procedure". This shall not cause the MME to reject the tracking area update.

The new MME shall determine the Maximum APN restriction based on the received APN Restriction of each bearer context from the P-GW and then store the new Maximum APN restriction value.

If the new MME is unable to support the same number of active bearer contexts as received from old SGSN, the new MME should use the prioritisation sent by old SGSN as input when deciding which bearer contexts to maintain active and which ones to delete. In any case, the new MME shall first update all contexts in one or more P-GWs and then deactivate the context(s) that it cannot maintain as described in subclause "MME Initiated Dedicated Bearer Deactivation Procedure". This shall not cause the MME to reject the tracking area update.

NOTE 7: In case MS (UE) was in PMM-CONNECTED state the bearer contexts are sent already in the Forward Relocation Request message as described in subclause "Serving RNS relocation procedures" of TS 23.060 [7].

If the tracking area update procedure fails a maximum allowable number of times, or if the MME returns a Tracking Area Update Reject (Cause) message, the UE shall enter EMM DEREGISTERED state.

If the Update Location Ack message indicates a reject, this should be indicated to the UE, and the UE shall not access non-PS services until a successful location update is performed.

5.3.3.3 Routeing Area Update with MME interaction and without SGW change

The Routeing Area Update without SGW change procedure takes place when a UE that is registered with an MME selects a UTRAN or GERAN cell and the SGW is not changed by the procedure. In this case, the UE changes to a Routeing Area that the UE has not yet registered with the network. This procedure is initiated by an ECM-IDLE state UE and may also be initiated if the UE is in ECM-CONNECTED state. The RA update case is illustrated in Figure 5.3.3.3-1.

NOTE 0: This procedure covers the MME to 2G or 3G SGSN RAU and the 2G or 3G SGSN to 2G or 3G SGSN RAU with MME interactions, e.g. when ISR is used.
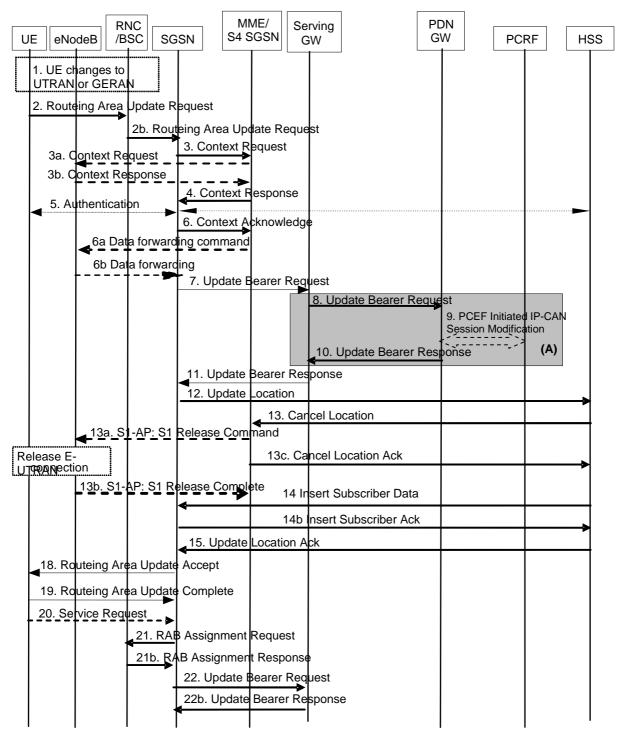
Figure 5.3.3.3-1: Routeing Area Update with MME interaction and without SGW change

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Steps 8 and 10 concern GTP based S5/S8.

1. The UE selects a UTRAN or GERAN cell. This cell is in a Routeing Area that is not yet registered with the network or the UE reselects a UTRAN or GERAN cell and is not registered or updated with the SGSN (e.g. periodic RAU timer expired while camping on E-UTRAN). The UE in ECM-CONNECTED state may change to the GERAN cell through Network Assisted Cell Change (NACC).

2a. The UE sends a Routeing Area Update Request (old P-TMSI, old RAI, UE Network Capability, P-TMSI Signature, additional P-TMSI/RAI) message to the new SGSN.

If the UE's internal TIN indicates "GUTI" and the UE holds a valid GUTI then the UE indicates the GUTI as the old P-TMSI and old RAI. If the UE's TIN indicates "P-TMSI" or "RAT-related TMSI" and the UE holds a valid P-TMSI and related RAI then these two elements are indicated as old P-TMSI and old RAI. Mapping a GUTI to a P-TMSI and an RAI is specified in Annex H.

If the UE holds a valid P-TMSI and related RAI then the UE indicates these parameters as additional P-TMSI/RAI, regardless whether the old P-TMSI and old RAI indicate the same parameters or parameters mapped from a GUTI.

The old P-TMSI is indicated in the RAU Request message for Iu-mode only. For Gb mode the TLLI is derived from the value that is determined as the old P-TMSI according to the rules above. The routing parameter that is signalled in the RRC signalling to the RNC for routing to the SGSN is derived from the identifier that is signalled as the old P-TMSI according to the rules above. For a combined MME/SGSN the RAN is configured to route the NRI(s) of this combined node to the same combined node. The RAN is also configured to route NRI(s) of P-TMSIs that are generated by the UE's mapping of the GUTIs allocated by the combined node. Such a RAN configuration may also be used for separate nodes to avoid changing nodes in the pool caused by inter RAT mobility.

If the UE has a follow-on request, i.e. if there is pending uplink traffic (signalling or data), the 3G SGSN may use, as an implementation option, the follow-on request indication to release or keep the Iu connection after the completion of the RA update procedure.

Editor's note: It is FFS whether, for O+M purposes, the Release 8 RAU Request should be extended to carry the last visited TAI.

2b. The RNC shall add the Routeing Area Identity before forwarding the message to the SGSN. This RA identity corresponds to the RAI in the MM system information sent by the RNC to the UE. The BSS shall add the Cell Global Identity (CGI) of the cell where the UE is located before passing the message to the new SGSN.

Editor's Note: It is FFS how the S-TMSI and P-TMSI handling is performed to let RAN select the same CN node for GERAN/UTRAN access as for E-UTRAN access, this to support co-location of the MME function and the SGSN function in one node.

35. The new SGSN uses the old RAI received from the UE to derive the old MME address, and sends a Context Request (GUTI, New SGSN Address) message to the old MME to get the context for the UE. If the UE is not known in the old MME, the old MME responds with an appropriate error cause. If the new SGSN indicates that it has authenticated the UE or if the old MME authenticates the UE, the old MME starts a timer.

3a. If the UE was in ECM-CONNECTED state, the source MME sends a Context Request message to the source eNodeB. The source eNodeB begins buffering downlink packets for forwarding rather than transmitting them to the UE.

3b. The source eNodeB sends a Context Response message to the source MME. Data forwarding is optional.

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

4. The old MME responds with one Context Response (MME Context) message. The MSISDN (if available in the old MME), bearer contexts, PDN GW address and Serving GW address are part of the MME Context. The old MME maps the EPS bearers to PDP contexts 1-to-1 and maps the EPS QoS parameter values of an EPS bearer to the pre-Rel-8 QoS parameter values of a bearer context as defined in Annex E. The bearer contexts shall be sent in a prioritized order, i.e. the most important bearer context first. The prioritization method is implementation dependent, but should be based on the current activity.

NOTE 2: Assigning the highest priority to the bearer context without TFT could be done to get service continuity for all ongoing services regardless of the number of supported EPS bearers in the UE and network.

The new SGSN shall ignore the UE Network Capability contained in the MME context of the Context Response only when it has previously received an UE Network Capability in the Routeing Area Update Request. If UE is not known in the old MME, the old MME responds with a appropriate error cause.

The new SGSN establishes the PDP context(s) in the indicated order. The SGSN deactivates the PDP contexts which cannot be established.

5. Security functions may be executed. Procedures are defined in clause 5.3.10 on "Security Function".

6. The SGSN determines whether to relocate the Serving GW or not. The Serving GW is relocated when the old Serving GW cannot continue to serve the UE. The SGSN may also decide to relocate the Serving GW in case a new Serving GW is expected to serve the UE longer and/or with a more optimal UE to PDN GW path, or in case a new Serving GW can be co-located with the PDN GW. Selection of a new Serving GW is performed according to clause 4.3.8.2 on "Serving GW selection function".

   The new SGSN sends an Context Acknowledge (Serving GW change indication) message to the old MME. Serving GW change indication indicates a new Serving GW has been selected. 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 RAU procedure.

   If the security functions do not authenticate the UE correctly, then the RAU is rejected, and the SGSN sends a reject indication to the MME. The MME shall continue as if the Identification and Context Request was never received.

6a. If packets are to be forwarded, the MME sends a Data Forwarding Command message to trigger the eNodeB to begin data forwarding.

6b. Forwarding occurs if applicable.

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

7. In this procedure flow the Serving GW is not relocated. The SGSN sends an Update Bearer Request (new SGSN Address and TEID, QoS Negotiated, serving network identity, RAT type, ISR) message to the Serving GW. The information element ISR indicates whether ISR is established.

   When the Update Bearer Request does not indicate ISR the S-GW deletes any ISR resources by sending a Delete Bearer Request to the other CN node that has bearer resources on the S-GW reserved.

8. The Serving GW informs the PDN GW(s) about the change of for example the RAT type that e.g. can be used for charging, by sending the message Update Bearer Request (Serving GW Address and TEID, RAT type) to the PDN GW(s) concerned.

9. If dynamic PCC is deployed, and RAT type information needs to be conveyed from the PDN GW to the PCRF, then the PDN GW shall send RAT type information to the PCRF by means of an IP-CAN Session Modification procedure as defined in TS 23.203 [6].

NOTE 3: The PDN GW does not need to wait for the PCRF response, but continues in the next step. If the PCRF response leads to an EPS bearer modification the PDN GW should initiate a bearer update procedure.

10. The PDN GW updates its context field and returns an Update Bearer Response (MSISDN, PDN GW address and TEID) message to the Serving GW. MSISDN is included if the PDN GW has it stored in its UE context.

11. The Serving GW updates its context fields and returns an Update Bearer Response (Serving GW address and TEID, PDN GW address and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic) message.

12. The new SGSN verifies whether it holds subscription data for the UE identified by the P-TMSI, the additional PTMSI/RAI or by the IMSI received with the context data from the old CN node. If there are no subscription data in the new SGSN for this UE then the new SGSN informs the HSS of the change of the SGSN by sending an Update Location (SGSN Number, SGSN Address, IMSI) message to the HSS.

13. The HSS sends a Cancel Location (IMSI, Cancellation Type) message to the old SGSN with the Cancellation Type set to Update Procedure.

   When receiving the Cancel Location message and the old node is an SGSN and the timer started in step 3 is not running, the old SGSN removes the MM and bearer contexts. Otherwise, the contexts are removed when the timer expires. It also ensures that the MM context is kept in the old SGAN for the case the UE initiates another TAU procedure before completing the ongoing RAU procedure to the new SGSN. The old SGSN acknowledges with a Cancel Location Ack (IMSI) message.

NOTE 4: ISR is never indicated from new to old SGSN.

An old SGSN deletes all bearer resources of an UE in any case when the timer started in step 3 expires, which is independent from receiving a Cancel Location message.

When the timer started in step 3 expires and the old node is an MME the MME releases any EPS bearer resources of the UE.

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

14. The HSS sends Insert Subscriber Data (IMSI, Subscription Data) to the new SGSN. The new SGSN validates the UE's presence in the (new) RA. If due to regional subscription restrictions or access restrictions the UE is not allowed to be attached in the RA, the SGSN rejects the Routeing Area Update Request with an appropriate cause to the UE, and may return an Insert Subscriber Data Ack (IMSI, SGSN Area Restricted) message to the HSS. If all checks are successful, the SGSN constructs an MM context for the UE and returns an Insert Subscriber Data Ack (IMSI) message to the HSS.

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

18. The new SGSN responds to the UE with a Routeing Area Update Accept (P-TMSI, P-TMSI signature, ISR) message to the UE. P-TMSI is included if the SGSN allocates a new P-TMSI.

    ISR indicates to the UE that its GUTI and list of TAs remain registered with the network and remain valid in the UE. If ISR is not indicated the UE sets in its internal data the update status of the GUTI to "update-needed".

    When receiving the RAU Accept message and there is no ISR indication the UE sets its TIN to "P-TMSI". When ISR is indicated and the UE's TIN indicates "P-TMSI" the TIN is not changed. When ISR is indicated and the UE's TIN indicates "GUTI" or "RAT-related TMSI" the UE sets its TIN to "RAT-related TMSI".

    In case of an SGSN change ISR is not activated by the new SGSN to avoid context transfer procedures with two old CN nodes.

19. If P-TMSI was included in the Routeing Area Update Accept message, the UE acknowledges the new P-TMSI by returning a Routeing Area Update Complete message to the SGSN.

20. For Iu-mode, if the UE has uplink data or signalling pending it shall send a Service Request (P-TMSI, CKSN, Service Type) message to the new SGSN. If a P-TMSI was allocated in step 18, that P-TMSI is the one included in this message. Service Type specifies the requested service. Service Type shall indicate one of the following: Data or Signalling.

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

22. If the SGSN established Direct Tunnel in step 21) it shall send Update Bearer Request to the Serving GW and include the RNC's Address for User Plane and downlink TEID for data. The Serving GW updates the Address for User Plane and TEID for downlink data and return an UpdateBearer Response.

NOTE 5: EPS does not support any CAMEL procedures.

NOTE 6: The new SGSN may initiate RAB establishment after execution of the security functions (step 5), or wait until completion of the RA update procedure. For the MS, RAB establishment may occur anytime after the RA update request is sent (step 2).

In the case of a rejected routeing area update operation, due to regional subscription, roaming restrictions, or access restrictions (see TS 23.221 [27] and TS 23.008 [28]) the new SGSN shall not construct an MM context. A reject shall be returned to the UE with an appropriate cause. The UE shall not re-attempt a routeing area update to that RA. The RAI value shall be deleted when the UE is powered up. It is FFS whether the RAI value being deleted until power up as specified both here and in TS 23.060 [7] is correct.

If the network supports the MOCN configuration for network sharing, the SGSN may, if the UE is not a 'Network Sharing Supporting MS', in this case decide to initiate redirection by sending a Reroute Command to the RNS, as described in TS 23.251 [24] instead of rejecting the routeing area update.

If the new SGSN is unable to update the bearer context in one or more P-GWs, the new SGSN shall deactivate the corresponding bearer contexts as described in clause "SGSN-initiated PDP Context Deactivation Procedure" of TS 23.060 [7]. This shall not cause the SGSN to reject the routeing area update.

The bearer contexts shall be sent from old to new SGSN in a prioritized order, i.e. the most important bearer context first in the SGSN Context Response message. (The prioritization method is implementation dependent, but should be based on the current activity).

The new SGSN shall determine the Maximum APN restriction based on the received APN Restriction of each bearer context from the P-GW and then store the new Maximum APN restriction value.

If the new SGSN is unable to support the same number of active bearer contexts as received from the old MME/SGSN, the new SGSN should use the prioritisation sent by old MME/SGSN as input when deciding which bearer contexts to maintain active and which ones to delete. In any case, the new SGSN shall first update all contexts in one or more P-GWs and then deactivate the context(s) that it cannot maintain as described in subclause "SGSN-initiated PDP Context Deactivation Procedure" of TS 23.060 [7]. This shall not cause the SGSN to reject the routeing area update.

NOTE 6: In case the UE was in PMM-CONNECTED state the bearer contexts are sent already in the Forward Relocation Request message as described in subclause "Serving RNS relocation procedures" of TS 23.060 [7].

If the routeing area update procedure fails a maximum allowable number of times, or if the SGSN returns a Routeing Area Update Reject (Cause) message, the UE shall enter PMM DETACHED state.

If the Update Location Ack message indicates a reject, this should be indicated to the UE, and the UE shall not access non-PS services until a successful location update is performed.

5.3.3.6 Routeing Area Update with MME interaction and with SGW change

The Routeing Area Update with SGW change procedure takes place when a UE that is registered with an MME selects a UTRAN or GERAN cell and the SGW is changed by the procedure. In this case, the UE changes to a Routeing Area that the UE has not yet registered with the network. This procedure is initiated by an ECM-IDLE state UE and may also be initiated if the UE is in ECM-CONNECTED state. This RA update case is illustrated in Figure 5.3.3.6-1.

NOTE 0: This procedure covers the MME to 2G or 3G SGSN RAU and the 2G or 3G SGSN to 2G or 3G SGSN RAU with MME interactions, e.g when ISR is used.
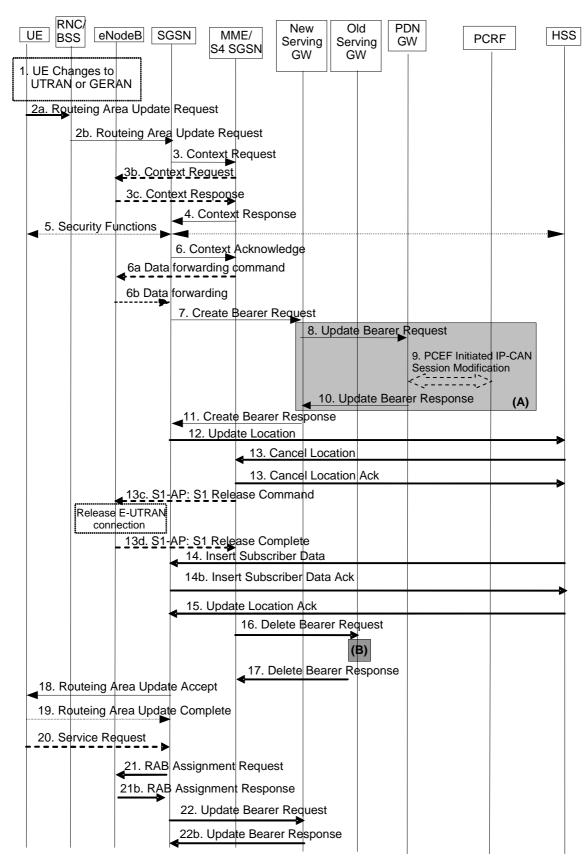
Figure 5.3.3.6-1: Routeing Area Update with MME interaction and with SGW change

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Steps 8 and 10 concern GTP based S5/S8

1. The UE selects a UTRAN or GERAN cell. This cell is in a Routeing Area that is not yet registered with the network. The UE in ECM-CONNECTED state may change to the GERAN cell through Network Assisted Cell Change (NACC).

2a. The UE sends a Routeing Area Update Request (old RAI, old P-TMSI, UE Network Capability, P-TMSI Signature, additional P-TMSI/RAI) message to the new SGSN.

If the UE's TIN indicates "GUTI" and the UE holds a valid GUTI then the UE indicates the GUTI as the old P-TMSI and old RAI. If the UE's TIN indicates "P-TMSI" or "RAT-related TMSI" and the UE holds a valid P-TMSI and related RAI then these two elements are indicated as old P-TMSI and old RAI. Mapping a GUTI to a P-TMSI and an RAI is specified in Annex H.

If the UE holds a valid P-TMSI and related RAI then the UE indicates these parameters as additional P-TMSI/RAI, regardless whether the old P-TMSI and old RAI indicate the same parameters or parameters mapped from a GUTI.

The old P-TMSI is indicated in the RAU Request message for Iu-mode only. For Gb mode the TLLI is derived from the value that is determined as the old P-TMSI according to the rules above. The routing parameter that is signalled in the RRC signalling to the RNC for routing to the SGSN is derived from the identifier that is signalled as the old P-TMSI according to the rules above. For a combined MME/SGSN the RAN is configured to route the NRI(s) of this combined node to the same combined node. The RAN is also configured to route NRI(s) of P-TMSIs that are generated by the UE's mapping of the GUTIs allocated by the combined node. Such a RAN configuration may also be used for separate nodes to avoid changing nodes in the pool caused by inter RAT mobility.

If the UE has a follow-on request, i.e. if there is pending uplink traffic (signalling or data), the 3G-SGSN may use, as an implementation option, the follow-on request indication to release or keep the Iu connection after the completion of the RA update procedure.

Editor's note: It is FFS whether, for O+M purposes, the Release 8 RAU Request should be extended to carry the last visited TAI.

Editor's Note: It is FFS how the S-TMSI and P-TMSI handling is performed to let RAN select the same CN node for GERAN/UTRAN access as for E-UTRAN access, this to support co-location of the MME function and the SGSN function in one node.

2b. The RNC shall add the Routeing Area Identity before forwarding the message to the SGSN. This RA identity corresponds to the RAI in the MM system information sent by the RNC to the UE. The BSS shall add the Cell Global Identity (CGI) of the cell where the UE is located before passing the message to the new SGSN.

Editor's note: It is FFS how the S-TMSI and P-TMSI handling is performed to let RAN select the same CN node for GERAN/UTRAN access as for E-UTRAN access, this to support co-location of the MME function and the SGSN function in one node.

3. The new SGSN uses the old TAI received from the UE to derive the old MME/SGSN address, and sends a Context Request (old GUTI, New SGSN Address) message to the old MME/SGSN to get the context for the UE. If the UE is not known in the old MME/SGSN, the old MME/SGSN responds with an appropriate error cause. If the new SGSN indicates that it has authenticated the UE or if the old MME/SGSN authenticates the UE, the old MME/SGSN starts a timer.

3b. If the UE was in ECM-CONNECTED state, the source MME sends a Context Request message to the source eNodeB. The source eNodeB begins buffering downlink packets for forwarding rather than transmitting them to the UE.

If the UE was in PMM-CONNECTED state, the source SGSN sends a Context Request message to the source RNS. The source RNC begins buffering downlink packets for forwarding rather than transmitting them to the UE.

3c. The source eNodeB sends a Context Response message to the source MME. Data forwarding is optional.

The source RNC sends a Context Response message to the source SGSN. Data forwarding is optional.

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

4. The old MME/SGSN responds with one Context Response (MME Context) message. The MSISDN (if available in the old MME), bearer contexts, PDN GW Address and Serving GW Address are part of the MME context. The old MME/SGSN maps the EPS bearers to PDP contexts 1-to-1 and maps the EPS QoS parameter values of an EPS bearer to the pre-Rel-8 QoS parameter values of a PDP context as defined in Annex E. The bearer contexts shall be sent in a prioritized order, i.e. the most important bearer context first. The prioritization method is implementation dependent, but should be based on the current activity.

NOTE 2: Assigning the highest priority to the bearer context without TFT could be done to get service continuity for all ongoing services regardless of the number of supported EPS bearers in the UE and network.

The new SGSN shall ignore the UE Network Capability contained in MME Context of the Context Response only when it has previously received an UE Network Capability in the Routeing Area Request. If UE is not known in the old MME, the old MME responds with a appropriate error cause.

The new SGSN establishes the PDP context(s) in the indicated order. The SGSN deactivates the PDP contexts which cannot be established.

5. Security functions may be executed. Procedures are defined in clause 5.3.10 on "Security Function".

6. The SGSN determines whether to relocate the Serving GW or not. The Serving GW is relocated when the old Serving GW cannot continue to serve the UE. The SGSN may also decide to relocate the Serving GW in case a new Serving GW is expected to serve the UE longer and/or with a more optimal UE to PDN GW path, or in case a new Serving GW can be co-located with the PDN GW. Selection of a new Serving GW is performed according to clause 4.3.8.2 on "Serving GW selection function".

The new SGSN sends a Context Acknowledge (Serving GW change indication) message to the old MME/SGSN. Serving GW change indication indicates a new Serving GW has been selected. The old MME/SGSN marks in its context that the information in the GWs and the HSS are invalid. This ensures that the old MME updates the GWs and the HSS if the UE initiates a RAU procedure back to the old MME before completing the ongoing RAU procedure.

If the security functions do not authenticate the UE correctly, then the RAU is rejected, and the SGSN sends a reject indication to the MME. The MME shall continue as if the Identification and Context Request was never received.

If packets are to be forwarded, the MME sends a Data Forwarding Command message to trigger the eNodeB to begin data forwarding. Forwarding occurs if applicable.

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

7. In this procedure flow the Serving GW is relocated. The SGSN sends a Create Bearer Request (IMSI, bearer contexts, SGSN Context ID, RAT Type, Type, the Protocol Type over S5/S8, etc) message to the selected new Serving GW. The PDN GW address is indicated in the bearer contexts. Type indicates to the Serving GW to send the Update Bearer Request the PDN GW. The Protocol Type over S5/S8 is provided to Serving GW which protocol should be used over S5/S8 interface.

8. The new Serving GW sends the message Update Bearer Request (Serving GW Address, Serving GW TEID, RAT type) to the PDN GW concerned.

9. If dynamic PCC is deployed, and RAT type information needs to be conveyed from the PDN GW to the PCRF, then the PDN GW shall send RAT type information to the PCRF by means of an IP-CAN Session Modification procedure as defined in TS 23.203 [6].

NOTE 3: The PDN GW does not need to wait for the PCRF response, but continues in the next step. If the PCRF response leads to an EPS bearer modification the PDN GW should initiate a bearer update procedure.

10. The PDN GW updates its context field and returns an Update Bearer Response (PDN GW address and TEID, MSISDN) message to the Serving GW. The MSISDN is included if the PDN GW has it stored in its UE context.

11. The new Serving GW updates its bearer context. This allows the Serving GW to route Bearer PDUs to the PDN GW when received from RNC. The new Serving GW returns an Create Bearer Response (Serving GW address and TEID, PDN GW Address and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic) message to the SGSN.

12. The new SGSN verifies whether it holds subscription data for the UE identified by the P-TMSI, the additional P-TMSI/RAI or by the IMSI received with the context data from the old CN node. If there are no subscription data in the new SGSN for this UE then the new SGSN informs the HSS of the change of SGSN by sending an Update Location (SGSN Number, SGSN Address, IMSI) message to the HSS.

13. The HSS sends a Cancel Location (IMSI, Cancellation Type) message to the old SGSN with the Cancellation Type set to Update Procedure.

    When the timer started in step 3 expires and the old node is an SGSN, the old SGSN removes the MM and bearer contexts. Otherwise, the contexts are removed when the timer expires. It also ensures that the MM context is kept in the old SGSN for the case the UE initiates another TAU procedure before completing the ongoing RAU procedure to the new SGSN. The old SGSN acknowledges with a Cancel Location Ack (IMSI) message.

    NOTE 6: ISR is never indicated from new to old SGSN.

    An old SGSN deletes all bearer resources of an UE in any case when the timer started in step 3 expires, which is independent from receiving a Cancel Location message.

    If the timer started in step 3 expires and the old node is an MME the MME releases any EPS bearer resources of the UE.

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

14. The HSS sends Insert Subscriber Data (IMSI, Subscription Data) to the new SGSN. The new SGSN validates the UE's presence in the (new) RA. If due to regional subscription restrictions or access restrictions the UE is not allowed to be attached in the RA, the SGSN rejects the Routeing Area Update Request with an appropriate cause to the UE, and may return an Insert Subscriber Data Ack (IMSI, SGSN Area Restricted) message to the HSS. If all checks are successful, the SGSN constructs an MM context for the UE and returns an Insert Subscriber Data Ack (IMSI) message to the HSS.

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

16. When the timer started in step 3 expires and the old MME/SGSN received the Serving GW change indication in the Context Acknowledge message, the old MME/SGSN deletes the EPS bearer resources by sending Delete Bearer Request (Cause, TEID) messages to the old Serving GW. Cause indicates to the old Serving GW that the old Serving GW shall not initiate a delete procedure towards the PDN GW. If the Serving GW has not changed, the old MME/SGSN does not delete the bearers. If ISR is established on the S-GW then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that CN node.

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

18. The new SGSN responds to the UE with a Routeing Area Update Accept (P-TMSI, P-TMSI Signature) message.

    If ISR is not indicated the UE sets in its internal data the update status of the GUTI to "update-needed".

    In case of an S-GW change ISR is never indicated by the SGSN to the UE as it needs a TAU with the same S-GW first to activate ISR. In case of an SGSN change ISR is not activated by the new SGSN to avoid context transfer procedures with two old CN nodes.

    When receiving the RAU Accept message and there is no ISR indication the UE sets its TIN to "P-TMSI". When ISR is indicated and the UE's TIN indicates "P-TMSI" the TIN is not changed. When ISR is indicated and the UE's TIN indicates "GUTI" or "RAT-related TMSI" the UE sets its TIN to "RAT-related TMSI".

19. If the P-TMSI was included in the RAU Accept message.the UE acknowledges the new P-TMSI by returning a Routeing Area Update Complete message to the SGSN.

20. For Iu-mode, if the UE has uplink data or signalling pending it shall send a Service Request (P-TMSI, CKSN, Service Type) message to the new SGSN. If a P-TMSI was allocated in step 18, that P-TMSI is the one included in this message. Service Type specifies the requested service. Service Type shall indicate one of the following: Data or Signalling.

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

22. If the SGSN established Direct Tunnel in step 21) it shall send Update Bearer Request to the Serving GW and include the RNC's Address for User Plane and downlink TEID for data. The Serving GW updates the Address for User Plane and TEID for downlink data and return an Update Bearer Response.

NOTE 7: EPS does not support any CAMEL procedures.

In the case of a rejected routeing area update operation, due to regional subscription, roaming restrictions, access restrictions (see TS 23.221 [80] and TS 23.008 [79]) or because the SGSN cannot determine the HLR address to establish the locating updating dialogue, the new SGSN shall not construct an MM context. A reject shall be returned to the UE with an appropriate cause. The UE does not re-attempt a routeing area update to that RA. The RAI value shall be deleted when the UE is powered-up. It is FFS whether the RAI value being deleted until power up as specified both here and in TS 23.060 [7] is correct.

If the new SGSN is unable to update the bearer context in one or more P-GWs, the new SGSN shall deactivate the corresponding bearer contexts as described in clause "SGSN-initiated PDP Context Deactivation Procedure" of TS 23.060 [7]. This shall not cause the SGSN to reject the routeing area update.

The bearer contexts shall be sent from old MME to new SGSN in a prioritized order, i.e. the most important bearer context first in the Context Response message. (The prioritization method is implementation dependent, but should be based on the current activity).

The new SGSN shall determine the Maximum APN restriction based on the received APN Restriction of each bearer context from the P-GW and then store the new Maximum APN restriction value.

If the new SGSN is unable to support the same number of active bearer contexts as received from old MME, the new SGSN should use the prioritisation sent by old MME as input when deciding which contexts to maintain active and which ones to delete. In any case, the new SGSN shall first update all contexts in one or more P-GWs and then deactivate the context(s) that it cannot maintain as described in subclause "SGSN-initiated PDP Context Deactivation Procedure" of TS 23.060 [7]. This shall not cause the SGSN to reject the routeing area update.

If the routeing area update procedure fails a maximum allowable number of times, or if the SGSN returns a Routeing Area Update Reject (Cause) message, the MS shall enter IDLE state.

5.3.4 Service Request procedures

5.3.4.1 UE triggered Service Request
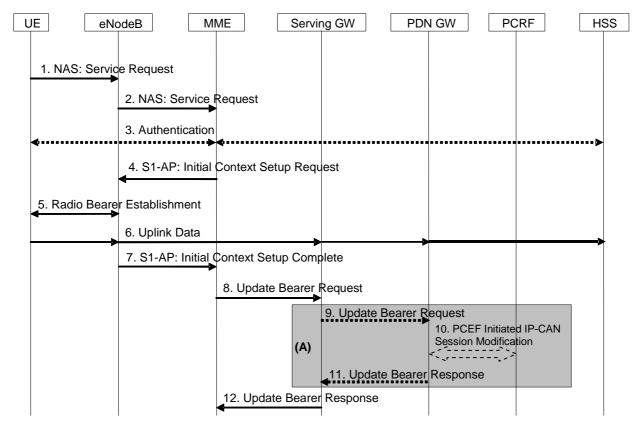
Figure 5.3.4.1-1: UE triggered Service Request procedure

NOTE: For a PMIP-based S5/S8, procedure steps (A) are defined in TS 23.402 [2]. Steps 9 and 11 concern GTP-based S5/S8.

1. The UE sends NAS message Service Request (S-TMSI) 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 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 TS 36.300 [5].

3. NAS authentication procedures may be performed.

4. The MME sends S1-AP Initial Context Setup Request (Serving GW address, S1-TEID(s) (UL), Bearer QoS(s), Security Context, MME Signalling Connection Id, Handover Restriction List) message to the eNodeB. This step activates the radio and S1 bearers for all the active EPS Bearers. 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 TS 36.300 [5]. Handover Restriction List is described in clause 4.3.5.7 "Mobility Restrictions".

5. The eNodeB performs the radio bearer establishment procedure. The user plane security is established at this step, which implicitly confirms the Service Request. This step is described in detail in TS 36.300 [5]. When user plane security has been established the EPS bearer state is synchronized between the UE and the network, i.e. the UE should remove the EPS bearer for which no radio bearers are setup.

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.

7. The eNodeB sends an S1-AP message Initial Context Setup Complete (eNodeB address, List of accepted EPS bearers, List of rejected EPS bearers, S1 TEID(s) (DL)) to the MME. This step is described in detail in TS 36.300 [5].

8. The MME sends an Update Bearer Request message (eNodeB address, S1 TEID(s) (DL) for the accepted EPS bearers, Delay Downlink Packet Notification Request, RAT Type) to the Serving GW. The Serving GW is now able to transmit downlink data towards the UE. The usage of the Delay Downlink Packet Notification Request Information Element is specified in clause 5.3.4.2 below.

   If any EPS bearers are to be released the MME triggers the bearer release procedure as specified in clause 5.4.4.2.

9. If the RAT Type has changed compared to the last reported RAT Type, the Serving GW shall send the Update Bearer Request message (RAT Type) to the PDN GW.

10. If dynamic PCC is deployed, the PDN GW interacts with the PCRF to get the PCC rule(s) according to the RAT Type by means of a PCEF initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6]. If dynamic PCC is not deployed, the PDN GW may apply local QoS policy.

11. The PDN GW sends the Update Bearer Response to the Serving GW.

12. The Serving GW sends an Update Bearer Response to the MME.

5.3.4.2 Handling of abnormal conditions in UE triggered Service Request

Editor's note: If /when suitable CT4 specifications are available, many of the details included below can be moved into it. However, as the details impact the interoperation between MME and S-GW they are currently included in this TS 23.401 (needed to ensure that the procedure is "stable"; avoids RAN impacts and that the negative impacts of shortening the DRX interval on UE battery life are avoided).

Under certain conditions, the current UE triggered Service Request procedure can cause unnecessary Downlink Packet Notification messages which increase the load of the MME.

This can occur when uplink data sent in step 6 causes a response on the downlink which arrives at the Serving GW before the Update Bearer Request message, step 8. This data cannot be forwarded from the Serving GW to the eNodeB and hence it triggers a Downlink Data Notification message.

If the MME receives a Downlink Data Notification after step 2 and before step 9, the MME shall not send S1 interface paging messages. However, across all the UEs on that MME, the MME shall monitor the rate at which these events occur. If the rate becomes significant (as configured by the operator) and the MME's load exceeds an operator configured value, the MME shall indicate "Delay Downlink Packet Notification Request" with parameter D to the Serving Gateway, where D is the requested delay given as an integer multiple of [50 ms (FFS)], or zero. The Serving GW then uses this delay in between receiving downlink data and sending the Downlink Data Notification message.

   Editor's note: The determination of the "rate that is significant" is FFS.

   NOTE 1: A low rate of reception of Downlink Data Notifications between steps 2 and 9 should be considered a normal circumstance, e.g. due to the chance that a UE Terminating call/session is initiated at roughly the same time as the UE triggered Service Request procedure.

   NOTE 2: It is recommended that this rate is determined over [60 (FFS)] second periods.

The MME shall use the step 8, Update Bearer Request of the UE initiated Service Request procedure to indicate "Delay Downlink Packet Notification Request" to the Serving GW.

To determine the amount of delay requested by a given MME, the Serving GW either uses the last Update Bearer Request message which is part of a Service Request procedure, or, just uses one of the Service Request procedure's Update Bearer Request messages received within the preceding [30 (FFS)] seconds. The latter mode of operation shall be taken into account when implementing the MME.

The MME is responsible for setting the value of D. The exact algorithm for setting the value is implementation dependent, two examples are given below to serve as a guideline:

   EXAMPLE 1: The MME adaptively increases the value of D when the rate of unnecessary Downlink Data Notifications is too high; and correspondingly it decreases the value when the rate is not too high.

EXAMPLE 2: When unnecessary Downlink Data Notifications arrive, the MME measures the average time from the reception of the unnecessary Downlink Data Notification to the reception of the Update Bearer Response from the Serving GW in the same UE triggered Service Request Procedure. The value of D is calculated from this average, by adding a safety margin.

Normally, upon receipt of a downlink data packet for which there is no DL-TEID of the S1 user plane tunnel, the S-GW shall send the Downlink Data Notification message to the MME without delay.

If the S-GW determines from the last Update Bearer Request message which is part of a Service Request procedure that a given MME request delaying of the Downlink Packet Notification by a delay of D, it shall (only for UEs of that MME) buffer the Downlink Data for a period D. If the DL-TEID and eNodeB address for the UE is received before the expiry of the timer, the timer shall be cancelled and the Network triggered Service Request procedure is finished without sending the Downlink Data Notification message to the MME, i.e. DL data are sent to the UE. Otherwise the Downlink Data Notification message is sent to the MME when the timer expires.

5.3.4.3 Network Triggered Service Request
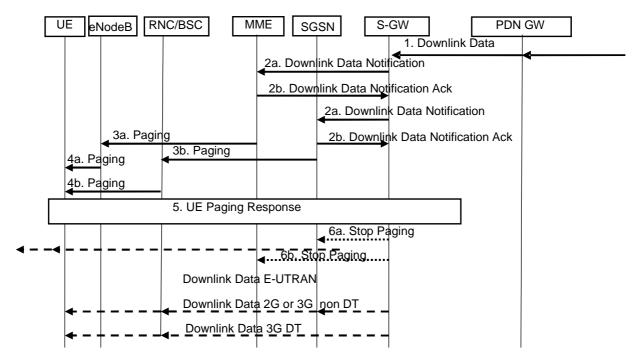
Figure 5.3.4.3-1: Network triggered Service Request procedure

If the MME needs to signal with the UE that is in ECM-IDLE state, e.g. to perform the MME/HSS-initiated detach procedure for the ECM-IDLE mode UE or receive control signalling (e.g. Create Dedicated Bearer Request or Modify Dedicated Bearer Request), the MME starts network triggered service request procedure from step 3.

If ISR is activated, when the Serving GW receives a Create Dedicated Bearer Request or Modify Bearer Request for a UE, and the SGW does not have a downlink S1-U and the SGSN has notified the Serving GW that the UE has moved to PMM-IDLE or STANDBY state, the Serving GW buffers signalling messages and triggers MME and SGSN to page UE. In this case the S-GW will be notified about the current RAT type based on the UE triggered service request procedure. The S-GW will go on executing the dedicated bearer activation or dedicated bearer modification procedure, i.e. send the corresponding buffered signalling to MME or SGSN which UE resides in now and inform the current RAT type to the PDN GW if the RAT type has been changed compared to the last reported RAT Type. If dynamic PCC is deployed, the current RAT type information shall also be conveyed from the PDN GW to the PCRF. If the PCRF response leads to an EPS bearer modification the PDN GW should initiate a bearer update procedure as specified in clause 5.4.2.1 below..

1. When the Serving GW receives a downlink data packet for a UE known as not user plane connected (i.e. the S-GW context data indicates no downlink user plane TEID), it buffers the downlink data packet. and identifies which MME or SGSN is serving that UE.

   If that MME has requested the S-GW to delay sending the Downlink Data Notification (see clause 5.3.4.2 on "Handling of abnormal conditions in UE triggered Service Request"), the Serving GW buffers the downlink data

and waits until the timer expires before continuing with step 2. If the DL-TEID and eNodeB address for that UE is received before the expiry of the timer, the timer shall be cancelled and the Network triggered Service Request procedure is finished without executing the steps below, i.e. DL data are sent to the UE.

If the Serving GW receives additional downlink data packets for this UE before the expiry of the timer, the Serving GW does not restart this timer.

2. The Serving GW sends a Downlink Data Notification message to the MME and SGSN nodes for which it has control plane connectivity for the given UE. The MME and SGSN respond to the S-GW with a Downlink Data Notification Ack message.

If the Serving GW receives additional downlink data packets for this UE, the Serving GW buffers these downlink data packets and the Serving GW does not send a new Downlink Data Notification.

3a. If the UE is registered in the MME, 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 TS 36.300 [5]. Steps 3-4 are omitted if the MME already has a signalling connection over S1-MME towards the UE.

3b. If the UE is registered in the SGSN, the SGSN sends paging messages to RNC/BSS, which is described in detail in TS 23.060 [7].

4a. If eNodeBs receive paging messages from the MME, the UE is paged by the eNodeBs. The step is described in detail in TS 36.300 [5].

4b. If RNC/BSS nodes receive paging messages from the SGSN the UE is paged by the RNSC/BSS, which is described in detail in TS 23.060 [7]

5. Upon reception of paging indication in E-UTRAN access, the UE initiates the UE triggered Service Request procedure, which is specified in clause 5.3.4.1.
Upon reception of paging indication in UTRAN or GERAN access, the MS shall respond in respective access as specified TS 24.008 [47] and the SGSN shall notify the S-GW.

The MME and/or SGSN supervises the paging procedure with a timer. If the MME and/or SGSN receives no response from the UE to the Paging Request message, it may repeat the paging. The repetition strategy is operator dependent.

If the MME and/or SGSN receives no response from the UE after this paging repetition procedure, it shall use the Update Bearer Request [FFS] message to notify the Serving GW about the paging failure. In that case, if ISR is not active, the Serving GW deletes the buffered packet(s). If ISR is active and the Serving GW receives paging failure from both SGSN and MME, the Serving GW deletes the bufferd packet(s).

6a. If ISR is active and paging response is received in E-UTRAN access the Serving GW sends a "Stop Paging" message to the SGSN.

6b. If ISR is active and paging response is received in UTRAN or GERAN access the Serving GW sends a "Stop Paging" message to the MME.

The Serving GW transmits downlink data towards the UE only via the RAT where paging response was received.

5.3.5   S1 release procedure

This procedure is used to release the logical S1-AP signalling connection (over S1-MME) and all S1 bearers (in S1-U) for a UE. The procedure will move the UE from ECM-CONNECTED to ECM-IDLE in both the UE and MME, and all UE related context information is deleted in the eNodeB.

The initiation of S1 Release procedure is either:

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

-   MME-initiated with cause e.g. authentication failure, detach, etc.

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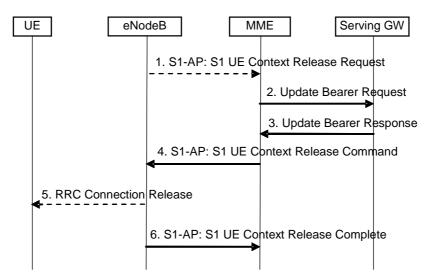
Figure 5.3.5-1: S1 Release Procedure

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

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

2. The MME sends an Update Bearer Request message to the S-GW that requests the release of all S1-U bearers for the UE. This message is triggered either by an S1 Release Request message from the eNodeB, or by another MME event.

3. The S-GW releases all eNodeB related information (address and TEIDs) for the UE and responds with an Update Bearer Response message to the MME. Other elements of the UE's S-GW context are not affected. The S-GW retains the S1-U configuration that the S-GW allocated for the UE's bearers. The S-GW starts buffering downlink packets received for the UE and initiating the "Network Triggered Service Request" procedure, described in sub-clause 5.3.4.3, if downlink packets arrive for the UE.

4. The MME releases S1 by sending the S1 UE Context Release Command (Cause) message to the eNodeB.

5. If the RRC connection is not already released, the eNodeB sends a RRC Connection Release message to the UE in Acknowledged Mode. Once the message is acknowledged by the UE, the eNodeB deletes the UE's context.

6. The eNodeB confirms the S1 Release by returning an S1 UE Context Release Complete message to the MME. With this, the signalling connection between the MME and the eNodeB for that UE is released. This step shall be performed promptly after step 4, e.g. it shall not be delayed in situations where the UE does not acknowledge the RRC Connection Release.

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

   If the cause of S1 release is different from User inactivity, e.g. loss of RRC connection, the MME shall trigger the MME Initiated Dedicated Bearer Deactivation procedure (sub-clause 5.4.4.2) for the GBR bearer(s) of the UE after the S1 Release procedure is completed.

Editor's note: FFS: Other causes of S1 release (in addition to user inactivity) that should lead to the preservation of the GBR bearer(s).

5.3.6   Void

5.3.7 GUTI Reallocation procedure

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

The GUTI Reallocation procedure is illustrated in Figure 5.3.7-1.
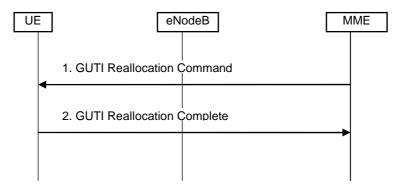
Figure 5.3.7-1: GUTI Reallocation Procedure

1. The MME sends GUTI Reallocation Command (GUTI, TAI list) to the UE.

2. The UE returns GUTI Reallocation Complete message to the MME.

5.3.8 Detach procedure

5.3.8.1 General

The Detach procedure allows:

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

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

The UE is detached either explicitly or implicitly:

- Explicit detach: The network or the UE explicitly requests detach and signal with each other.

- Implicit detach: The network detaches the UE, without notifying the UE. This is typically the case when the network presumes that it is not able to communicate with the UE, e.g. due to radio conditions.

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

- UE-Initiated Detach Procedure;

- MME-Initiated Detach Procedure;

- HSS-Initiated Detach Procedure.

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

5.3.8.2 UE-initiated Detach procedure

The Detach procedure when initiated by the UE is illustrated in Figure 5.3.8.2-1.
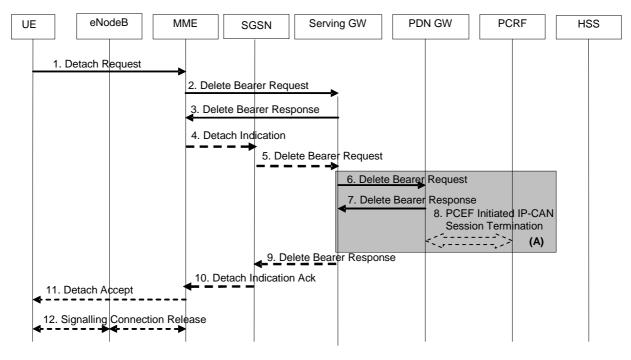
Figure 5.3.8.2-1: UE-Initiated Detach Procedure

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) are defined in TS 23.402 [2]. Steps 6, 7 and 8 concern GTP based S5/S8

NOTE 2: When multiple PDN connections are active, parts of this procedure are repeated.

1. The UE sends NAS message Detach Request (GUTI, Switch Off) to the MME. This NAS message is used to trigger the establishment of the S1 connection if the UE was in ECM-IDLE mode. Switch Off indicates whether detach is due to a switch off situation or not.

NOTE 3: Security procedures may be invoked if the NAS message is used to establish the S1 connection.

2. The active EPS Bearers in the Serving GW regarding this particular UE are deactivated by the MME sending Delete Bearer Request (TEID) to the Serving GW.

3. The Serving GW acknowledges with Delete Bearer Response (TEID). If ISR is not activated, this step shall be executed after step 7.

4. If ISR is activated, MME sends Detach Indication (IMSI) message to the associated SGSN.

5. The active PDP contexts in the Serving GW regarding this particular UE are deactivated by the SGSN sending Delete Bearer Request (TEID) to the Serving GW.

6. The Serving GW sends Delete Bearer Request (TEID) to the PDN GW. If ISR is not activated, this step shall be triggered by step 2.

Editor's note: If ISR is activated, it is FFS step 6 is triggered by step 2 or step 5 (after both the bearers of EUTRAN and 2G/3G are requested to be deleted).

7. The PDN GW acknowledges with Delete Bearer Response (TEID).

8. The PDN GW employs a PCEF initiated IP-CAN Session Termination Procedure as defined in TS 23.203 [6] with the PCRF to indicate to the PCRF that EPS Bearer is released if PCRF is applied in the network.

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

10. The SGSN sends Detach Indication Acknowledge message to the MME.

11. If Switch Off indicates that detach is not due to a switch off situation, the MME sends a Detach Accept to the UE.

12. The MME releases the S1-MME signalling connection for the UE by sending S1 Release Command to the eNodeB with Cause = Detach. The details of this step are covered in the "S1 Release Procedure", as described in clause 5.3.5.

5.3.8.3 MME-initiated Detach procedure

The MME-Initiated Detach procedure when initiated by the MME is illustrated in Figure 5.3.8.3-1.
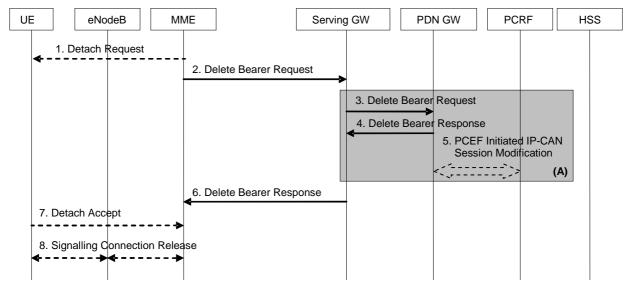
Figure 5.3.8.3-1: MME-Initiated Detach Procedure

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) are defined in TS 23.402 [2]. Steps 3, 4 and 5 concern GTP based S5/S8.

NOTE 2: When multiple PDN connections are active, parts of this procedure are repeated.

1. The MME initiated detach procedure is either explicit or implicit. The MME may implicitly detach a UE, if it has not had communication with UE for a long period of time. The MME does not send the Detach Request (Detach Type) message to the UE in case of implicit detach. The MME may explicitly detach the UE by sending a Detach Request message to the UE. The Detach Type may be set to re-attach in which case the UE should re-attach at the end of the detach process.

2. Any EPS Bearers in the Serving GW regarding this particular UE are deactivated by the MME sending Delete Bearer Request (TEID) message to the Serving GW.

3. The Serving GW sends a Delete Bearer Request (TEID) message to the PDN GW.

4. The PDN GW acknowledges with Delete Bearer Response (TEID) message.

5. The PDN GW employs an IP-CAN Session Termination procedure as defined in TS 23.203 [6] with the PCRF to indicate to the PCRF that the EPS Bearer(s) are released if a PCRF is configured.

6. The Serving GW acknowledges with Delete Bearer Response (TEID) message.

7. If the UE receives the Detach Request message from the MME in the step 1, the UE sends a Detach Accept message to the MME any time after step 1.

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

5.3.8.4 HSS-initiated Detach procedure

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

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

The HSS-Initiated Detach Procedure is illustrated in Figure 5.3.8.4-1.
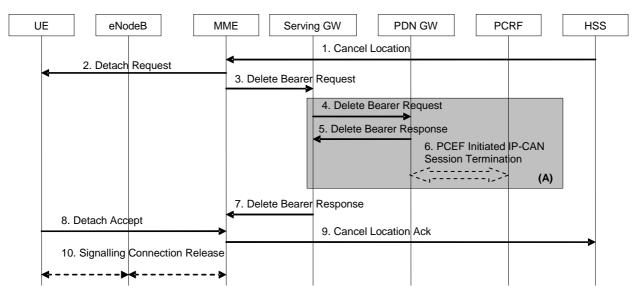
Figure 5.3.8.4-1: HSS-Initiated Detach Procedure

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) are defined in TS 23.402 [2]. Steps 4, 5 and 6 concern GTP based S5/S8.

NOTE 2: When multiple PDN connections are active, parts of this procedure are repeated.

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

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

2. If Cancellation Type is Subscription Withdrawn, the MME informs the UE, that it has been detached, by sending Detach Request message to the UE.

3. The EPS Bearers in the Serving GW regarding this particular UE are deactivated by the MME sending a Delete Bearer Request (TEID) message to the Serving GW.

4. The Serving GW sends Delete Bearer Request (TEID) message to the PDN GW.

Editor's note: If ISR is activated, step 4 may be triggered after both the bearers of EUTRAN and 2G/3G are requested to be deleted, FFS.

5. The PDN GW acknowledges with Delete Bearer Response (TEID) message.

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

6. The PDN GW employs a PCEF initiated IP-CAN Session Termination procedure as defined in TS 23.203 [6] with the PCRF to indicate to the PCRF that the EPS bearer is released if a PCRF is configured.

7. The Serving GW acknowledges with Delete Bearer Response (TEID) message.

8. If the UE receives the Detach Request message from the MME, the UE sends a Detach Accept message to the MME any time after step 2.

9. The MME confirms the deletion of the MM contexts and the EPS Bearer(s) with a Cancel Location Ack (IMSI) message.

10. After receiving the Detach Accept message, the MME releases the S1-MME signalling connection for the UE by sending S1 Release Command (Cause) message to the eNodeB with Cause set to Detach. The details of this step are covered in the "S1 Release Procedure", as described in clause 5.3.5.

NOTE 3: Steps 2,8,10 are only for the Cancellation type is set to Subscription Withdrawn.

5.3.9 HSS User Profile management function procedure

5.3.9.1 General

The HSS user profile management function allows the HSS to update the HSS user profile stored in the MME. Whenever the HSS user profile is changed for a user in the HSS, and the changes affect the HSS user profile stored in the MME, the MME shall be informed about these changes by the means of the following procedure:

- Insert HSS User Profile procedure, used to add or modify the HSS user profile in the MME.

5.3.9.2 Insert Subscriber Data procedure

The Insert Subscriber Data procedure is illustrated in Figure 5.3.9.2-1.
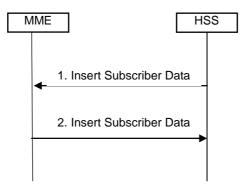
Figure 5.3.9.2-1: Subscriber Data procedure

1. The HSS sends an Insert Subscriber Data (IMSI, Subscription Data) message to the MME.

2. The MME updates the stored Subscription Data and acknowledges the Insert Subscriber Datamessage by returning an Insert Subscriber DataAck (IMSI) message to the HSS. The update result should be contained in the Ack message. The MME compares the PDN subscription contexts contained in the Subscription Datareceived from the HSS with the PDN subscription contexts the MME stores and the MME performs following action:

    - For received PDN subscription contexts that have no related active EPS bearer in the MME, no further action is required except storage in the MME.

    - For received PDN subscription contexts with a related active EPS bearer, the MME shall in addition compare the received updated PDN subscription context with the existing data for that EPS bearer and take actions. MME initiated bearer deactivation could be triggered if VPLMN address is not allowed. If QoS subscribed has changed, e.g. AMBR, and UE is in the ECM-CONNECTED state, an EPS bearer modification procedure shall be triggered. If QoS subscribed has changed and when UE is not in the ECM-CONNECTED state or the EPS bearer modification is not successful when UE is in the ECM-CONNECTED state:

a) If ISR is activated when the next activity from UE is detected the MME shall compare the stored updated subscription data with the existing data for that EPS bearer and initiate EPS bearer modification procedure.

b) If ISR is not activated, the MME should directly delete the concerned EPS bearer.

If other Subscription Data are changed compared to the Subscription Data stored by the MME before receiving the Insert Subscriber Data the MME initiates appropriate action, e.g. if roaming restrictions are modified the MME initiated detach could be triggered.

==It is FFS whether a specific HSS User Profile Delete procedure is needed similar to "Delete User Profile"== ==procedure in TS 23.060 [7].== If such a procedure is needed, then the HSS should send the IMSI as well as the PDN subscription context identifiers list so that the MME may trigger the corresponding EPS bearer deactivation procedure. This procedure may be needed when HSS replaces unsupported services in an MME and as a consequence the MME deactivates affected active EPS bearers.

5.3.9.3 Purge function

The Purge function allows an MME to inform the HSS that it has deleted the subscription data and MM context of a detached MS. The MME may, as an implementation option, delete the subscription data and MM context of an UE immediately after the implicit or explicit detach of the UE. Alternatively the MME may keep for some time the subscription data and the MM context of the detached UE, so that the data can be reused at a later attach without accessing the HSS.
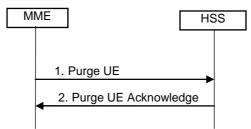
Figure 5.3.9.3-1: Purge Procedure

1. After deleting the Subscription data and MM contexts of a detached UE, the MME sends Purge UE (IMSI) message to the HSS.

2. The HSS sets the UE Purged for E-UTRAN flag and acknowledges with a Purge UE Ack message.

5.3.10 Security Function

5.3.10.1 General

The security functions include:

The security functions include:

- Guards against unauthorised EPS service usage (authentication of the UE by the network and service request validation).

- Provision of user identity confidentiality (temporary identification and ciphering).

- Provision of user data and signalling confidentiality (ciphering).

- Provision of origin authentication of signalling data (integrity protection).

- Authentication of the network by the UE.

Security-related network functions for EPS are described in TS 33.401 [41].

5.3.10.2   Authentication and Key Agreement

EPS AKA is the authentication and key agreement procedure that shall be used over E-UTRAN, between the UE and MME. EPS AKA is specified in TS 33.102 [40].

5.3.10.3   User Identity Confidentiality

An M-TMSI identifies a user between the UE and the MME. The relationship between M-TMSI and IMSI is known only in the UE and in the MME.

5.3.10.4   User Data and Signalling Confidentiality

There are two different levels of the security associations between the UE and the network.

   i) RRC and UP security association is between the UE and eUTRAN. The RRC security associations protect the RRC signalling between the UE and eUTRAN (integrity protection and ciphering). The UP security association is also between the UE and eUTRAN and provide user plane encryption function.

   ii) NAS security association is between the UE and the MME. It provides integrity protection and encryption of NAS signalling.

5.3.10.4.1   AS security mode command procedure

The MME triggers the AS security mode command procedure to enable ciphering of the UP traffic and ciphering and integrity protection of the RRC signalling as described in TS 33.401 [41].

   Editor's note: It is FFS whether the AS security mode command procedure represents a stand-alone procedure or whether it can be combined with other signalling messages.

5.3.10.4.2   NAS Security Mode Command procedure

The MME uses the NAS security mode command procedure to establish a NAS security association between the UE and MME, in order to protect the further NAS signalling messages. More details of the procedure are described in TS 33.401 [41].

   Editor's note: It is FFS whether the NAS security mode command procedure represents a stand-alone procedure or whether it can be combined with other signalling messages.

5.3.10.5   ME identity check procedure

   Editor's note: The term Mobile Equipment Identity is used in this text so as to indicate that the EPC should support multiple equipment identity formats (e.g. those from 3GPP2, WiMAX, etc) as well as the IMEISV

   Editor's note: The development of a Global EIR concept might require refinement of these procedures.

The Mobile Equipment Identity Check Procedure permits the operator(s) of the MME and/or the HSS and/or the PDN-GW to check the Mobile Equipment's identity (e.g. to check that it has not been stolen, or, to verify that it does not have faults).

The ME Identity can be checked by the MME passing it to an Equipment Identity Register (EIR) and then the MME analysing the response from the EIR in order to determine its subsequent actions (e.g. sending an Attach Reject if the EIR indicates that the Mobile Equipment is blacklisted).

The ME identity check procedure is illustrated in Figure 5.3.10.5-1.
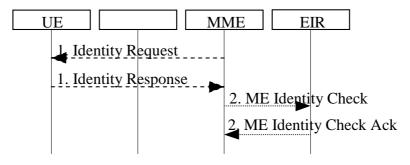
Figure 5.3.10.5-1: Identity Check Procedure

1. The MME sends Identity Request (Identity Type) to the UE. The UE responds with Identity Response (Mobile Identity).

2. If the MME is configured to check the IMEI against the EIR, it sends ME Identity Check (ME Identity, IMSI) to EIR. The EIR responds with ME Identity Check Ack (Result).

NOTE: The Identity Check Procedure is typically executed as part of the Attach procedure (see clause 5.3.2.1).

For roaming situations, in order to permit the HPLMN operator to check the ME Identity, the VPLMN shall obtain the ME identity at Initial Attach when Attach Type does not indicate handover, and, at Tracking Area Update from UTRAN/GERAN if the old SGSN does not provide the ME Identity. In order to minimise signalling delays during these procedures, the MME should obtain the ME Identity during the EPC Authentication and Ciphering procedure. (FFS)

At Initial Attach when Attach Type does not indicate handover, the MME includes the ME Identity in the Update Location message to the HSS.

NOTE: It is FFS whether the mechanisms by which the HSS and/or PDN-GW check the ME Identity are to be standardised in this release of the 3GPP specifications.

5.4 Session Management, QoS and interaction with PCC functionality

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.
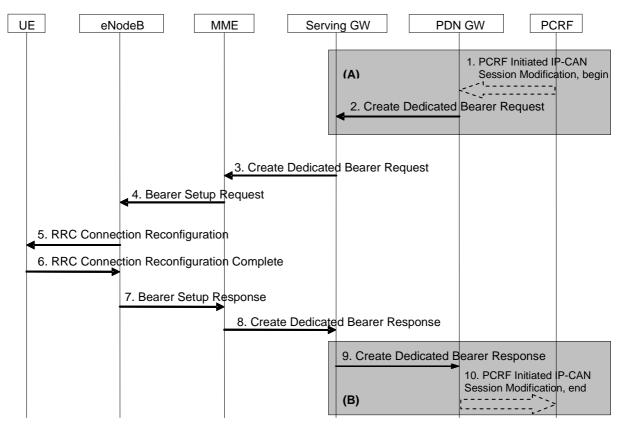
Figure 5.4.1-1: Dedicated Bearer Activation Procedure

NOTE 1: Steps 3-8 are common for architecture variants with GTP based S5/S8 and PMIP-based S5/S8. For an PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Steps 1, 2, 9 and 10 concern GTP based S5/S8.

1. If dynamic PCC is deployed, the PCRF sends a PCC decision provision (QoS policy) message to the PDN GW. This corresponds to the initial steps of the PCRF-Initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6], up to the point that the PDN GW requests IP-CAN Bearer Signalling. If dynamic PCC is not deployed, the PDN GW may apply local QoS policy.

2. The PDN GW uses this QoS policy to assign the EPS Bearer QoS, i.e., it assigns the values to the bearer level QoS parameters (excluding AMBR); see clause 4.7.3. The PDN GW sends a Create Dedicated Bearer Request message (IMSI, PTI, EPS Bearer QoS, UL TFT, S5/S8 TEID, LBI) to the Serving GW, the Linked EPS Bearer Identity (LBI) is the EPS Bearer Identity of the default bearer. The Procedure Transaction Id (PTI) parameter is only used when the procedure was initiated by a UE Requested Bearer Resource Allocation Procedure - see clause 5.4.5.

3. The Serving GW sends the Create Dedicated Bearer Request (IMSI, PTI, EPS Bearer QoS, UL TFT, S1-TEID, LBI, DL TFT (for PMIP-based S5/S8)) message to the MME. If the UE is in ECM-IDLE state the MME will trigger the Network Triggered Service Request from step 3 (which is specified in clause 5.3.4.3). In that case the following steps 4-7 may be combined into Network Triggered Service Request procedure or be performed standalone. It is FFS in case there is no paging response.

4. The MME selects an EPS Bearer Identity, which has not yet been assigned to the UE. The MME then builds a Session Management Configuration IE including the PTI, UL TFT, EPS Bearer QoS parameters (excluding ARP), the EPS Bearer Identity and the Linked EPS Bearer Identity (LBI). If the UE has UTRAN or GERAN capabilities, the MME uses the EPS bearer QoS information to derive the corresponding PDP context parameters QoS Negotiated (R99 QoS profile), Radio Priority and Packet Flow Id and includes them in the Session Management Configuration. If the UE indicated in the UE Network Capability it does not support BSS packet flow procedures, then the MME shall not include the Packet Flow Id. The MME then signals the Bearer Setup Request (EPS Bearer QoS, Session Management Configuration, S1-TEID) message to the eNodeB.

5. The eNodeB maps the EPS Bearer QoS to the Radio Bearer QoS. It then signals a RRC Connection Reconfiguration (Radio Bearer QoS, Session Management Configuration, EPS RB Identity) message to the UE.

The UE shall store the QoS Negotiated, Radio Priority, Packet Flow Id, which it received in the Session Management Configuration, for use when accessing via GERAN or UTRAN. The UE NAS stores the EPS Bearer Identity and links the dedicated bearer to the default bearer indicated by the Linked EPS Bearer Identity (LBI). The UE uses the uplink packet filter (UL TFT) to determine the mapping of service data flows to the radio bearer. The UE may provide the EPS Bearer QoS parameters to the application handling the service data flow. The application usage of the EPS Bearer QoS is implementation dependent. The UE shall not reject the RRC Connection Reconfiguration on the basis of the EPS Bearer QoS parameters contained in the Session Management Configuration IE.

NOTE 2: The details of the Radio Bearer QoS are specified in TS 36.300 [5].

6. The UE NAS layer builds a Session Management Response IE including the EPS Bearer Identity. The UE then acknowledges the radio bearer activation to the eNodeB with a RRC Connection Reconfiguration Complete (Session Management Response) message.

7. The eNodeB acknowledges the bearer activation to the MME with a Bearer Setup Response (EPS Bearer Identity, S1-TEID, Session Management Response) message. The eNodeB indicates whether the requested EPS Bearer QoS could be allocated or not.

8. The MME acknowledges the bearer activation to the Serving GW by sending a Create Dedicated Bearer Response (EPS Bearer Identity, S1-TEID) message.

9. The Serving GW acknowledges the bearer activation to the PDN GW by sending a Create Dedicated Bearer Response (EPS Bearer Identity, S5/S8-TEID) message.

10. 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, allowing the completion of the PCRF-Initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6], proceding after the completion of IP-CAN bearer signalling.

NOTE 3: 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 TS 23.203 [6]. Steps 1 and 10 are included here only for completeness.

5.4.2 Bearer modification with bearer QoS update

5.4.2.1 PDN GW initiated bearer modification with bearer QoS update

The PDN-GW initiated bearer modification procedure (including EPS Bearer QoS update and APN-AMBR) for a GTP based S5/S8 is depicted in figure 5.4.2.1-1. In this procedure, the UE is assumed to be in active mode.
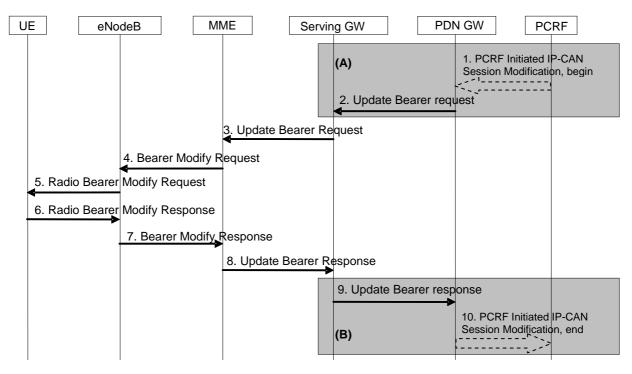
Figure 5.4.2.1-1: Bearer Modification Procedure with Bearer QoS Update, UE in active mode

NOTE 1: Steps 3-8 are common for architecture variants with GTP based S5/S8 and PMIP-based S5/S8. For a PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Steps 1, 2, 9 and 10 concern GTP based S5/S8.

1. If dynamic PCC is deployed, the PCRF sends a PCC decision provision (QoS policy) message to the PDN GW. This corresponds to the initial steps of the PCRF-Initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6], up to the point that the PDN GW requests IP-CAN Bearer Signalling. If dynamic PCC is not deployed, the PDN GW may apply local QoS policy.

2. The PDN GW uses this QoS policy to determine that the authorized QoS of a service data flow has changed or that a service data flow shall be aggregated to or removed from an active bearer. The PDN GW generates the UL TFT and updates the EPS Bearer QoS to match the aggregated set of service date flows. The PDN GW then sends the Update Bearer Request (PTI, EPS Bearer Identity, EPS Bearer QoS, APN-AMBR, UL TFT) message to the Serving GW. The Procedure Transaction Id (PTI) parameter is used when the procedure was initiated by a UE Requested Bearer Resource Allocation Procedure - see clause 5.4.5 or is used when the procedure was initiated by a UE Requested Bearer Resource Release Procedure - see clause 5.4.6. For APN-AMBR, the EPS bearer identity must refer to a non-GBR bearer.

3. The Serving GW sends the Update Bearer Request (PTI, EPS Bearer Identity, EPS Bearer QoS, UL TFT, APN-AMBR, DL TFT (for PMIP-based S5/S8)) message to the MME. If the UE is in ECM-IDLE state the MME will trigger the Network Triggered Service Request from step 3 (which is specified in clause 5.3.4.3). In that case the following steps 4-7 may be combined into Network Triggered Service Request procedure or be performed standalone. It is FFS in case there is no paging response.

4. The MME builds a Session Management Configuration IE including the PTI, EPS Bearer QoS parameters (excluding ARP), UL TFT, APN-AMBR and EPS Bearer Identity. If the UE has UTRAN or GERAN capabilities, the MME uses the EPS Bearer QoS information to derive the corresponding PDP context parameters QoS Negotiated (R99 QoS profile), Radio Priority and Packet Flow Id and includes them in the Session Management Configuration. If the UE indicated in the UE Network Capability it does not support BSS packet flow procedures, then the MME shall not include the Packet Flow Id. If the APN-AMBR has changed the MME may update the used UE-AMBR if appropriate. The MME then sends the Bearer Modify Request (EPS Bearer Identity, EPS Bearer QoS, Session Management Configuration, UE-AMBR) message to the eNodeB.

5. The eNodeB maps the modified EPS Bearer QoS to the Radio Bearer QoS. It then signals a Radio Bearer Modify Request (Radio Bearer QoS, Session Management Configuration, EPS RB Identity) message to the UE. The UE shall store the QoS Negotiated, Radio Priority, Packet Flow Id, which it received in the Session Management Configuration, for use when accessing via GERAN or UTRAN. The UE uses the uplink packet

filter (UL TFT) to determine the mapping of service data flows to the radio bearer. The UE may provide EPS Bearer QoS parameters to the application handling the service data flow. The application usage of the EPS Bearer QoS is implementation dependent. The UE shall not reject the Radio Bearer Modify Request on the basis of the EPS Bearer QoS parameters contained in the Session Management Configuration IE.

NOTE 2: The details of the Radio Bearer QoS are specified in TS 36.300 [5].

6. The UE NAS layer builds a Session Management Response IE including EPS Bearer Identity. 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 (EPS Bearer Identity, Session Management Response) message. With this message, the eNodeB indicates whether the requested EPS Bearer QoS could be allocated or not.

8. The MME acknowledges the bearer modification to the Serving GW by sending an Update Bearer Response (EPS Bearer Identity) message.

9. The Serving GW acknowledges the bearer modification to the PDN GW by sending an Update Bearer Response (EPS Bearer Identity) message.

10. If the 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 allowing the completion of the PCRF-Initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6], proceding after the completion of IP-CAN bearer signalling.

NOTE 3: 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 bearer activation procedure are to be specified in TS 23.203 [6]. Steps 1 and 10 are included here only for completeness.

5.4.2.2 HSS Initiated Subscribed QoS Modification

The HSS Initiated Subscribed QoS Modification for a GTP-based S5/S8 is depicted in figure 5.4.2.2-1.

If the APN-AMBR of the subscribed QoS has changed, the MME updates the APN-AMBR. The EPS bearer identity for APN-AMBR changes must refer to a non-GBR bearer.
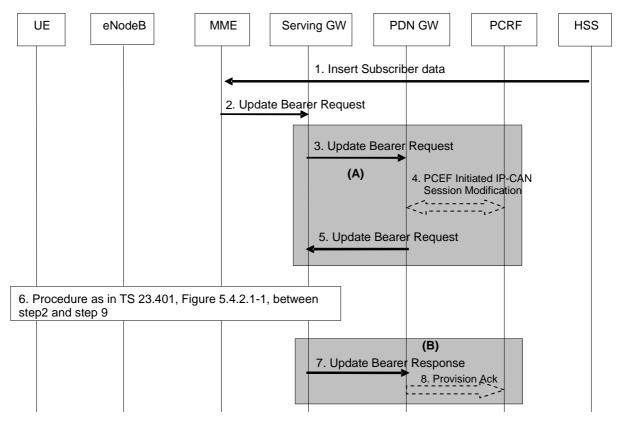
Figure 5.4.2.2-1: HSS Initiated Subscribed QoS Modification

NOTE: For a PMIP-based S5/S8, procedure steps (A) and steps (B) are defined in TS 23.402 [2]. Steps 3, 4, 5 and 7 concern GTP based S5/S8.

1. The HSS sends an Insert Subscriber Data (IMSI, Subscription Data) message to the MME (see clause 5.3.9.2).

2. The MME sends the Update Bearer Request (EPS Bearer Identity, Bearer QoS, APN-AMBR) message to the Serving GW. The EPS Bearer Identity identifies the default bearer. The EPS Bearer QoS contains the EPS subscribed QoS profile to be updated.

3. The Serving GW sends the Update Bearer Request (EPS Bearer Identity, EPS Bearer QoS, APN-AMBR) message to the PDN GW.

4. If PCC infrastructure is deployed, the PDN GW informs the PCRF about the bearer QoS update. The PCRF sends new updated PCC decision to the PDN GW. This corresponds to the PCEF-initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6].

5. The PDN GW then sends the Update Bearer Request (PTI, EPS Bearer Identity, EPS Bearer QoS, UL TFT, APN-AMBR) message to the Serving GW.

6. Steps between 2 and 9, as described in clause 5.4.2.1, are invoked.

7. The Serving GW acknowledges the bearer modification to the PDN GW by sending an Update Bearer Response (EPS Bearer Identity) message.

8. The PDN GW indicates to the PCRF whether the requested PCC decision was enforced or not by sending a Provision Ack message.

5.4.3 Bearer modification without bearer QoS update

The bearer modification procedure without QoS update is used to update the UL TFT for an active default or dedicated bearer. This procedure for a GTP based S5/S8 is depicted in figure 5.4.3-1.
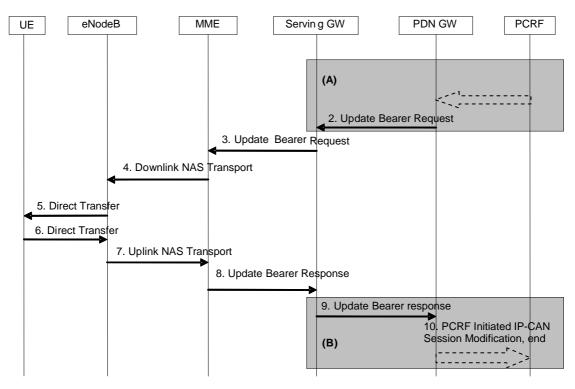
**Figure 5.4.3-1: Bearer Modification Procedure without Bearer QoS Update**

NOTE 1: Steps 3-8 are common for architecture variants with GTP based S5/S8 and PMIP-based S5/S8. For an PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Steps 1, 2, 9 and 10 concern GTP based S5/S8.

1. If dynamic PCC is deployed, the PCRF sends a PCC decision provision (QoS policy) message to the PDN GW. This corresponds to the beginning of the PCRF-initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6], up to the point that the PDN GW requests IP-CAN Bearer Signalling. If dynamic PCC is not deployed, the PDN GW may apply local QoS policy.

2. The PDN GW uses this QoS policy to determine that a service data flow shall be aggregated to or removed from an active 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 Bearer Request (PTI, EPS Bearer Identity, UL TFT) message to the Serving GW. The Procedure Transaction Id (PTI) parameter is used when the procedure was initiated by a UE Requested Bearer Resource Allocation procedure – see clause 5.4.5 or is used when the procedure was initiated by a UE Requested Bearer Resource Release Procedure - see clause 5.4.6.

3. The Serving GW sends the Update Bearer Request (PTI, EPS Bearer Identity, UL TFT, DL TFT (for PMIP-based S5/S8)) message to the MME. If the UE is in ECM-IDLE state the MME will trigger the Network Triggered Service Request from step 3 (which is specified in clause 5.3.4.3). In that case the following steps 4-7 may be combined into Network Triggered Service Request procedure or be performed standalone. It is FFS in case there is no paging response.

4. The MME builds a Session Management Configuration IE including the UL TFT and EPS Bearer Identity. 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 including EPS Bearer Identity. 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 MME.

8. The MME acknowledges the bearer modification to the Serving GW by sending an Update Bearer Response (EPS Bearer Identity) message.

9. The Serving GW acknowledges the bearer modification to the PDN GW by sending an Update Bearer Response (EPS Bearer Identity) message.

10. If the 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. This then allows the PCRF-Initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6] to continue and eventually conclude, proceding after the completion of IP-CAN bearer signalling.

NOTE 2: 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 bearer activation procedure are to be specified in TS 23.203 [6]. Steps 1 and 10 are included here only for completeness.

5.4.4 Bearer deactivation

5.4.4.1 PDN GW initiated bearer deactivation

The bearer deactivation procedure for a GTP based S5/S8 is depicted in figure 5.4.4.1-1. In this procedure, the UE is assumed to be in ECM-CONNECTED. This procedure can be used to deactivate a dedicated bearer or deactivate all bearers belonging to a PDN address.
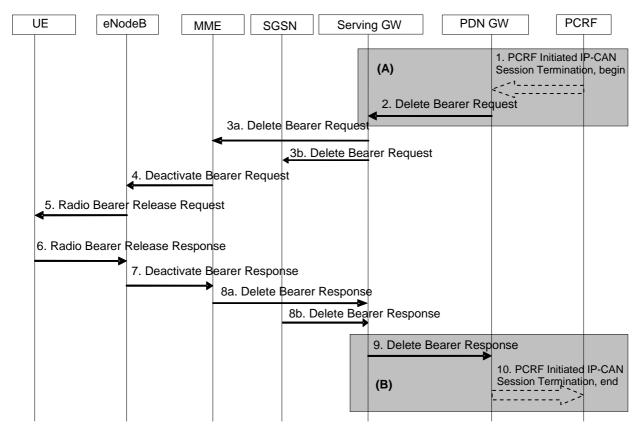
Figure 5.4.4.1-1: PDN GW Initiated Bearer Deactivation, UE in active mode

NOTE 1: Steps 3-8 are common for architecture variants with GTP based S5/S8 and PMIP-based S5/S8. For an PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Steps 1, 2, 9 and 10 concern GTP-based S5/S8.

1. If dynamic PCC is not deployed, The PDN GW is triggered to initiate the Bearer Deactivation procedure due either a QoS policy or on request from the MME (as outlined in clause 5.4.4.2). Optionally, the PCRF sends QoS policy to the PDN GW. This corresponds to the initial steps of the PCRF-initiated IP-CAN Session Termination procedure as defined in TS 23.203 [6], up to the point that the PDN GW requests IP-CAN Bearer Signalling. If dynamic PCC is not deployed, the PDN GW may apply local QoS policy. The PDN GW initiated Bearer deactivation is also performed when handovers without optimization occurs from 3GPP to non-3GPP, in which

case, the default bearer and all the dedicated bearers associated with the PDN address are released, but the PDN address is kept in the PDN GW.

2. The PDN GW sends a Delete Bearer Request (PTI, EPS Bearer Identity, Causes) message to the Serving GW. The Procedure Transaction Id (PTI) parameter in this step and in the following steps is only used when the procedure was initiated by a UE Requested Bearer Resource Release Procedure - see clause 5.4.6. This message can include an indication that all bearers belonging to that PDN connection shall be released. The PDN GW includes 'Cause' IE in the Delete Bearer Request message and sets the IE to 'RAT changed from 3GPP to Non-3GPP' if the Delete Bearer Request message is caused by handover without optimization occurs from 3GPP to non-3GPP.

3a. The Serving GW sends the Delete Bearer Request (PTI, EPS Bearer Identity, Cause) message to the MME. This message can include an indication that all bearers belonging to that PDN connection shall be released.

3b. If ISR is activated, the Serving GW sends the Delete Bearer Request (PTI, EPS Bearer Identity, Cause) message to the SGSN. This message can include an indication that all bearers belonging to that PDN connection shall be released, and the SGSN releases all bearer resources of the PDN connection.

NOTE 2: If all the bearers belonging to a UE are released due to handover without optimization occurs from 3GPP to non-3GPP, the SGSN changes the MM state of the UE to IDLE (GERAN network) or PMM-DETACHED (UTRAN network).

4. If the release of the bearer in E-UTRAN has already been signalled to the MME, steps 4-7 are omitted. Otherwise the MME builds a Session Management Configuration IE including the PTI, a Deletion Indicator and EPS Bearer Identity. The MME then signals the Deactivate Bearer Request (EPS Bearer Identity, Session Management Configuration) message to the eNodeB.

5. The eNodeB signals a Radio Bearer Release Request (EPS RB Identity, Session Management Configuration) message to the UE.

6. The UE NAS removes the UL TFTs and EPS Bearer Identity according to the Session Management Configuration. The UE NAS then layer builds a Session Management Response including the EPS Bearer Identity. The UE then acknowledges the radio bearer release to the eNodeB with a Radio Bearer Release Response (Session Management Response)message.

7. The eNodeB acknowledges the bearer deactivation to the MME with a Deactivate Bearer Response (EPS Bearer Identity, Session Management Response) message.

8a. The MME deletes the bearer context related to the deactivated EPS bearer acknowledges the bearer deactivation to the Serving GW by sending a Delete Bearer Response (EPS Bearer Identity) message.

8b The SGSN deletes PDP Context related to the deactivated EPS bearer and acknowledges the bearer deactivation to the Serving GW by sending a Delete Bearer Response (EPS Bearer Identity) message.

9. If ISR is active, after receiving the two Delete Bearer Response messages from the MME and the SGSN, or if ISR is not active, after receiving the Delete Bearer Response messages from the MME, the Serving GW deletes the bearer context related to the deactivated EPS bearer acknowledges the bearer deactivation to the PDN GW by sending a Delete Bearer Response (EPS Bearer Identity) message.

10. The PDN GW deletes the bearer context related to the deactivated EPS bearer. If the dedicated bearer deactivation procedure was triggered by a PCC Decision Provision message from the PCRF, the PDN GW indicates to the PCRF whether the requested PCC decision was successfully enforced by completing the PCRF-initiated IP-CAN Session Termination procedure as defined in TS 23.203 [6], proceding after the completion of IP-CAN bearer signalling.

NOTE 3: 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 TS 23.203 [6]. Steps 1 and 10 are included here only for completeness.

Steps 4 to 7 are not performed when the UE is in ECM-IDLE. The EPS bearer state is synchronized between the UE and the network at the next ECM-IDLE to ECM-CONNECTED transition (e.g. Service Request or TAU procedure).

If all the bearers belonging to a UE are released, the MME shall change the MM state of the UE to EMM-DEREGISTERED and the MME sends the S1 Release Command to the eNodeB, which initiates the release of

the RRC connection for the given UE if it is not released yet, and returns an S1 Release Complete message to the MME.

If the UE detects that all of its bearers are released, the UE shall also change the MM state to EMM-DEREGISTERED.

Editor's note: FFS: handling of steps 4 to 7 when the UE is in ECM-CONNECTED but not reachable.

5.4.4.2 MME Initiated Dedicated Bearer Deactivation

MME initiated Dedicated Bearer Deactivation is depicted in Figure 5.4.4-2 below. This procedure deactivates dedicated bearers. Default bearers are not affected.
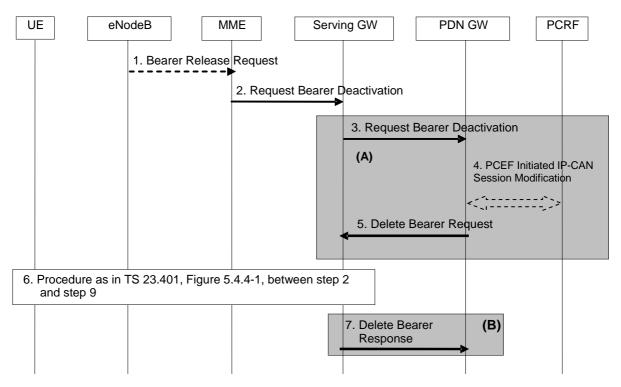
Figure 5.4.4.2-1: MME-initiated Dedicated Bearer Deactivation

NOTE: For a PMIP-based S5/S8, procedure steps (A) and steps (B) are defined in TS 23.402 [2]. Steps 3, 4, 5 and 7 concern GTP based S5/S8

1. The eNodeB may send an indication of bearer release to the MME. This indication may be e.g. the Bearer Release Request (EPS Bearer Identity) message to the MME (e.g. the radio conditions do not allow the eNodeB to maintain all the allocated bearers), or alternatively Initial Context Setup Complete, Handover Request Ack and UE Context Response, Path Switch Request may also indicate the release of a bearer.

2. The MME sends the Request Dedicated Bearer Deactivation (EPS Bearer Identity) message to the Serving GW to deactivate the selected dedicated bearer.

3. The Serving GW sends the Request Dedicated Bearer Deactivation (PTI, EPS Bearer Identity) message to the PDN GW.

4. If PCC infrastructure is deployed, the PDN GW informs the PCRF about the loss of resources by means of a PCEF-initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6]. The PCRF sends a updated PCC decision to the PDN GW.

5. The PDN GW sends a Delete Bearer Request (PTI, EPS Bearer Identity) message to the Serving GW.

6. Steps between 2 and 9, as described in clause 5.4.4.1, are invoked.

7. The Serving GW deletes the bearer context related to the deactivated EPS bearer and acknowledges the bearer deactivation to the PDN GW by sending a Delete Bearer Response (EPS Bearer Identity) message.

5.4.5   UE requested bearer resource allocation

The UE requested bearer resource allocation procedure for an E-UTRAN is depicted in figure 5.4.5-1. The procedure allows the UE to request for an allocation of bearer resources to one new Service Data Flow with a specific QoS demand. Alternatively, the procedure allows the UE to request for the modification of the GBR allocated to an active Service Data Flow. If accepted by the network, the request invokes either the Dedicated Bearer Activation Procedure or the Dedicated Bearer Modification Procedure. The procedure is used by the UE when the UE already has an IP-CAN session with the PDN. A UE can send a subsequent Request Bearer Resource Allocation Message before the previous procedure is completed.
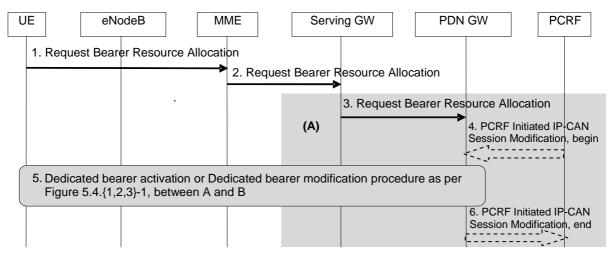
Figure 5.4.5-1: UE requested bearer resource activation

NOTE: Steps 1, 2, and 5 are common for architecture variants with GTP-based S5/S8 and PMIP-based S5/S8. The procedure steps marked (A) differ in the case that PMIP-based S5/S8 is employed and is defined in TS 23.402 [2].

1. The UE sends a Request Bearer Resource Allocation (LBI, PTI, SDF QoS, TFT) message to the MME. If the UE was in ECM-IDLE mode, this NAS message is preceded by the Service Request procedure. The SDF QoS includes the QCI and, optionally, the GBR requirement of the Service Data Flow. The UE sends the Linked Bearer Id (LBI) to indicate to which PDN the additional bearer resource is linked to. The Procedure Transaction Id is dynamically allocated by the UE for UE requested bearer resource activation procedure. The UE should ensure as far as possible that previously used PTI values are not immediately reused. The PTI is released when the procedure is completed.

2. The MME sends the Request Bearer Resource Allocation (IMSI, LBI, PTI, SDF QoS, TFT) message to the selected Serving GW. The MME validates the request using the Linked Bearer Id. The same Serving GW address is used by the MME as for the EPS Bearer identified by the Linked Bearer Id received in the Request Bearer Resource Allocation message.

3. The Serving GW sends the Request Bearer Resource Allocation (IMSI, LBI, PTI, SDF QoS, TFT) message to the PDN GW. The Serving GW sends the message to the same PDN GW as for the EPS Bearer identified by the Linked Bearer Id.

4. The PDN GW may either interact with PCRF to trigger the appropriate PCC decision (refer to TS 23.203 [6]), which may take into account subscription information, or it may apply a locally configured QoS policy. This corresponds to the beginning of a PCEF-initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6], up to the point that the PDN GW requests IP-CAN Bearer Signalling.

5. If the request is accepted, either the Dedicated Bearer Activation Procedure (according to subclause 5.4.1) or one of the Dedicated Bearer Modification Procedures (according to subclause 5.4.2 or 5.4.3) is invoked. The PTI allocated by the UE is used as a parameter in the invoked Dedicated Bearer Activation Procedure or the Dedicated Bearer Modification Procedure to correlate it to the UE Requested Bearer Resource Allocation Procedure. This provides the UE with the necessary linkage to what EPS Bearer to be used for the new SDF. The PDN GW shall not modify the QoS parameters requested by the UE. If the requested QoS is not granted, the PDN GW sends a reject indication, which shall be delivered to the UE. A cause indicates the reason why the request was rejected.

6. The PDN GW indicates the result of the provisioning of policy during the completion of the PCEF-initiated IP-CAN session modification procedure as defined in TS 23.203 [6], proceding after the completion of IP-CAN bearer signalling.

5.4.6 UE Requested Bearer Resource Release

The UE Requested Bearer Resource Release procedure for an E-UTRAN is depicted in figure 5.4.6-1. The procedure allows the UE to request for release of bearer resources associated with a Service Data Flow. When receiving the request, the network invokes either the Dedicated Bearer Deactivation Procedure or the Dedicated Bearer Modification Procedure.
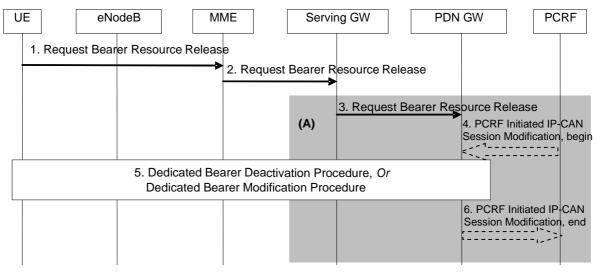
Figure 5.4.6-1: UE Requested Bearer Resource Release

NOTE: Steps 1, 2, and 5 are common for architecture variants with GTP-based S5/S8 and PMIP-based S5/S8. The procedure steps marked (A) differ in the case that PMIP-based S5/S8 is employed and is defined in TS 23.402 [2].

1. The UE sends a Request Bearer Resource Release (LBI, PTI, TFT) message to the MME. If the UE was in ECM-IDLE mode, this NAS message is preceded by the Service Request procedure. The UE sends the Linked Bearer Id (LBI) to indicate to which PDN the bearer resource is linked to. The Procedure Transaction Id is dynamically allocated by the UE for UE Requested Bearer Resource Release procedure. The UE should ensure as far as possible that previously used PTI values are not immediately reused. The PTI is released when the procedure is completed.

2. The MME sends the Request Bearer Resource Release (IMSI, LBI, PTI, TFT) message to the Serving GW. The MME validates the request using the Linked Bearer Id. The same Serving GW address is used by the MME as for the EPS Bearer identified by the Linked Bearer Id received in the Request Bearer Resource Release message.

3. The Serving GW sends the Request Bearer Resource Release (IMSI, LBI, PTI, TFT) message to the PDN GW. The Serving GW sends the message to the same PDN GW as for the EPS Bearer identified by the Linked Bearer Id.

4. If PCC infrastructure is deployed, the PDN GW informs the PCRF about the change of resources. This corresponds to the beginning of a PCEF-initiated IP-CAN Session Modification procedure as defined in TS 23.203 [6], up to the point that the PDN GW requests IP-CAN Bearer Signalling.

5. The PDN GW invokes either the Dedicated Bearer Deactivation procedure (according to subclause 5.4.4.1) or one of the Dedicated Bearer Modification procedures (according to clause 5.4.2 or 5.4.3). The PTI allocated by the UE is used as a parameter in the invoked Dedicated Bearer Deactivation or Dedicated Bearer Modification procedure to correlate it to the UE Requested Bearer Resource Release procedure. This provides the UE with the necessary linkage to which EPS Bearer the Dedicated Bearer Deactivation or Dedicated Bearer Modification procedure applies.

6. The PDN GW indicates the result of the provisioning of policy during the completion of the PCEF-initiated IP-CAN session modification procedure as defined in TS 23.203 [6], proceding after the completion of IP-CAN bearer signalling.

5.5 Handover

5.5.1 Intra-EUTRAN handover

5.5.1.1 Inter eNodeB handover without MME relocation

5.5.1.1.1 General

These procedures are used to hand over a UE from a source eNodeB to a target eNodeB when the MME is unchanged. Two procedures are defined depending on whether the Serving GW is unchanged or is relocated. The procedures rely on the presence of the X2 reference point between the source and target eNodeB, and the presence of S1-MME reference point between the MME and the source eNodeB as well as between the MME and the target eNodeB. The handover preparation and execution phases are performed as specified in TS 36.300 [5]. When the UE receives the handover command it will remove any EPS bearers for which it did not receive and corresponding EPS radio bearers in the target cell. As part of handover execution, downlink packets are forwarded from the source eNodeB to the target eNodeB. When the UE has arrived to the target eNodeB, downlink data forwarded from the source eNodeB can be sent to it. Uplink data from the UE can be delivered via the (source) Serving GW to the PDN GW. Only the handover completion phase is affected by a potential change of the Serving GW, the handover preparation and execution phases are identical.

5.5.1.1.2 Inter eNodeB handover without MME relocation and without Serving GW relocation

This procedure is used to hand over a UE from a source eNodeB to a target eNodeB when the MME is unchanged and decides that the Serving GW is also unchanged. The presence of IP connectivity between the Serving GW and the source eNodeB, as well as between the Serving GW and the target eNodeB is assumed.
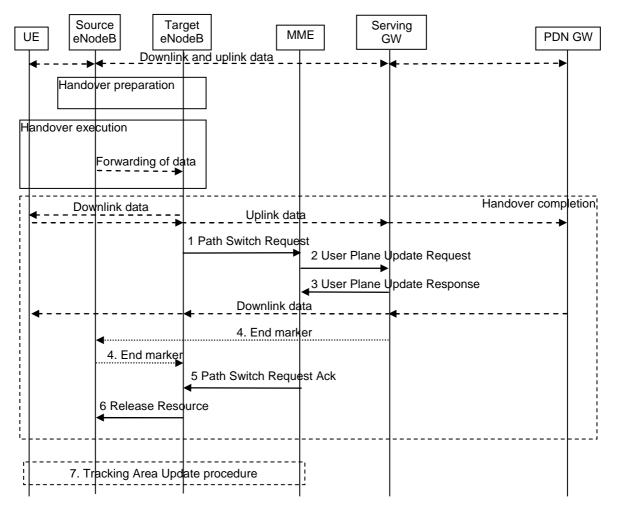
Figure 5.5.1.1.2-1: Inter eNodeB handover without MME and without Serving GW relocation

1. The target eNodeB sends a Path Switch Request message to MME to inform that the UE has changed cell, including the Cell Global Identity of the target cell and the list of rejected EPS bearers. The MME determines that the Serving GW can continue to serve the UE

2. The MME sends a User Plane Update Request (eNodeB address(es) and TEIDs for downlink user plane for the accepted EPS bearers) message to the Serving GW.

   In case any EPS bearers are to be released the MME triggers the bearer release procedure as specified in clause 5.4.4.2.

3. The Serving GW starts sending downlink packets to the target eNodeB using the newly received address and TEIDs. A User Plane Update Response message is sent back to the MME.

4. In order to assist the reordering function in the target eNB, the Serving GW shall send one or more "end marker" packets on the old path immediately after switching the path for each SAE bearer of the UE as defined in TS 36.300 [5], clause 10.1.2.2.

5. The MME confirms the Path Switch Request message with the Path Switch Request Ack message. The MME may provide the eNodeB with Handover Restriction List. Handover Restriction List is described in clause 4.3.5.7 "Mobility Restrictions".

6. By sending Release Resource the target eNodeB informs success of the handover to source eNodeB and triggers the release of resources. This step is specified in TS 36.300 [5].

7. Depending on RAN configuration the eNB triggers the UE to initiate a Tracking Area Update procedure. It is RAN functionality to provide the ECM-CONNECTED UE with the trigger information.

NOTE: It is only a subset of the TA update procedure that is performed by the MME, since the UE is in ECM-CONNECTED state and the MME is not changed.

5.5.1.1.3 Inter eNodeB handover without MME relocation, with Serving GW relocation

This procedure is used to hand over a UE from a source eNodeB to a target eNodeB when the MME is unchanged and the MME decides that the Serving GW is to be relocated. The presence of IP connectivity between the source Serving GW and the source eNodeB, between the source Serving GW and the target eNodeB, and between the target Serving GW and target eNodeB is assumed. (If there is no IP connectivity between target eNodeB and source Serving GW, it is assumed that the Inter eNodeB handover with MME relocation procedure in clause 5.5.1.2 shall be used instead.)
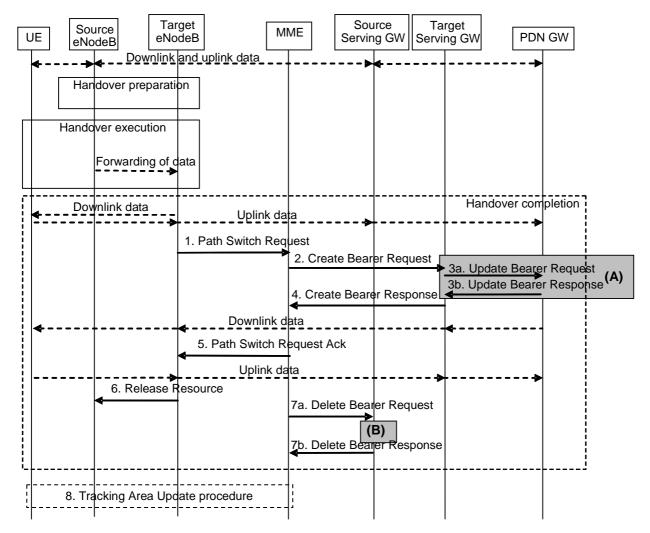
Figure 5.5.1.1.3-1: Inter eNodeB handover without MME relocation, with Serving GW relocation.

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2].

1. The target eNodeB sends a Path Switch Request message to MME to inform that the UE has changed cell, including the Cell Global Identity of the target cell and the list of rejected EPS bearers. The MME determines that the Serving GW is relocated and selects a new Serving GW according to clause 4.3.8.2 on "Serving GW Selection Function".

NOTE 2: The MME knows the S-GW Service Area with a TA granularity.

2. The MME sends a Create Bearer Request (bearer context(s) with PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic, eNodeB address(es) and TEIDs for downlink user plane for the accepted EPS bearers, the Protocol Type over S5/S8) message to the target Serving GW. The target Serving GW allocates the S-GW addresses and TEIDs for the uplink traffic on S1_U reference point (one TEID per bearer). The Protocol Type over S5/S8 is provided to Serving GW which protocol should be used over S5/S8 interface.

   In case any EPS bearers are to be released the MME triggers the bearer release procedure as specified in clause 5.4.4.2.

3. The target Serving GW assigns addresses and TEIDs (one per bearer) for downlink traffic from the PDN GW. It sends an Update Bearer Request (Serving GW addresses for user plane and TEID(s)) message to the PDN GW(s). The PDN GW updates its context field and returns an Update Bearer Response (PDN GW address and TEID, MSISDN, etc.) message to the Serving GW. The MSISDN is included if the PDN GW has it stored in its UE context. The PDN GW starts sending downlink packets to the target GW using the newly received address and TEIDs. These downlink packets will use the new downlink path via the target Serving GW to the target eNodeB. An Update Bearer Response message is sent back to the target serving GW.

4. The target Serving GW sends a Create Bearer Response (Serving GW addresses and uplink TEID(s) for user plane) message back to the target MME. The MME starts a timer, to be used in step 7.

5. The MME confirms the Path Switch Request message with the Path Switch Request Ack (Serving GW addresses and uplink TEID(s) for user plane) message. The target eNodeB starts using the new Serving GW address(es) and TEID(s) for forwarding subsequent uplink packets. The MME may provide the eNodeB with Handover Restriction List. Handover Restriction List is described in clause 4.3.5.7 "Mobility Restrictions".

6. By sending Release Resource the target eNodeB informs success of the handover to source eNodeB and triggers the release of resources. This step is specified in TS 36.300 [5].

7. When the timer has expired after step 4, the source MME releases the bearer(s) in the source Serving GW by sending a Delete Bearer Request message, which is acknowledged by the Serving GW.

8. Depending on RAN configuration the eNB triggers the UE to initiate a the Tracking Area Update procedure, e.g. when ISR is activated. It is RAN functionality to provide the ECM-CONNECTED UE with the trigger information. Note that it is only a subset of the TA update procedure that is performed by the MME, since the UE is in ECM-CONNECTED state. During the TA update procedure the MME deactivates ISR because of the S-GW change.

5.5.1.2 Inter eNodeB handover with MME relocation

The *inter eNodeB handover with MME relocation* procedure is used to relocate MME, or both the MME and the Serving GW. The procedure is initiated in the source eNodeB. The source MME selects the target MME. The MME should not be relocated during inter-eNodeB handover unless the UE leaves the MME Pool Area where the UE is served. If the target MME determines if the Serving GW needs to be relocated. If the Serving GW needs to be relocated the target MME selects the target Serving GW, as specified in clause 4.3.8.2 on Serving GW selection function.

This procedure is also used for load re-balancing (clause 4.3.7.3), in which case the source eNodeB is identical to the target eNodeB. When this procedure is used for load re-balancing, a Handover Trigger message is sent from the source MME to the eNodeB.

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 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).

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. The MMEs (source and target) use configuration data to determine whether indirect forwarding paths are to be established. Depending on configuration data, the source MME determines and indicates to the target MME whether indirect forwarding paths should be established. Based on this indication and on its configuration data, the target MME determines whether indirect forwarding paths are established.
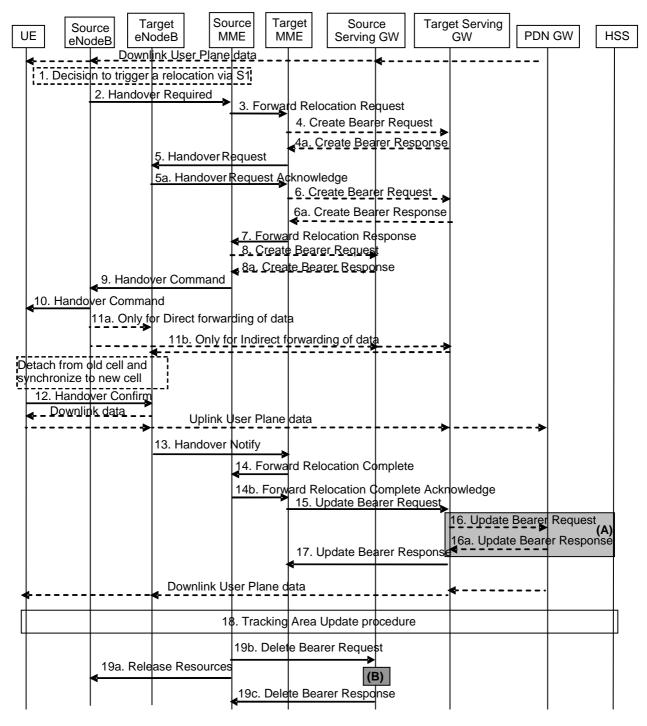
Figure 5.5.1.2-1: Inter-eNodeB Handover with CN Node re-location

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Steps 16 and 16a concern GTP based S5/S8.

NOTE 2: If the Serving GW is not relocated, the box "Source Serving GW" in figure 5.5.1.2-1 is acting as the target Serving GW.

1. The source eNodeB decides to initiate an inter-eNodeB handover with CN node relocation to the target eNodeB. This can be triggered e.g. by no X2 connectivity to the target eNodeB, or by an error indication from the target eNodeB after an unsuccessful X2-based handover, or by dynamic information learnt by the source eNodeB.

   If this procedure is used for load re-balancing (clause 4.3.7.3), a Handover Trigger message is sent from the MME to the eNodeB which triggers the next step.

2. The source eNodeB sends Handover Required to the source MME. The source eNodeB indicates which bearers are subject to data forwarding. This message contains an indication whether direct forwarding is available from the source eNodeB to the target eNodeB. This indication from source eNodeB can be based on e.g. the presence of X2.

3. The source MME selects the target MME as described in clause 4.3.8.3 on "MME Selection Function" and sends a Forward Relocation Request (MME UE context that includes the PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic and Serving GW addresses and TEIDs for uplink traffic) message to the target MME. This message also includes an indication if direct forwarding is applied, or if indirect forwarding is going to be set up by the source side.

4. The target MME verifies whether the source Serving GW can continue to serve the UE. If not, it selects a new Serving GW as described in clause 4.3.8.2 on "Serving GW Selection Function".

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

   If a new Serving GW is selected, the target MME sends a Create Bearer Request (bearer context(s) with PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) at the PDN GW(s) for uplink traffic) message to the target Serving GW. The target Serving GW allocates the S-GW addresses and TEIDs for the uplink traffic on S1_U reference point (one TEID per bearer). The target Serving GW sends a Create Bearer Response (Serving GW addresses and uplink TEID(s) for user plane, the Protocol Type over S5/S8) message back to the target MME. The Protocol Type over S5/S8 is provided to Serving GW which protocol should be used over S5/S8 interface.

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

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

6. If indirect forwarding is used, the target MME sets up forwarding parameters in the target Serving GW.

7. The target MME sends a Forward Relocation Response (Serving GW change indication) message to the source MME. In case of indirect forwarding is used this message includes Serving GW Address and TEIDs for indirect forwarding (source or target). Serving GW change indication indicates a new Serving GW has been selected.

8. If indirect forwarding is used, the source MME updates the source Serving GW about the tunnels used for indirect forwarding. In case the Serving GW is relocated it includes the tunnel identifier to the target serving GW.

9. The source MME sends a Handover Command (target addresses and TEID(s) for data forwarding) message to the source eNodeB.

10. The Handover Command is sent to the UE. Upon reception of this message the UE will remove any EPS bearers for which it did not receive and corresponding EPS radio bearers in the target cell.

11. The source eNodeB should start forwarding of downlink data from the source eNodeB towards the target eNodeB for bearers subject to data forwarding. This may be either direct (step 11a) or indirect forwarding (step 11b).

12. After the UE has successfully synchronized to the target cell, it sends a Handover Confirm message to the target eNodeB. Downlink packets forwarded from the source eNodeB can be sent to the UE. Also, uplink packets can be sent from the UE, which are forwarded to the target Serving GW and on to the PDN GW.

13. The target eNodeB sends a Handover Notify message to the target MME.

14. The target MME sends a Forward Relocation Complete to the source MME. The source MME in response sends a Forward Relocation Complete Acknowledge to the target MME. A timer in source MME is started to supervise when resources in Source eNodeB and Source Serving GW shall be released.

15. The target MME sends an Update Bearer Request (eNodeB addresses and TEIDs allocated at the target eNodeB for downlink traffic on S1_U for the accepted EPS bearers, PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic) message to the target Serving GW.

    In case any EPS bearers are to be released the MME triggers the bearer release procedure as specified in clause 5.4.4.2.

16. If the Serving GW is relocated, the target Serving GW assigns addresses and TEIDs (one per bearer) for downlink traffic from the PDN GW. It sends an Update Bearer Request (Serving GW addresses for user plane and TEID(s)) message to the PDN GW(s). The PDN GW updates its context field and returns an Update Bearer Response (PDN GW address and TEID, MSISDN, etc.) message to the Serving GW. The MSISDN is included if the PDN GW has it stored in its UE context. The PDN GW starts sending downlink packets to the target GW using the newly received address and TEIDs. These downlink packets will use the new downlink path via the target Serving GW to the target eNodeB. An Update Bearer Response message is sent back to the target serving GW.

    If the Serving GW is not relocated, no message is sent in this step and downlink packets from the Serving-GW are immediately sent on to the target eNodeB.

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

17. The target Serving GW sends an Update Bearer Response (PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic) message to the target MME.

18. The eNodeB triggers the UE to initiate a Tracking Area Update procedure with the target MME. It is RAN functionality to provide the ECM-CONNECTED UE with the trigger information.

    Thetarget MME knows that it is a Handover procedure that has been performed for this UE as it received the bearer context(s) by handover messages and therefore the target MME performs only a subset of the TA update procedure, specifically it excludes the context transfer procedures between source MME and target MME.

19. When the timer started in step 14 expires the source MME sends a Release Resources message to the source eNodeB. The source eNodeB releases its resources related to the UE. When the timer started in step 14 expires and if the source MME received the Serving GW change indication in the Forward Relocation Response message, it deletes the EPS bearer resources by sending Delete Bearer Request (Cause, TEID) messages to the Source Serving GW. Cause indicates to the old Serving GW that the Serving GW changes and the old Serving GW shall not initiate a delete procedure towards the PDN GW. The Source Serving GW acknowledges with Delete Bearer Response (TEID) messages. If ISR is established on the S-GW then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that CN node. If resources for indirect forwarding have been allocated then they are released.

5.5.2 Inter RAT handover

Editor's note: The PDP context and EPS bearer mapping is 1-to-1 for inter 3GPP RAT HOs between 2G/3G and E-UTRAN. Implication for an EPS bearer supporting more than 1 IP address is FFS.

Editor's note: The target SGSN or MME may restrict the received mapped QoS attributes from the source system during inter 3GPP RAT HOs according to its capabilities and current load.

Editor's note: PCC interaction takes place in parallel with the bearer re-establishment in the target access in order to shorten the inter 3GPP RAT HO time and as changes due to PCC are assumed rare. The details of the PCC interaction are FFS.
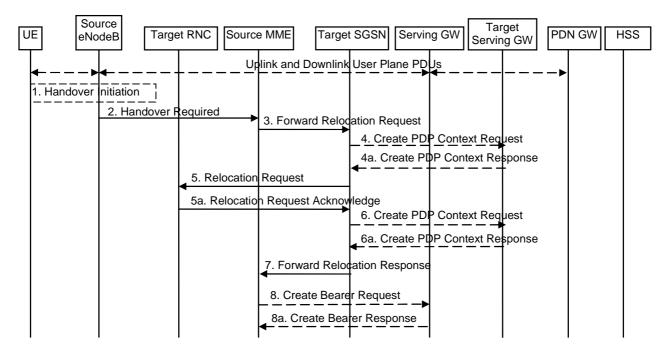
5.5.2.1 E-UTRAN to UTRAN Iu mode Inter RAT handover

5.5.2.1.1 General

Pre-conditions:

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

5.5.2.1.2 Preparation phase

Figure 5.5.2.1.2-1: E-UTRAN to UTRAN Iu mode Inter RAT HO, preparation phase

1. The source eNodeB decides to initiate an Inter-RAT handover to the target access network, UTRAN Iu mode. At this point both uplink and downlink user data is transmitted via the following: Bearer(s) between UE and source eNodeB, GTP tunnel(s) between source eNodeB, Serving GW and PDN GW.

NOTE 1: The process leading to the handover decision is outside of the scope of this specification.

2. The source eNodeB sends a Handover Required (Cause, Target RNC Identifier, Source eNodeB Identifier, Source to Target Transparent Container, Bearers Requesting Data Forwarding List) message to the source MME to request the CN to establish resources in the target RNC, target SGSN and the Serving GW.

    The 'Bearers Requesting Data Forwarding List' IE contains the list of bearers for which the source eNodeB decided that data forwarding (direct or indirect) is necessary.

3. The source MME maps the EPS bearers to PDP contexts 1-to-1 and maps the EPS QoS parameter values of an EPS bearer to the pre-Rel-8 QoS parameter values of a PDP context as defined in Annex E. The PDP Contexts shall be sent in a prioritized order, i.e. the most important PDP Context first. The prioritization method is implementation dependent, but should be based on the current activity.

NOTE 2: Assigning the highest priority to the PDP context without TFT could be done to get service continuity for all ongoing services regardless of the number of supported EPS bearers in the UE and network.

    The source MME determines from the 'Target RNC Identifier' IE that the type of handover is IRAT Handover to UTRAN Iu mode. The Source MME initiates the Handover resource allocation procedure by sending a Forward Relocation Request (IMSI, Target Identification, MM Context, PDP Context, MME Tunnel Endpoint Identifier for Control Plane, MME Address for Control plane, Source to Target Transparent Container, S1-AP Cause Direct Forwarding Flag) message to the target SGSN. When ISR is activated the message should be sent to the SGSN that maintains ISR for the UE when this SGSN is serving the target identified by the Target Identification. This message includes all PDP contexts corresponding to the bearers established in the source system and the uplink Tunnel endpoint parameters of the Serving GW.

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

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

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

Editor's note: It is FFS how the mapping of individual parameters and bearer identifiers is done. It is FFS how the bearer identifiers are mapped.

4. The target SGSN determines if the Serving GW is relocated, e.g., due to PLMN change. If the Serving GW is relocated, the target SGSN selects the target Serving GW as described under clause 4.3.8.2 on "Serving GW selection function", and sends a Create PDP Context Request message (IMSI, SGSN Tunnel Endpoint Identifier for Control Plane, SGSN Address for Control plane, PDN GW address(es) for user plane, PDN GW UL TEID(s) for user plane, PDN GW address(es) for control plane, and PDN GW TEID(s) for control plane, the Protocol Type over S5/S8) to the target Serving GW. The Protocol Type over S5/S8 is provided to Serving GW which protocol should be used over S5/S8 interface.

   The target SGSN establishes the PDP context(s) in the indicated order. The SGSN deactivates the PDP contexts which cannot be established.

4a. The target Serving GW allocates its local resources and returns a Create PDP Context Response (Serving GW address(es) for user plane, Serving GW UL TEID(s) for user plane, Serving GW Address for control plane, Serving GW TEID for control plane) message to the target SGSN.

5. The target SGSN requests the target RNC to establish the radio network resources (RABs) by sending the message Relocation Request (UE Identifier, Cause, CN Domain Indicator, Integrity protection information (i.e. IK and allowed Integrity Protection algorithms), Encryption information (i.e. CK and allowed Ciphering algorithms), RAB to be setup list, Source to Target Transparent Container).

   For each RAB requested to be established, RABs To Be Setup shall contain information such as RAB ID, RAB parameters, Transport Layer Address, and Iu Transport Association. The target SGSN shall not request resources for which the Activity Status Indicator within a PDP Context indicates that no active radio bearer exist on the source side for that PDP Context. The RAB ID information element contains the NSAPI value, and the RAB parameters information element gives the QoS profile. The Transport Layer Address is the Serving GW Address for user plane (in case Direct Tunnel is used) or the SGSN Address for user plane (in case Direct Tunnel is not used), and the Iu Transport Association corresponds to the uplink Tunnel Endpoint Identifier Data in Serving GW or SGSN respectively.

   Ciphering and integrity protection keys are sent to the target RNC to allow data transfer to continue in the new RAT/mode target cell without requiring a new AKA (Authentication and Key Agreement) procedure. Information that is required to be sent to the UE (either in the Relocation Command message or after the handover completion message) from RRC in the target RNC shall be included in the RRC message sent from the target RNC to the UE via the transparent container.

   In the target RNC radio and Iu user plane resources are reserved for the accepted RABs.

5a. The target RNC allocates the resources and returns the applicable parameters to the target SGSN in the message Relocation Request Acknowledge(Target to Source Transparent Container, RABs setup list, RABs failed to setup list).

   Upon sending the Relocation Request Acknowledge message the target RNC shall be prepared to receive downlink GTP PDUs from the Serving GW, or Target SGSN in case Direct Tunnel is not used, for the accepted RABs.

   Each RAB to be setup is defined by a Transport Layer Address, which is the target RNC Address for user data, and the Iu Transport Association, which corresponds to the downlink Tunnel Endpoint Identifier for user data.

6. If 'Indirect Forwarding' and relocation of Serving GW applies the target SGSN sends a Create PDP Context Request message (IMSI SGSN Tunnel Endpoint Identifier for Control Plane, SGSN Address for Control plane, Target RNC Address and TEID(s) for DL user plane (in case Direct Tunnel is used) or SGSN Address and TEID(s) for DL user plane (in case Direct Tunnel is not used)) to the target Serving GW.

6a. The target Serving GW returns a Create PDP Context Response (Cause, Serving GW DL TEID(s)) message to the target SGSN.

7. The target SGSN sends the message Forward Relocation Response (Cause, SGSN Tunnel Endpoint Identifier for Control Plane, SGSN Address for Control Plane, Target to Source Transparent Container, RANAP cause, RAB Setup Information, Additional RAB Setup Information, Address(es) and TEID(s) for User Traffic Data
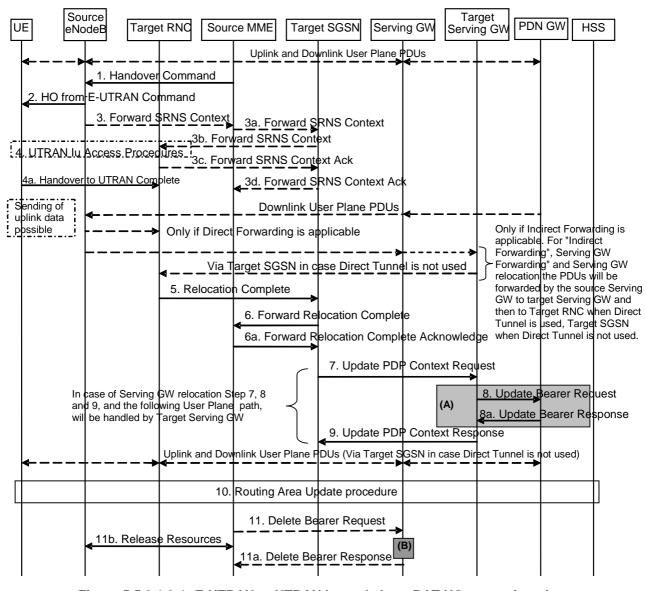
Forwarding, Serving GW change indication) to the source MME. Serving GW change indication indicates a new Serving GW has been selected.

The IE 'Address(es) and TEID(s) for User Traffic Data Forwarding' defines the destination tunnelling endpoint for data forwarding in target system, and it is set as follows.
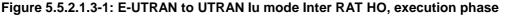
- If 'Direct Forwarding' is applicable, then the IE 'Address(es) and TEID(s) for User Traffic Data Forwarding' contains the DL GTP-U tunnel endpoint parameters to the Target RNC received in Step 5a.

- If 'Indirect Forwarding' is applicable when Direct Tunnel is used the IE 'Address(es) and TEID(s) for User Traffic Data Forwarding' contains the DL GTP-U tunnel endpoint parameters to the Target RNC (received in Step 5a) or the Target Serving GW for Serving GW re-location(received in Step 6a).

- If 'Indirect Forwarding' is applicable when Direct Tunnel is not used the IE 'Address(es) and TEID(s) for User Traffic Data Forwarding' contains the DL GTP-U tunnel endpoint parameters to the Target SGSN or the Target Serving GW in case of Serving-GW re-location (received in Step 6a).

8. If the "Direct Forwarding" is not applicable, the Source MME sends the message Create Bearer Request (Cause, Address(es) and TEID(s) for Data Forwarding (see step 7), EPS Bearer ID(s)) to the Serving GW used for indirect packet forwarding. The Cause indicates that the bearer(s) are subject to data forwarding.

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

8a. The Serving GW returns the forwarding parameters by sending the message Create Bearer Response (Cause, Serving GW Address(es) and TEID(s) for Data Forwarding). If the Serving GW doesn't support data forwarding, an appropriate cause value shall be returned and the Serving GW Address(es) and TEID(s) will not be included in the message.

5.5.2.1.3 Execution phase

Figure 5.5.2.1.3-1: E-UTRAN to UTRAN Iu mode Inter RAT HO, execution phase

NOTE: For a PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Step (B) shows PCRF interaction in the case of PMIP-based S5/S8. Steps 8 and 8a concern GTP based S5/S8

The source eNodeB continues to receive downlink and uplink user plane PDUs.

1. The source MME completes the preparation phase towards source eNodeB by sending the message Handover Command (Target to Source Transparent Container, Bearers Subject to Data Forwarding List). The "Bearers Subject to Data forwarding list" IE may be included in the message and it shall be a list of 'Address(es) and TEID(s) for user traffic data forwarding' received from target side in the preparation phase (Forward Relocation Response message (Step 7) in case of 'Direct Forwarding', else parameters received in Step 8a).

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

2. The source eNodeB will give a command to the UE to handover to the target access network via the message HO from E-UTRAN Command. This message includes a transparent container including radio aspect parameters that the target RNC has set-up in the preparation phase. The details of this E-UTRAN specific signalling are described in TS 36.300 [5].

Upon the reception of the HO from E-UTRAN Command message containing the Handover Command message, the UE shall associate its bearer IDs to the respective RABs based on the relation with the NSAPI and shall suspend the uplink transmission of the user plane data.

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

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

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

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

5. When the new source RNC-ID + S-RNTI are successfully exchanged with the UE, the target RNC shall send the Relocation Complete message to the target SGSN. The purpose of the Relocation Complete procedure is to indicate by the target RNC the completion of the relocation from the source E-UTRAN to the RNC. After the reception of the Relocation Complete message the target SGSN shall be prepared to receive data from the target RNC. Each uplink N-PDU received by the target SGSN is forwarded directly to the Serving GW.

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 Forward Relocation Complete (ISR, Serving GW change) message. ISR indicates whether the target SGSN maintains ISR after the handover, which is only possible when the S-GW is not changed. The source MME will also acknowledge that information. A timer in source MME is started to supervise when resources in Source eNodeB and Source Serving GW (for Serving GW relocation) shall be released.

   When the timer expires and ISR is not indicated by the target SGSN the source MME releases all bearer resources of the UE. If Serving GW change is indicated and this timer expires the source MME deletes the EPS bearer resources by sending Delete Bearer Request (Cause, TEID) messages to the Serving GW. Cause indicates to the old Serving GW that the Serving GW changes and the old Serving GW shall not initiate a delete procedure towards the PDN GW. If Serving GW change is indicated and ISR is established on the S-GW then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that CN node.

7. The target SGSN will now complete the Handover procedure by informing the Serving GW (for Serving GW relocation this will be the Target 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 PDP Context Request (SGSN Tunnel Endpoint Identifier for Control Plane, NSAPI(s), SGSN Address for Control Plane, SGSN Address(es) and TEID(s) for User Traffic for the accepted EPS bearers (in case Direct Tunnel is not used) or RNC Address(es) and TEID(s) for User Traffic for the accepted EPS bearers (in case Direct Tunnel is used), PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic and RAT type).

   In case any PDP contexts are to be released the SGSN triggers the PDP context deactivation procedure.

8. The Serving GW (for Serving GW relocation this will be the Target Serving GW) may inform the PDN GW(s) the change of for example for Serving GW relocation or 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. In the case of Serving GW relocation, the PDN GW updates its context field and returns an Update Bearer Response (PDN GW address and TEID, MSISDN, etc.) message to the Serving GW. The MSISDN is included if the PDN GW has it stored in its UE context.

   If PCC infrastructure is used, the PDN GW informs the PCRF about the change of, for example, the RAT type.

9. The Serving GW (for Serving GW relocation this will be the Target Serving GW) acknowledges the user plane switch to the target SGSN via the message Update PDP Context Response (Cause, Serving GW Tunnel Endpoint Identifier for Control Plane, Serving GW Address for Control Plane, Protocol Configuration Options, PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic). At this stage the user plane path is established for all PDP contexts between the UE, target RNC, target

SGSN in case Direct Tunnel is not used, Serving GW (for Serving GW relocation this will be the Target Serving GW) and PDN GW.

10. When the UE recognises that its current Tracking Area is not registered with the network the UE initiates a Routeing Area Update procedure with the target SGSN informing it that the UE is located in a new routing area. It is RAN functionality to provide the PMM-CONNECTED UE with Routing Area information.

    The target SGSN knows that an IRAT Handover has been performed for this UE as it received the bearer context(s) by handover messages and therefore the target SGSN performs only a subset of the RAU procedure, specifically it excludes the context transfer procedures between source MME and target SGSN.
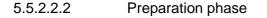
11. When the timer started at step 6 expires, the source MME sends a Release Resources message to the Source eNodeB. The Source eNodeB releases its resources related to the UE.

    When the timer started in step 6 expires and if the source MME received the Serving GW change indication in the Forward Relocation Response message, it deletes the EPS bearer resources by sending Delete Bearer Request (Cause, TEID) messages to the Source Serving GW. Cause indicates to the old Serving GW that the old Serving GW shall not initiate a delete procedure towards the PDN GW. The Source Serving GW acknowledges with Delete Bearer Response (TEID) messages. If ISR is established on the S-GW then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that CN node. If resources for indirect forwarding have been allocated then they are released.

5.5.2.2   UTRAN Iu mode to E-UTRAN Inter RAT handover

5.5.2.2.1   General

The UTRAN Iu mode to E-UTRAN Inter RAT handover procedure takes place when the network decides to perform a handover. The decision to perform PS handover from UTRAN Iu mode to E-UTRAN is taken by the network based on radio condition measurements reported by the UE to the UTRAN RNC.

5.5.2.2.2   Preparation phase
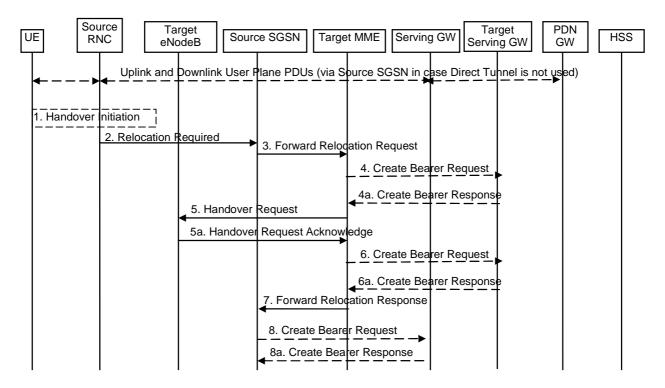
Figure 5.5.2.2.2-1: UTRAN Iu mode to E-UTRAN Inter RAT HO, preparation phase

1. The source RNC decides to initiate an Inter-RAT handover to the E-UTRAN. At this point both uplink and downlink user data is transmitted via the following: Bearers between UE and source RNC, GTP tunnel(s) between source RNC, source SGSN (only in case Direct Tunnel is not used), Serving GW and PDN GW.

NOTE 1: The process leading to the handover decision is outside of the scope of this specification.

2. The source RNC sends a Relocation Required (Cause, Target eNodeB Identifier, Source RNC Identifier, Source to Target Transparent Container, Bearers Requesting Data Forwarding List) message to the source SGSN to request the CN to establish resources in the target eNodeB, Target MME and the Serving GW. The 'Bearers Requesting Data Forwarding List' IE contains that list of RABs for which the source RNC decided that data forwarding (direct or indirect) is necessary.

3. The source SGSN determines from the 'Target eNodeB Identifier' IE that the type of handover is IRAT Handover to E-UTRAN. The Source SGSN initiates the Handover resource allocation procedure by sending Forward Relocation Request (IMSI, Target Identification, MM Context, PDP Context, SGSN Tunnel Endpoint Identifier for Control Plane, SGSN Address for Control plane, Source to Target Transparent Container, Direct Forwarding Flag) message to the target MME. This message includes all PDP contexts corresponding to all the bearers established in the source system and the uplink Tunnel endpoint parameters of the Serving GW. When ISR is activated the message should be sent to the MME that maintains ISR for the UE when this MME is serving the target identified by the Target Identification.

   The PDP Contexts shall be sent in a prioritized order, i.e. the most important PDP Context first. The prioritization method is implementation dependent, but should be based on the current activity.

NOTE 2: Assigning the highest priority to the PDP context without TFT could be done to get service continuity for all ongoing services regardless of the number of supported EPS bearers in the UE and network.

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

   The MM context contains security related information, e.g. UE capabilities and used NAS integrity and ciphering algorithm(s) as well as keys, as described in TS 29.060 [14].

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

   The target MME maps the PDP contexts to the EPS bearers 1-to-1 and maps the pre-Rel-8 QoS parameter values of a PDP context to the EPS QoS parameter values of an EPS bearer as defined in Annex E. The MME establishes the EPS bearer(s) in the indicated order. The MME deactivates the EPS bearers which cannot be established.

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

Editor's note: It is FFS how the mapping of individual parameters and bearer identifiers is done. It is FFS how the bearer identifiers are mapped.

4. The target MME determines if the Serving GW is relocated, e.g., due to PLMN change. If the Serving GW is relocated, the target MME selects the target Serving GW as described under clause 4.3.8.2 on "Serving GW selection function". The target MME sends a Create Bearer Request message (IMSI, MME context ID, MME Tunnel Endpoint Identifier for Control Plane, MME Address for Control plane, PDN GW address(es) for user plane, PDN GW UL TEID(s) for user plane, PDN GW address for control plane, and PDN GW TEID(s) for control plane, the Protocol Type over S5/S8) to the target Serving GW. The Protocol Type over S5/S8 is provided to Serving GW which protocol should be used over S5/S8 interface.

4a. The target Serving GW allocates its local resources and returns them in a Create Bearer Response (Serving GW address(es) for user plane, Serving GW UL TEID(s) for user plane, Serving GWAddress for control plane, Serving GW TEID for control plane) message to the target MME.

5. The target MME requests the target eNodeB to establish the bearer(s) by sending the message Handover Request (UE Identifier, Cause, K_{eNB}, allowed AS Integrity Protection and Ciphering algorithm(s), NAS Integrity Protection and Ciphering algorithm(s), EPS Bearers to be setup list, Source to Target Transparent Container). NAS Integrity Protection and Ciphering algorithm(s), KSI and key derivation parameters are targeted for the UE.

   If the MME already has a security association with the UE, the earlier selected NAS Integrity Protection and Ciphering algorithm(s) and keys are indicated. If the MME does not have a security association with the UE, then NAS Integrity Protection and Ciphering algorithm(s) are selected utilizing information of the MM context about supported algorithms.

For each EPS bearer requested to be established, 'EPS Bearers To Be Setup' IE shall contain information such as ID, bearer parameters, Transport Layer Address, and S1 Transport Association. The target MME shall not request resources for which the Activity Status Indicator within a PDP Context indicates that no active radio bearer exist on the source side for that PDP context. The Transport Layer Address is the Serving GW Address for user data, and the S1 Transport Association corresponds to the uplink Tunnel Endpoint Identifier Data.

The information about the selected ciphering and integrity protection algorithm(s), KSI and key derivation parameter will be sent transparently from the target eNodeB to the UE in the Target to Source Transparent Container, and in the message UTRAN HO Command from source RNC to the UE. This will then allow data transfer to continue in the new RAT/mode target cell without requiring a new AKA (Authentication and Key Agreement) procedure.

5a. The target eNodeB allocates the request resources and returns the applicable parameters to the target MME in the message Handover Request Acknowledge (Target to Source Transparent Container, EPS Bearers setup list, EPS Bearers failed to setup list). Upon sending the Handover Request Acknowledge message the target eNodeB shall be prepared to receive downlink GTP PDUs from the Serving GW for the accepted EPS bearers.

6. If 'Indirect Forwarding' and relocation of Serving GW applies the target MME sends an Create Bearer Request message (IMSI, MME TEID for control plane, MME Address for control plane,, Target eNodeB Address, TEID(s) for DL user plane) to the target Serving GW.

The target eNodeB selects AS integrity and ciphering algorithm(s). In addition to the information provided by the MME (KSI, NAS Integrity Protection and Ciphering algorithm(s) and key derivation parameter), the target eNodeB inserts AS integrity and ciphering algorithm(s) and eNodeB C-RNTI into the UTRAN RRC message, which is contained in the Target to Source Transparent Container. The eNodeB C-RNTI is used by the UE to derive target eNodeB KeNB as well as the RRC and UP keys.

6a. The target Serving GW returns a Create Bearer Response (Cause, Serving GW DL TEID(s)) message to the target MME.

7. The target MME sends the message Forward Relocation Response (Cause, List of Set Up RABs, MME Tunnel Endpoint Identifier for Control Plane, S1-AP cause, MME Address for control plane, Target to Source Transparent Container, Address(es) and TEID(s) for Data Forwarding, Serving GW change indication) to the source SGSN. Serving GW change indication indicates a new Serving GW has been selected.

The IE 'Address(es) and TEID(s) for User Traffic Data Forwarding' defines the destination tunnelling endpoint for data forwarding in target system, and it is set as follows. If 'Direct Forwarding' is applicable, then the IEs 'Address(es) and TEID(s) for Data Forwarding' contains the DL GTP-U tunnel endpoint parameters to the eNodeB.
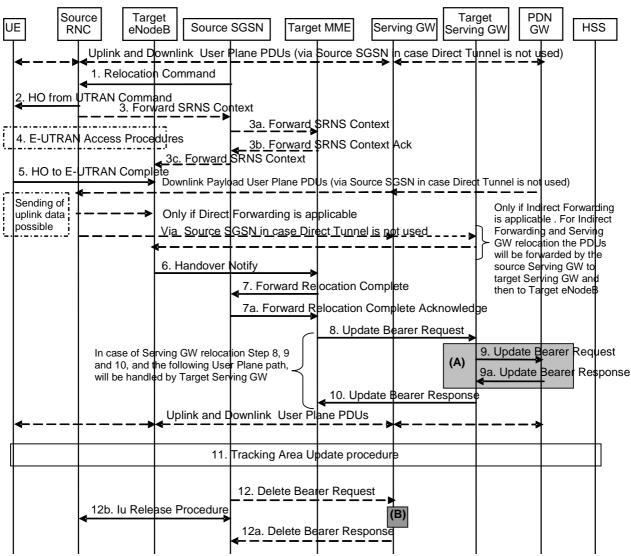
If 'Indirect Forwarding' is applicable the IEs 'Address(es) and TEID(s) for Data Forwarding' contains the DL GTP-U tunnel endpoint parameters to the Target eNodeB or to the Target Serving GW for Serving GW re-location.

8. If "Direct Forwarding" is not applicable, the source SGSN shall send the message Create Bearer Request (Cause, Address(es) and TEID(s) for Data Forwarding (see step 7), NSAPI(s)) to the Serving GW used for indirect packet forwarding. The Cause shall indicate that the Bearer is subject to data forwarding.

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

8a. The Serving GW returns the forwarding user plane parameters by sending the message Create Bearer Response (Cause, Serving GW Address(es) and TEID(s) for Data Forwarding). If the Serving GW doesn't support data forwarding, an appropriate cause value shall be returned and the Serving GW Address(es) and TEID(s) will not be included in the message.

5.5.2.2.3 Execution phase

Figure 5.5.2.2.3-1: UTRAN Iu mode to E-UTRAN Inter RAT HO, execution phase

NOTE: For a PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Step (B) shows PCRF interaction in the case of PMIP-based S5/S8. Steps 9 and 9a concern GTP based S5/S8.

The source RNC continues to receive downlink and uplink user plane PDUs.

1. The source SGSN completes the preparation phase towards source RNC by sending the message Relocation Command (Target to Source Transparent Container, RABs to be Released List, RABs Subject to Data Forwarding List). The "RABs to be Released list" IE will be the list of all NSAPIs (RAB Ids) for which a Bearer was not established in Target eNodeB. The "RABs Subject to Data forwarding list" IE may be included in the message and it shall be a list of 'Address(es) and TEID(s) for user traffic data forwarding' received from target side in the preparation phase (Forward Relocation Response message (Step 7) in case of 'Direct Forwarding' is applicable. In case 'Indirect Forwarding' is applicable and Direct Tunnel is not used the "RABs Subject to Data Forwarding" IE includes the source SGSN address(es) and TEID(s) allocated for indirect data forwarding by Source SGSN. In case 'Indirect Forwarding' is applicable and Direct Tunnel is used the "RABs Subject to Data Forwarding" IE includes paramters received in Step 8a).

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

   The source RNC may initiate data forwarding for the indicated RABs/PDP contexts specified in the "RABs Subject to Data Forwarding List". The data forwarding may go directly to target eNodeB, or alternatively go e.g.

via the source SGSN (in case Direct Tunnel is not used) and the Serving GW if so decided by source SGSN and/or target MME in the preparation phase.

Upon the reception of the HO from UTRAN Command message containing the Relocation Command message, the UE shall associate its RAB IDs to the respective bearers ID based on the relation with the NSAPI and shall suspend the uplink transmission of the user plane data.

3. The Source RNC may inform the Source SGSN which then informs the Target MME regarding "delivery order" parameters in the message Forward SRNS Context.

    The target MME forwards the SRNS Context to eNodeB.

    The need for the step 3 is *FFS*.

4. The UE moves to the E-UTRAN and performs access procedures toward target eNodeB.

5. When the UE has got access to target eNodeB it sends the message HO to E-UTRAN Complete.

6. When the UE has successfully accessed the target eNodeB, the target eNodeB informs the target MME by sending the message Handover Notify.

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 Forward Relocation Complete (ISR, Serving GW change) message. ISR indicates whether the target MME maintains ISR after the handover, which is only possible when the S-GW is not changed. The source SGSN will also acknowledge that information. A timer in source SGSN is started to supervise when resources in the in Source RNC and Source Serving GW (in case of Serving GW relocation) shall be released

8. The target MME will now complete the Inter-RAT Handover procedure by informing the Serving GW (for Serving GW relocation this will be the Target Serving GW) that the target MME is now responsible for all the bearers the UE have established. This is performed in the message Update Bearer Request (Cause, MME Tunnel Endpoint Identifier for Control Plane, EPS Bearer ID, MME Address for Control Plane, eNodeB Address(es) and TEID(s) for User Traffic for the accepted EPS bearers, PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic and RAT type).

    In case any EPS bearers are to be released the MME triggers the bearer release procedure as specified in clause 5.4.4.2.

9. The Serving GW (for Serving GW relocation this will be the Target Serving GW) may inform the PDN GW the change of for example for Serving GW relocation or 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. In the case of Serving GW relocation, the PDN GW updates its context field and returns an Update Bearer Response (PDN GW address and TEID, MSISDN, etc.) message to the Serving GW. The MSISDN is included if the PDN GW has it stored in its UE context.

    If PCC infrastructure is used, the PDN GW informs the PCRF about the change of, for example, the RAT type.

10. The Serving GW (for Serving GW relocation this will be the Target Serving GW) acknowledges the user plane switch to the target MME via the message Update Bearer Response (Cause, Serving GW Tunnel Endpoint Identifier for Control Plane, Serving GW Address for Control Plane, Protocol Configuration Options, PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic). At this stage the user plane path is established for all bearers between the UE, target eNodeB, Serving GW (for Serving GW relocation this will be the Target Serving GW) and PDN GW.

11. The eNodeB triggers the UE to initiate a Tracking Area Update procedure with the target MME informing it that the UE is located in a new tracking area. It is RAN functionality to provide the ECM-CONNECTED UE with the trigger information.

    The target MME knows that an IRAT Handover has been performed for this UE as it received the bearer context(s) by handover messages and therefore the target MME performs only a subset of the TA update procedure, specifically it excludes the context transfer procedures between source SGSN and target MME.

12. When the timer started in step 7 expires the source SGSN will clean-up all its resources towards source RNC by performing the Iu Release procedures. When there is no longer any need for the RNC to forward data, the source RNC responds with an Iu Release Complete message.

When the timer started in step 7 expires and if the source SGSN received the Serving GW change indication in the Forward Relocation Response message, it deletes the EPS bearer resources by sending Delete Bearer Request (Cause, TEID) messages to the Source Serving GW. Cause indicates to the old Serving GW that the Serving GW changes and the old Serving GW shall not initiate a delete procedure towards the PDN GW. The Source Serving GW acknowledges with Delete Bearer Response (TEID) messages. If ISR is established on the S-GW then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that CN node. If resources for indirect forwarding have been allocated then they are released.

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

5.5.2.3.1 General

The procedure is based on Packet-switched handover for GERAN A/Gb mode defined in TS 43.129 [8].

Pre-conditions:

- The UE is in ECM-CONNECTED state (E-UTRAN mode);

- The BSS must support PFM, Packet Flow Management, procedures.

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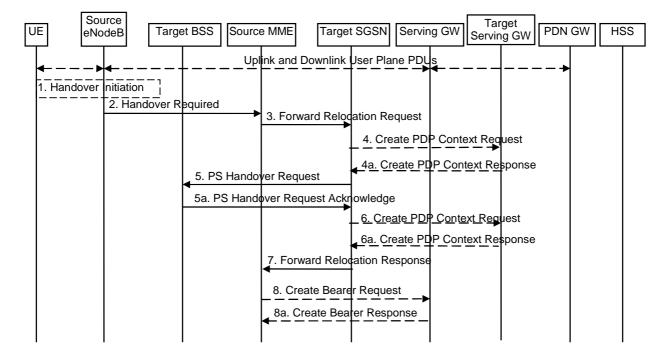
Figure 5.5.2.3.2-1: E-UTRAN to GERAN A/Gb Inter RAT HO, preparation phase

1. The source eNodeB decides to initiate an Inter RAT 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.

NOTE 1: The process leading to the handover decision is outside of the scope of this specification

2. The source eNodeB sends a Handover Required (Cause, Target System Identifier, Source eNodeB Identifier, Source to Target Transparent Container, Bearers Requesting Data Forwarding List) message to the Source MME to request the CN to establish resources in the Target BSS, Target SGSN and the Serving GW.

The 'Target System Identifier' IE contains the identity of the target global cell Id.

The 'Bearers Requesting Data Forwarding List' IE contains the list of bearers for which the source eNodeB decided that data forwarding (direct or indirect) is necessary.

3. The source MME maps the EPS bearers to PDP contexts 1-to-1 and maps the EPS QoS parameter values of an EPS bearer to the pre-Rel-8 QoS parameter values of a PDP context as defined in Annex E. The PDP Contexts shall be sent in a prioritized order, i.e. the most important PDP Context first. The prioritization method is implementation dependent, but should be based on the current activity.

NOTE 2: Assigning the highest priority to the PDP context without TFT could be done to get service continuity for all ongoing services regardless of the number of supported EPS bearers in the UE and network.

The Source MME determines from the 'Target System Identifier' IE that the type of handover is IRAT Handover to GERAN A/Gb mode. The Source MME initiates the Handover resource allocation procedure by sending a Forward Relocation Request (IMSI, Target Identification (shall be set to "empty"), MM Context, PDP Context, MME Tunnel Endpoint Identifier for Control Plane, MME Address for Control plane, Source to Target Transparent Container, Packet Flow ID , XID parameters (if available), Target Cell Identification, Direct Forwarding Flag) message to the target SGSN. When ISR is activated the message should be sent to the SGSN that maintains ISR for the UE when this SGSN is serving the target identified by the Target Identification. This message includes all PDP contexts corresponding to the bearers established in the source system and the uplink Tunnel endpoint parameters of the Serving GW. If the Source MME supports IRAT Handover to GERAN A/Gb procedure it has to allocate a valid PFI during the bearer activation procedure.

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

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

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

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

Editor's note: It is FFS how the mapping of individual parameters and bearer identifiers is done. It is FFS how the bearer identifiers are mapped.

When the target SGSN receives the Forward Relocation Request message the required PDP, MM, SNDCP and LLC contexts are established and a new P-TMSI is allocated for the UE. When this message is received by the target SGSN, it begins the process of establishing PFCs for all PDP contexts.

When the target SGSN receives the Forward Relocation Request message it extracts from the PDP Contexts the NSAPIs and SAPIs and PFIs to be used in the target SGSN. If for a given PDP Context the target SGSN does not receive a PFI from the source MME, it shall not request the target BSS to allocate TBF resources corresponding to that PDP Context. If none of the PDP Contexts forwarded from the source MME has a valid PFI allocated the target SGSN shall consider this as a failure case and the request for Handover shall be rejected.

If when an SAPI and PFI was available at the source MME but the target SGSN does not support the same SAPI and PFI for a certain NSAPI as the source MME, the target SGSN shall continue the Handover procedure only for those NSAPIs for which it can support the same PFI and SAPI as the source MME. All PDP contexts for which no resources are allocated by the target SGSN or for which it cannot support the same SAPI and PFI (i.e. the corresponding NSAPIs are not addressed in the response message of the target SGSN), are maintained and the related SAPIs and PFIs are kept. These PDP contexts may be modified or deactivated by the target SGSN via explicit SM procedures upon RAU procedure.

The source MME shall indicate the current XID parameter settings if available (i.e. those XID parameters received during a previous IRAT Handover procedure) to the target SGSN. If the target SGSN can accept all XID parameters as indicated by the source MME, the target SGSN shall create a NAS container for Handover indicating 'Reset to the old XID parameters'. Otherwise, if the target SGSN cannot accept all XID parameters indicated by the source MME or if no XID parameters were indicated by the source MME, the target SGSN shall create a NAS container for Handover indicating Reset (i.e. reset to default parameters).

4. The target SGSN determines if the Serving GW is relocated, e.g., due to PLMN change. If the Serving GW is relocated, the target SGSN selects the target Serving GW as described under clause 4.3.8.2 on "Serving GW selection function", and sends a Create PDP Context Request message (IMSI, SGSN Tunnel Endpoint Identifier for Control Plane, SGSN Address for Control plane, PDN GW address(es) for user plane, PDN GW UL TEID(s)

for user plane, PDN GW address(es) for control plane, and PDN GW TEID(s) for control plane, the Protocol Type over S5/S8) to the target Serving GW. The Protocol Type over S5/S8 is provided to Serving GW which protocol should be used over S5/S8 interface.

4a. The target Serving GW allocates its local resources and returns a Create PDP Context Response (Serving GW address(es) for user plane, Serving GW UL TEID(s) for user plane, Serving GW Address for control plane, Serving GW TEID for control plane) message to the target SGSN.

5. The target SGSN establishes the PDP context(s) in the indicated order. The SGSN deactivates the PDP contexts which cannot be established.

   The Target SGSN requests the Target BSS to establish the necessary resources (PFCs) by sending the message PS Handover Request (Local TLLI, IMSI, Cause, Target Cell Identifier, PFCs to be set-up list, Source to Target Transparent Container and NAS container for handover). The target SGSN shall not request resources for which the Activity Status Indicator within a PDP Context indicates that no active bearer exists on the source side for that PDP context.

   Based upon the ABQP for each PFC the target BSS makes a decision about which PFCs to assign radio resources. The algorithm by which the BSS decides which PFCs that need resources is implementation specific. Due to resource limitations not all downloaded PFCs will necessarily receive resource allocation. The target BSS allocates TBFs for each PFC that it can accommodate.

   The target BSS shall prepare the 'Target to Source Transparent Container' which contains a PS Handover Command including the EPC part (NAS container for Handover) and the RN part (Handover Radio Resources).

5a. The Target BSS allocates the requested resources and returns the applicable parameters to the Target SGSN in the message PS Handover Request Acknowledge (Local TLLI, List of set-up PFCs, Target to Source Transparent Container). Upon sending the PS Handover Request Acknowledge message the target BSS shall be prepared to receive downlink LLC PDUs from the target SGSN for the accepted PFCs.

   Any PDP contexts for which a PFC was not established are maintained in the target SGSN and the related SAPIs and PFIs are kept. These PDP contexts may be modified or deactivated by the target SGSN via explicit SM procedures upon the completion of the routing area update (RAU) procedure.

6. If indirect forwarding and relocation of Serving GW applies the target SGSN sends a Create PDP Context Request message (IMSI, SGSN Tunnel Endpoint Identifier for Control Plane, SGSN Address for Control plane, Target SGSN Address(es) and TEID(s) for DL user plane) to the target Serving GW.

6a. The target Serving GW returns a Create PDP Context Response (Cause, Serving GW DL TEID(s)) message to the target SGSN.

7. The Target SGSN sends the message Forward Relocation Response (Cause, SGSN Tunnel Endpoint Identifier for Control Plane, SGSN Address for Control Plane, Target to Source Transparent Container (in the 'BSS Container' IE), BSSGP Cause, List of set-up PFIs, Address(es) and TEID(s) for User Traffic Data Forwarding, Serving GW change indication) to the Source MME. Serving GW change indication indicates a new Serving GW has been selected.

   If 'Direct Forwarding' is applicable, then the IEs 'Address(es) and TEID(s) for User Traffic Data Forwarding' contains the DL GTP-U tunnel endpoint parameters to the Target SGSN. Otherwise the IEs 'Address(es) and TEID(s) for User Traffic Data Forwarding' contains the DL GTP-U tunnel endpoint parameters to the Target SGSN or to the Target Serving GW in case of Serving GW re-location.
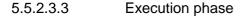
   The target SGSN activates the allocated LLC/SNDCP engines as specified in TS 44.064 [23] for an SGSN originated Reset or 'Reset to the old XID parameters'.

8. If "Direct Forwarding" is not applicable, the Source MME sends the message Create Bearer Request (Cause, Address(es) and TEID(s) for Data Forwarding (see step 7), NSAPI(s)) to the Serving GW used for indirect packet forwarding. The Cause indicates that the bearer(s) are subject to data forwarding.

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

8a. The Serving GW returns the forwarding user plane parameters by sending the message Create Bearer Response (Cause, Serving GW Address(es) and TEID(s) for Data Forwarding). If the Serving GW doesn't support data

forwarding, an appropriate cause value shall be returned and the Serving GW Address(es) and TEID(s) will not be included in the message.

5.5.2.3.3 Execution phase

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

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) and (B) are defined in TS 23.402 [2]. Step (B) shows PCRF interaction in the case of PMIP-based S5/S8. Steps 10 and 10a concern GTP based S5/S8

The source eNodeB continues to receive downlink and uplinkuser plane PDUs.

1. The Source MME completes the preparation phase towards Source eNodeB by sending the message Handover Command (Target to Source Transparent Container (PS Handover Command with RN part and EPC part), Bearers Subject to Data Forwarding List). The "Bearers Subject to Data forwarding list" may be included in the message and it shall be a list of 'Address(es) and TEID(s) for user traffic data forwarding' received from target side in the preparation phase (Forward Relocation Response message (Step 7) in case of Direct Forwarding, else parameters received in Step 8a).

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

2. The Source eNodeB will give a command to the UE to handover to the Target Access System via the message HO from E-UTRAN Command. This message includes a transparent container including radio aspect parameters that the Target BSS has set-up in the preparation phase (RN part). This message also includes the XID and IOV-UI parameters received from the Target SGSN (EPC part).

    Upon the reception of the HO from E-UTRAN Command message containing the Handover Command message, the UE shall associate its bearer IDs to the respective PFIs based on the relation with the NSAPI and shall suspend the uplink transmission of the user plane data.

3. The Source eNodeB may inform the Source MME which then informs the Target SGSN regarding "delivery order" parameters in the message Forward SRNS Context.

    The need for step 3 is FFS.

4. The UE moves to the Target GERAN A/Gb (2G) system and performs executes the handover according to the parameters provided in the message delivered in step 2. The procedure is the same as in step 6 in subclause 5.3.2.2 in TS 43.129 [8] with the additional function of association of the received PFI and existing Bearer Id related to the particular NSAPI.

5. After accessing the cell using access bursts and receiving timing advance information from the BSS in step 4, the UE processes the NAS container and then sends one XID response message to the target SGSN via target BSS. The UE sends this message immediately after receiving the Packet Physical Information message containing the timing advance or, in the synchronised network case, immediately if the PS Handover Access message is not required to be sent.

    Upon sending the XID Response message, the UE shall resume the user data transfer only for those NSAPIs for which there are radio resources allocated in the target cell. For NSAPIs using LLC ADM, for which radio resources were not allocated in the target cell, the MS may request for radio resources using the legacy procedures.

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

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

6. Upon reception of the first correct RLC/MAC block (sent in normal burst format) from the UE to the Target BSS, the Target BSS informs the Target SGSN by sending the message PS Handover Complete (IMSI, and Local TLLI).

7. The Target BSS also relays the message XID Response to the Target SGSN. Note, the message in step 6 and 7 may arrive in any order in the Target SGSN.

8. Then the Target SGSN knows that the UE has arrived to the target side and Target SGSN informs the Source MME by sending the Forward Relocation Complete (ISR, Serving GW change) message. ISR indicates whether the target SGSN maintains ISR after the handover, which is only possible when the S-GW is not changed. The Source MME will also acknowledge that information. A timer in source MME is started to supervise when resources in Source eNodeB and Source Serving GW (in case of Serving GW relocation) shall be released.

9. The Target SGSN will now complete the Handover procedure by informing the Serving GW (for Serving GW relocation this will be the Target 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 PDP Context Request (Serving GW Tunnel Endpoint Identifier for Control Plane, NSAPI(s), SGSN Address for Control Plane, SGSN Address(es) and TEID(s) for User Traffic for the accepted EPS bearers, PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic and RAT type).

    In case any PDP contexts are to be released the SGSN triggers the PDP context deactivation procedure.

10. The Serving GW (for Serving GW relocation this will be the Target Serving GW) may inform the PDN GW the change of, for example, in case of Serving GW relocation or 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. In the case of Serving GW relocation, the PDN GW updates its context field and returns an Update Bearer Response (PDN GW address and TEID, MSISDN, etc.) message to the Serving GW. The MSISDN is included if the PDN GW has it stored in its UE context.

    If PCC infrastructure is used, the PDN GW informs the PCRF about the change of, for example, the RAT type.

11. The Serving GW (for Serving GW relocation this will be the Target Serving GW) acknowledges the user plane switch to the Target SGSN via the message Update PDP Context Response (Cause, Serving GW Tunnel Endpoint Identifier for Control Plane, Serving GW Address for Control Plane, Protocol Configuration Options, PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic). At this stage the user plane path is established for all PDP contexts between the UE, Target BSS, Target SGSN, Serving GW (for Serving GW relocation this will be the Target Serving GW) and PDN GW.

12. If the Target SGSN indicated XID Reset (i.e. reset to default XID parameters) in the NAS container included in the HO from E-UTRAN Command message, then on receipt of the PS Handover Complete the Target SGSN initiates an LLC/SNDCP XID negotiation for each LLC SAPI used in LLC ADM. In this case if the Target SGSN wants to use the default XID parameters, it shall send an empty XID Command. If the Target SGSN indicated 'Reset to the old XID parameters' in the NAS container, no further XID negotiation is required for LLC SAPIs used in LLC ADM only.

12a.   The Target SGSN (re-)establishes LLC ABM for the PDP contexts which use acknowledged information transfer. During the exchange of SABM and UA the SGSN shall perform LLC/SNDCP XID negotiation.

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

13. The RAN triggers the UE to initiate a Routeing Area Update procedure with the target SGSN. It is RAN functionality to provide the PMM-CONNECTED UE with the trigger information.

    The target SGSN knows that an IRAT Handover has been performed for this UE as it received the bearer context(s) by handover messages and therefore the target SGSN performs only a subset of the RAU procedure, specifically it excludes the context transfer procedures between source MME and target SGSN.

14. When the timer started at step 8 expires, the source MME sends a Release Resources message to the source eNodeB. The Source eNodeB releases its resources related to the UE.

When the timer started in step 8 expires and if the source MME received the Serving GW change indication in the Forward Relocation Response message, it deletes the EPS bearer resources by sending Delete Bearer Request (Cause, TEID) messages to the Source Serving GW. Cause indicates to the old Serving GW that the Serving GW changes and the old Serving GW shall not initiate a delete procedure towards the PDN GW. The Source Serving GW acknowledges with Delete Bearer Response (TEID) messages. If ISR is established on the S-GW then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that CN node. If resources for indirect forwarding have been allocated then they are released.

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

5.5.2.4.1   General

The procedure is based on Packet-switched handover for GERAN A/Gb mode, defined in TS 43.129 [8].

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
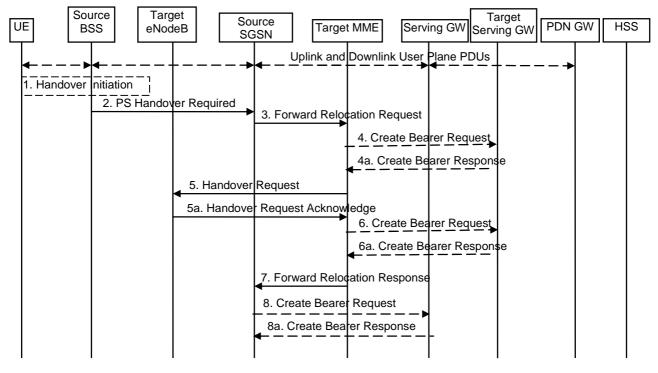
Figure 5.5.2.4.2-1: GERAN A/Gb mode to E-UTRAN inter RAT HO, preparation phase

1. The source access system, Source BSS, decides to initiate an Inter-RAT 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.

NOTE 1: The process leading to the handover decision is outside of the scope of this specification.

2. The source BSS sends the message PS handover Required (TLLI, Cause, Source Cell Identifier, Target eNodeB Identifier, Source to Target Transparent Container (RN part), and active PFCs list) to Source SGSN to request the CN to establish resources in the Target eNodeB, Target MME and the Serving GW.

3. The Source SGSN determines from the 'Target eNodeB Identifier' IE that the type of handover is IRAT PS Handover to E-UTRAN. The Source SGSN initiates the Handover resource allocation procedure by sending message Forward Relocation Request (IMSI, Target Identification, MM Context, PDP Context, SGSN Tunnel Endpoint Identifier for Control Plane, SGSN Address for Control plane, Source to Target Transparent Container (RN part), Packet Flow ID, SNDCP XID parameters, LLC XID parameters, and Direct Forwarding Flag) to the target MME. When ISR is activated the message should be sent to the MME that maintains ISR for the UE when this MME is serving the target identified by the Target Identification. This message includes all PDP contexts that are established in the source system indicating the PFIs and the XID parameters related to those PDP Contexts, and the uplink Tunnel endpoint parameters of the Serving GW.

    The PDP Contexts shall be sent in a prioritized order, i.e. the most important PDP Context first. The prioritization method is implementation dependent, but should be based on the current activity.

NOTE 2: Assigning the highest priority to the PDP context without TFT could be done to get service continuity for all ongoing services regardless of the number of supported EPS bearers in the UE and network.

    The 'Direct Forwarding Flag' IE indicates if Direct Forwarding of data to Target side shall be used or not. This flag is set by the source SGSN. The target MME maps the PDP contexts to the EPS bearers 1-to-1 and maps the pre-Rel-8 QoS parameter values of a PDP context to the EPS QoS parameter values of an EPS bearer as defined in Annex E. The MME establishes the EPS bearer(s) in the indicated order. The MME deactivates the EPS bearers which cannot be established.

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

For the PDP Context with traffic class equals 'Background', the source SGSN shall indicate via the Activity Status Indicator IE that EPS bearers shall be established on the target side.

4. The target MME determines if the Serving GW is relocated, e.g. due to PLMN change. If the Serving GW is relocated, the target MME selects the target Serving GW as described under clause 4.3.8.2 on "Serving GW selection function". The target MME sends a Create Bearer Request message (IMSI, MME Tunnel Endpoint Identifier for Control Plane, MME Address for Control plane, PDN GW address(es) for user plane, PDN GW UL TEID(s) for user plane, PDN GW address for control plane, and PDN GW TEID(s) for control plane, the Protocol Type over S5/S8) to the target Serving GW. The Protocol Type over S5/S8 is provided to Serving GW which protocol should be used over S5/S8 interface.

4a. The target Serving GW allocates its local resources and returns them in a Create Bearer Response (Serving GW address(es) for user plane, Serving GW UL TEID(s) for user plane, Serving GW Address for control plane, Serving GW TEID for control plane) message to the target MME.

5. The Target MME will request the Target eNodeB to establish the Bearer(s) by sending the message Handover Request (UE Identifier, Cause, 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). The Target MME shall not request resources for which the Activity Status Indicator within a PDP Context indicates that no active bearer exists on the source side for that PDP Context.

    For each EPS bearer requested to be established, 'EPS Bearers To Be Setup' IE shall contain information such as ID, bearer parameters, Transport Layer Address, and S1 Transport Association. The Transport Layer Address is the Serving GW Address for user data, and the S1 Transport Association corresponds to the uplink Tunnel Endpoint Identifier Data.

    The ciphering and integrity protection keys will be sent transparently from the target eNodeB to the UE in the Target to Source Transparent Container, and in the message PS Handover Command from source BSS to the UE. This will then allow data transfer to continue in the new RAT/mode target cell without requiring a new AKA (Authentication and Key Agreement) procedure.

5a. The Target eNodeB allocates the request resources and returns the applicable parameters to the Target MME in the message Handover Request Acknowledge (Target to Source Transparent Container, EPS Bearers setup list, EPS Bearers failed to setup list). Upon sending the Handover Request Acknowledge message the target eNodeB shall be prepared to receive downlink GTP PDUs from the Serving GW for the accepted EPS bearers.

6. If indirect forwarding and relocation of Serving GW applies, the target MME sends a Create Bearer Request message (IMSI, MME Tunnel Endpoint Identifier for Control Plane, MME Address for Control plane, Target eNodeB Address(es), TEID(s) for DL user plane) to the target Serving GW.

6a. The target Serving GW returns a Create Bearer Response (Cause, Serving GW DL TEID(s)) message to the target MME.

7. The Target MME sends the message Forward Relocation Response (Cause, List of Set Up PFCs, MME Tunnel Endpoint Identifier for Control Plane, S1-AP cause, MME Address for control plane, Target to Source Transparent Container, Address(es) and TEID(s) for Data Forwarding, Serving GW change indication) to the Source SGSN. Serving GW change indication indicates a new Serving GW has been selected.

    If 'Direct Forwarding' is applicable, then the IEs 'Address(es) and TEID(s) for Data Forwarding' contains the DL GTP-U tunnel endpoint parameters to the eNodeB. Otherwise the IEs 'Address(es) and TEID(s) for Data Forwarding' contains the DL GTP-U tunnel endpoint parameters to the Target eNodeB or to the Target Serving GW in case of Serving GW re-location.

8. If "Direct Forwarding" is not applicable, the source SGSN shall send the message Create Bearer Request (Cause, Address(es) and TEID(s) for Data Forwarding (see step 7), NSAPI(s)) to the Serving GW used for indirect packet forwarding. The Cause shall indicate that the Bearer is subject to data forwarding.

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

8a. The Serving GW returns the forwarding user plane parameters by sending the message Create Bearer Response (Cause, Serving GW Address(es) and TEID(s) for Data Forwarding). If the Serving GW doesn't support data forwarding, an appropriate cause value shall be returned and the Serving GW Address(es) and TEID(s) will not be included in the message.

5.5.2.4.3 Execution phase

Figure 5.5.2.4.3-1: GERAN A/Gb mode to E-UTRAN Inter RAT HO, execution phase

NOTE: For a PMIP-based S5/S8, procedure steps (A) are defined in TS 23.402 [2]. Steps 9 and 9a concern GTP based S5/S8.

The source SGSN continues to receive downlink and uplink user plane PDUs.

When source SGSN receives the Forward Relocation Response message it may start downlink N-PDU relay and duplication to the target eNodeB (in case of Direct Forwarding) or via the Serving GW (in case Indirect Forwarding), and the target eNodeB may start blind transmission of downlink user data towards the UE over the allocated radio channels.

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.

Before sending the PS Handover Required Acknowledge message, the source SGSN may suspend downlink data transfer for any PDP contexts.

Before sending the PS Handover Command message to the UE the source BSS, may try to empty the downlink BSS buffer for any BSS PFCs.

2. The Source BSS will command the UE to handover to the target eNodeB via the message PS Handover Command. 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.

3. Source SGSN informs the Target MME/Target eNodeB 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 Handover Notify.

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 Forward Relocation Complete (ISR, Serving GW change) message. ISR indicates whether the target MME maintains ISR after the handover, which is only possible when the S-GW is not changed. The Source SGSN will also acknowledge that information. When the Forward Relocation Complete message has been received and there is no longer any need for the SGSN to forward data, the SGSN stops data forwarding. A timer in source SGSN is started to supervise when resources in the Source Serving GW (in case of Serving GW relocation) shall be released.

8. The Target MME will now complete the Handover procedure by informing the Serving GW (for Serving GW relocation this will be the Target Serving GW) that the Target MME is now responsible for all the EPS bearers the UE have established. This is performed in the message Update Bearer Request (Cause, MME Tunnel Endpoint Identifier for Control Plane, EPS Bearer ID(s), MME Address for Control Plane, eNodeB Address(es) and TEID(s) for User Traffic for the accepted EPS bearers, PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic and RAT type).

   In case any EPS bearers are to be released the MME triggers the bearer release procedure as specified in clause 5.4.4.2.

9. The Serving GW (for Serving GW relocation this will be the Target Serving GW) informs the PDN GW(s) the change of, for example, for Serving GW relocation or 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.

   If PCC infrastructure is used, the PDN GW informs the PCRF about the change of, for example, the RAT type.

10. The Serving GW (for Serving GW relocation this will be the Target Serving GW) acknowledges the user plane switch to the Target MME via the message Update Bearer Response (Cause, Serving GW Tunnel Endpoint Identifier for Control Plane, Serving GW (for Serving GW relocation this will be the Target Serving GW) Address for Control Plane, Protocol Configuration Options, PDN GW addresses and TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) at the PDN GW(s) for uplink traffic). At this stage the user plane path is established for all bearers between the UE, Target eNodeB, Serving GW (for Serving GW relocation this will be the Target Serving GW) and PDN GW.

11. When the timer started in step 7 expires the Source SGSN will clean-up all its resources towards Source BSS by performing the BSS Packet Flow Delete procedure.

12. The RAN triggers the UE to initiate a Tracking Area Update procedure with the target MME. It is RAN functionality to provide the ECM-CONNECTED UE with the trigger information.

    The target MME knows that an IRAT Handover has been performed for this UE as it received the bearer context(s) by handover messages and therefore the target MME performs only a subset of the TA update procedure, specifically it excludes the context transfer procedures between source SGSN and target MME.

13. When the timer started in step 7 expires and if the source SGSN received the Serving GW change indication in the Forward Relocation Response message, it deletes the EPS bearer resources by sending Delete Bearer Request (Cause, TEID) messages to the Source Serving GW. Cause indicates to the old Serving GW that the Serving GW changes and the old Serving GW shall not initiate a delete procedure towards the PDN GW. The Source Serving GW acknowledges with Delete Bearer Response (TEID) messages. If ISR is established on the S-GW then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that CN node. If resources for indirect forwarding have been allocated then they are released.

5.6 Network Assisted Cell Change

Network Assisted Cell Change (NACC) is a means that enables better performance for packet data services upon inter-cell change for those networks that do not support PS Handover. It reduces the service interruption time for UEs in active mode upon cell change by providing in the source cell, prior to the cell change, system information of a target cell allowing packet access.

Within the scope of this specification, NACC is applicable for inter-RAT cell changes from a source E-UTRAN cell towards a target GERAN cell.

5.6.1 Architecture Principles for E-UTRAN to GERAN NACC

Introducing NACC from E-UTRAN to GERAN follows the principles of the Network Assisted Cell Change between UTRAN and GERAN as described in TS 25.413 [22] and TS 23.060 [7]. It comprises the specification of the E-UTRAN GERAN RAN Information Management (RIM) procedures in E-UTRAN and GERAN CN and RAN nodes as depicted in figure 5.6-1.
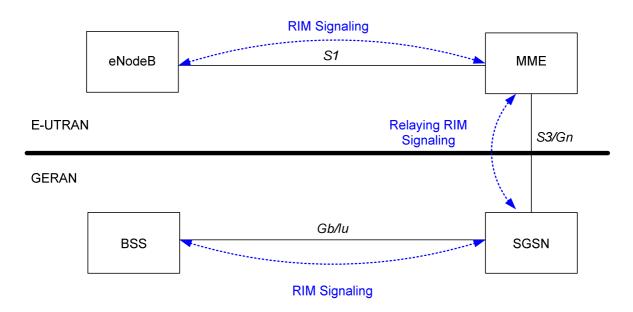
Figure 5.6-1: E-UTRAN to GERAN NACC basic network architecture

The support for the NACC from E-UTRAN to GERAN has the following impacts on E-UTRAN / GERAN architecture:

- Affected nodes: BSC,eNB, MME, SGSN;

- Affected network interfaces: Gb, Iu, S3, Gn, S1;

- Affected radio interfaces: Um and Uu.

5.6.2 RAN Information Management (RIM) procedures

5.6.2.1 General

The RAN Information Management (RIM) procedures provide a generic mechanism for the exchange of arbitrary information between applications belonging to the RAN nodes. The RAN information is transferred via the MME and SGSN core network node(s). In order to make the RAN information transparent for the Core Network, the RAN information is included in a RIM container that shall not be interpreted by the Core Network nodes.

The RIM procedures are optional both in the RAN and the CN nodes. For the Gb interface the use of RIM procedures is negotiated at start/restart of the Gb link. For the Iu interface there is no negotiation of using RIM procedures or not at Iu link start/restart.

The RAN information is transferred in RIM containers from the source RAN node to the destination RAN node by use of messages. Each message carrying the RIM container is routed and relayed independently by the core network node(s). Any relation between messages is transparent for the MME/SGSN, i.e. a request/response exchange between RIM applications, for example, is routed and relayed as two independent messages by the MME/SGSN.

The interfaces which will be used are the Gb, the Iu, the S1, Gn and the S3 interfaces. The RAN information in the RIM container shall be transparent for the Core Network. An MME or SGSN supporting the RIM procedures provides addressing, routeing and relaying functions.

5.6.2.2 Addressing, routeing and relaying

5.6.2.2.1 Addressing

All the messages used for the exchange of RAN information contain the addresses of the source and destination RAN nodes. A BSS is addressed by Routeing Area Identity (RAI) + Cell Identity (CI) of one of its cells. An eNodeB is addressed by the Target eNodeB Identifier.

5.6.2.2.2 Routeing

The following description applies to all the messages used for the exchange of RAN information.

The source RAN node sends a message to its MME or SGSN including the source and destination addresses. The SGSN/MME uses the destination address to route the message encapsulated in a GTP message to the correct MME/SGSN via the S3 or Gn interface.

The MME/SGSN connected to the destination RAN node decides which RAN node to send the message to based on the destination address.

5.6.2.2.3 Relaying

The SGSN performs relaying between BSSGP messages, RANAP messages and GTP messages as described in TS 48.018 [42], TS 25.413 [22], TS 29.060 [14] and TS 29.274 [43]. The MME performs relaying between S1 and S3/Gn messages as described in TS 36.413 [36] and TS 29.274 [43] / TS 29.060 [14].

5.6.2.3 Applications using the RIM Procedures

The RAN node applications, which use the RIM procedures, are fully transparent for the MME and SGSN. These applications are described in RAN specifications. An example is the Network Assisted Cell Change described in TS 48.018 [42], TS 25.413 [22] and TS 36.413 [36].

5.7 Information storage

This clause describes information storage structures required for the EPS when 3GPP access only is deployed. Information storage for the case where non 3GPP accesses are deployed is in TS 23.402 [2]

5.7.1 HSS

IMSI is the prime key to the data stored in the HSS. The data held in the HSS is defined in Table 5.7.1-1 here below.

The table below is applicable to E-UTRAN in standalone operation only.

Table 5.7.1-1: HSS data

Field	Description	Status
IMSI	IMSI is the main reference key.	
MSISDN	The basic MSISDN of the UE (Presence of MSISDN is optional).	
IMEI / IMEISV	International Mobile Equipment Identity - Software Version Number	
MME Address	The IP address of the MME currently serving this MS.	
MS PS Purged from EPS	Indicates that the EMM and ESM contexts of the UE are deleted from the MME.	
ODB parameters	Indicates that the status of the operator determined barring	
Access Restriction	Indicates the access restriction subscription information.	FFS
Subscribed-UE-AMBR	The Maximum Aggregated MBR to be provided across all Non-GBR bearers according to the subscription of the user.	
APN-OI Replacement	Indicates the domain name to replace the APN OI when constructing the PDN GW FQDN upon which to perform a DNS resolution. This replacement applies for all the APNs in the subscriber's profile.	
Each subscription profile contains one or more PDN subscription contexts:		
Context Identifier	Index of the PDN subscription context.	
PDN Address	Indicates subscribed IP address(es).	
Access Point Name (APN)	A label according to DNS naming conventions describing the access point to the packet data network.	
EPS subscribed QoS profile	The bearer level QoS parameter values for that APN's default bearer (QCI and ARP) and APN-AMBR (see clause 4.7.3).	
VPLMN Address Allowed	Specifies whether for this APN the UE is allowed to use the PDN GW in the domain of the HPLMN only, or additionally the PDN GW in the domain of the VPLMN.	
PDN GW identity	The identity of the PDN GW used for this APN. The PDN GW identity may be an FQDN, an IP address, or both. The PDN GW identity refers to a specific PDN GW.	
PDN GW Allocation Type	Indicates whether the PDN GW is statically allocated or dynamically selected by other nodes. A statically allocated PDN GW is not changed during PDN GW selection.	

NOTE 1: IMEI and SVN are stored in HSS when the Automatic Device Detection feature is supported, see subclause 15.5 of TS 23.060 [7].

NOTE 2: The 'EPS subscribed QoS profile' stored in HSS is complementary to the legacy 'GPRS subscribed QoS profile'.

NOTE 3: In order to avoid impacts on the current GPRS roaming environment (including that used on the GRX network), such format as "*.mnc<MNC>.mcc<MCC>.gprs" for the value of APN-OI Replacement is be required.

Editor's note: The "Status" columns will be removed when the FFS's are resolved.

Editor's note: How to store the information that a PDN subscription context is the default one is FFS.

5.7.2 MME

The MME maintains MM context and EPS bearer context information for UEs in the ECM-IDLE, ECM-CONNECTED and EMM-DEREGISTERED states. Table 5.7.2-1 shows the context fields for one UE.

Table 5.7.2-1: MME MM and EPS bearer Contexts

Field	Description	Status
IMSI	IMSI (International Mobile Subscriber Identity) is the subscribers permanent identity.	
MSISDN	The basic MSISDN of the UE. The presence is dictated by its storage in the HSS.	
MM State	Mobility management state ECM-IDLE, ECM-CONNECTED, EMM-DEREGISTERED.	
GUTI	Globally Unique Temporary Identity.	
ME Identity	Mobile Equipment Identity – (e.g. IMEI/IMEISV) Software Version Number	
Tracking Area List	Current Tracking area list	
Cell Global Identity	Last known cell	
Cell Identity Age	Time elapsed since the last Cell Global Identity was acquired	
Authentication Vector	Temporary authentication and key agreement data that enables an MME to engage in AKA with a particular user. An EPS Authentication Vector consists of four elements: a) network challenge RAND, b) an expected response XRES, c) Key K_{ASME}, d) a network authentication token AUTN.	
UE Radio Access Capability	UE radio access capabilities.	
UE Network Capability	UE network capabilities including security algorithms and key derivation functions supported by the UE	
Selected NAS Algorithm	Selected NAS security algorithm	
Selected AS Algorithm	Selected AS security algorithms.	
KSI_{ASME}	Key Set Identifier for the main key K_{ASME}	
K_{ASME}	Main key for E-UTRAN key hierarchy based on CK, IK and Serving network identity	
NAS Keys and COUNT	K_{NASint}, $K_{\_NASenc}$, and NAS COUNT parameter.	
Selected CN operator id	Selected core network operator identity (to support network sharing as defined in TS 23.251 [24]).	
Recovery	Indicates if the HSS is performing database recovery.	
Access Restriction	The access restriction subscription information.	
ODB for PS parameters	Indicates that the status of the operator determined barring for packet oriented services.	
MME IP address for S11	MME IP address for the S11 interface (used by S-GW)	
MME TEID for S11	MME Tunnel Endpoint Identifier for S11 interface.	
S-GW IP address for S11	S-GW IP address for the S11 interface (used by MME)	
S-GW TEID for S11	S-GW Tunnel Endpoint Identifier for the S11 interface.	
eNodeB Address in Use	The IP address of the eNodeB currently used.	
eNB UE S1AP ID	Unique identity of the UE over the S1 interface within eNodeB.	
MME UE S1AP ID	Unique identity of the UE over the S1 interface within MME.	
APN Restriction	Denotes the restriction on the combination of types of APN for the APN associated with this EPS bearer Context.	FFS
Subscribed Charging Characteristics	e.g. Normal, prepaid, flat rate and/or hot billing.	
For each active PDN connection:		
APN in Use	The APN currently used. This APN shall be composed of the APN Network Identifier and the APN Operator Identifier.	
APN Subscribed	The subscribed APN received from the HSS.	
IP Address(es)	IPv4 and/or IPv6 address(es)	FFS if these are stored.
VPLMN Address Allowed	Specifies whether the UE is allowed to use the APN in the domain of the HPLMN only, or additionally the APN in the domain of the VPLMN.	
PDN GW Address in Use (control plane)	The IP address of the PDN GW currently used for sending control plane signalling.	
Location Change Report Required	Need to communicate Cell or TAI to the PDN GW with this EPS bearer Context.	
EPS subscribed QoS profile	The bearer level QoS parameter values for that APN's default bearer (QCI and ARP) and that APN's AMBR (see clause 4.7.3).	
PDN GW GRE Key for uplink traffic (user plane)	PDN GW assigned GRE Key for the S5/S8 interface for the user plane for uplink traffic. (For PMIP-based S5/S8 only)	

Field	Description	Status
For each EPS Bearer within the PDN connection		
EPS Bearer ID	An EPS bearer identity uniquely identifies an EP S bearer for one UE accessing via E-UTRAN	
IP address for S1-u	IP address of the S-GW for the S1-u interfaces.	
TEID for S1u	Tunnel Endpoint Identifier of the S-GW for the S1-u interface.	
EPS bearer QoS parameters	QCI and ARP optionally: GBR and MBR in case of GBR bearer	
EPS Bearer Charging Characteristics	e.g. Normal, prepaid, flat-rate and/or hot billing.	
Charging Id	Charging identifier, identifies charging records generated by SGW and PDN GW.	<mark>FFS</mark>
DL TFT	Downlink Traffic Flow Template. (For PMIP-based S5/S8 only)	
UL TFT	Uplink Traffic Flow Template. (For PMIP-based S5/S8 only)	

Editor's note: The"Status" columns will be removed when the FFS's are resolved.

Editor's note: FFS how detached state security context caching is handled in E-UTRAN.

5.7.3 Serving GW

The Serving GW maintains the following EPS bearer context information for UEs. Table 5.7.3-1 shows the context fields for one UE.

Table 5.7.3-1: SGW EPS bearer context

Field	Description	E-UTRAN	UTRAN/ GERAN
IMSI	IMSI (International Mobile Subscriber Identity) is the subscriber permanent identity.	X	X
MSISDN	The basic MSISDN of the UE. The presence is dictated by its storage in the HSS.	X	X
Selected CN operator id	Selected core network operator identity (to support network sharing as defined in TS 23.251 [24]).	X	X
MME TEID for S11	MME Tunnel Endpoint Identifier for the S11 interface	X	
MME IP address for S11	MME IP address the S11 interface.	X	
SGW TEID for S11/S4 (control plane)	SGW Tunnel Endpoint Identifier for the S11 Interface and the S4 Interface (control plane).	X	X
SGW IP address for S11/S4 (control plane)	SGW IP address for the S11 interface and the S4 Interface (control plane).	X	X
SGSN IP address for S4 (control plane)	SGSN IP address for the S4 interface (Used by the S-GW).		X
SGSN TEID for S4 (control plane)	SGSN Tunnel Endpoint Identifier for the S4 interface.		X
Trace reference	Identifies a record or a collection of records for a particular trace.	X	X
Trace type	Indicates the type of trace	X	X
Trigger id	Identifies the entity that initiated the trace	X	X
OMC identity	Identifies the OMC that shall receive the trace record(s).	X	X
For each PDN Connection:			
NOTE: The following entries are repeated for each PDN.			
APN in Use	The APN currently used. This APN shall be composed of the APN Network Identifier and the APN Operator Identifier.	X	X
P-GW Address in Use (control plane)	The IP address of the P-GW currently used for sending control plane signalling.	X	X
P-GW TEID for S5/S8 (control plane)	P-GW Tunnel Endpoint Identifier for the S5/S8 interface for the control plane.	X	X
S-GW IP address for S5/S8 (control plane)	S-GW IP address for the S5/S8 for the control plane signalling.	X	X
S-GW TEID for S5/S8 (control plane)	S-GW Tunnel Endpoint Identifier for the S5/S8 control plane interface.	X	X
APN Restriction	Denotes the restriction on the combination of types of APN for the APN associated with this EPS bearer Context.	X	X
For each EPS Bearer within the PDN Connection:			
NOTE: The following entries defining the EPS Bearer specific parameters are included within the set of parameters defining the PDN Connection.			
EPS Bearer Id	An EPS bearer identity uniquely identifies an EPS bearer for one UE accessing via E-UTRAN	X	X
UL TFT	Uplink Traffic Flow Template	X	X
DL TFT	Downlink Traffic Flow Template	X	X
P-GW Address in Use (user plane)	The IP address of the P-GW currently used for sending user plane traffic.	X	X
P-GW TEID for S5/S8 (user plane)	P-GW Tunnel Endpoint Identifier for the S5/S8 interface for the user plane.	X	X
S-GW IP address for S5/S8 (user plane)	S-GW IP address for user plane data received from PDN GW.	X	X
S-GW TEID for S5/S8 (user plane)	S-GW Tunnel Endpoint Identifier for the GTP Based S5/S8 interface for user plane.	X	X
S-GW IP address for S1-u	S-GW IP address for the S1-u interface (Used by the eNodeB)	X	
S-GW TEID for S1-u	S-GW Tunnel Endpoint Identifier for the S1-u interface.	X	
eNodeB IP address for S1-u	eNodeB IP address for the S1-u interface (Used by the S-GW).	X	
eNodeB TEID for S1-u	eNodeB Tunnel Endpoint Identifier for the S1-u interface.	X	
S-GW IP address for S12	S-GW IP address for the S12 interface (Used by the RNC)		X
S-GW TEID for S12	S-GW Tunnel Endpoint Identifier for the S12 interface.		X
RNC IP address for S12	RNC IP address for the S12 interface (Used by the S-GW).		X
RNC TEID for S12	RNC Tunnel Endpoint Identifier for the S12 interface.		X
S-GW IP address for S4 (user plane)	S-GW IP address for the S4 interface (Used by the SGSN)		X
S-GW TEID for S4 (user plane)	S-GW Tunnel Endpoint Identifier for the S4 interface.		X
SGSN IP address for S4	SGSN IP address for the S4 interface (Used by the S-GW).		X

Field	Description	E-UTRAN	UTRAN/ GERAN
(user plane) SGSN TEID for S4 (user plane)	SGSN Tunnel Endpoint Identifier for the S4 interface.		X
EPS Bearer QoS Profile	ARP, GBR, MBR, QCI.	X	X
Charging Id	Charging identifier, identifies charging records generated by S-GW and PDN GW.	X	X
Charging Characteristics	Normal, prepaid, flat rate and/or hot billing	X	X

Editor's note: The table needs to be reviewed to identify differences for PMIP based S5/S8.

5.7.4 PDN GW

The PDN GW maintains the following EPS bearer context information for UEs. Table 5.7.4-1 shows the context fields for one UE.

Table 5.7.4-1: PGW context

Field	Description	E-UTRAN	UTRAN/ GERAN
IMSI	IMSI (International Mobile Subscriber Identity) is the subscriber permanent identity.	X	X
MSISDN	The basic MSISDN of the UE. The presence is dictated by its storage in the HSS.	X	X
Selected CN operator id	Selected core network operator identity (to support network sharing as defined in TS 23.251 [24]).	X	X
RAT type	Current RAT	X	X
Trace reference	Identifies a record or a collection of records for a particular trace.	X	X
Trace type	Indicates the type of trace	X	X
Trigger id	Identifies the entity that initiated the trace	X	X
OMC identity	Identifies the OMC that shall receive the trace record(s).	X	X
For each APN in use:			
NOTE: The following entries are repeated for each APN.			
APN in use	The APN currently used. The APN shall be composed of the APN Network Identifier and the APN Operator Identifier.	X	X
APN-AMBR	The APN-AMBR for this APN.	X	X
For each PDN Connection within the APN:			
NOTE: The following entries are repeated for each PDN connection within the APN.			
IP Address(es)	IPv4 address and/or IPv6 address	X	X
PDN type	IPv4, IPv6, or IPv4v6	X	X
S-GW Address in Use (control plane)	The IP address of the S-GW currently used for sending control plane signalling.	X	X
S-GW TEID for S5/S8 (control plane)	S-GW Tunnel Endpoint Identifier for the S5/S8 interface for the control plane.	X	X
P-GW IP address for S5/S8 (control plane)	P-GW IP address for the S5/S8 for the control plane signalling.	X	X
P-GW TEID for S5/S8 (control plane)	P-GW Tunnel Endpoint Identifier for the S5/S8 control plane interface.	X	X
SGSN support for CGI/SAI/RAI change reporting	Indicated that the SGSN serving the UE supports procedures for reporting CGI/SAI/RAI changes (according to 23.060 [7] clause 15.1.1a).		X
CGI/SAI/RAI change report required	Denotes whether the SGSN is requested to send changes in CGI/SAI or RAI for this bearer		X
BCM	The negotiated Bearer Control Mode for GERAN/UTRAN.		X
For each EPS Bearer within the PDN Connection:			
NOTE: The following entries defining the EPS Bearer specific parameters are included within the set of parameters defining the PDN Connection.			
EPS Bearer Id	An EPS bearer identity uniquely identifies an EPS bearer for one UE accessing via E-UTRAN	X	X
UL TFT	Uplink Traffic Flow Template	X	X
DL TFT	Downlink Traffic Flow Template	X	X
S-GW Address in Use (user plane)	The IP address of the S-GW currently used for sending user plane traffic.	X	X
S-GW TEID for S5/S8 (user plane)	S-GW Tunnel Endpoint Identifier for the S5/S8 interface for the user plane.	X	X
P-GW IP address for S5/S8 (user plane)	P-GW IP address for user plane data received from PDN GW.	X	X
P-GW TEID for S5/S8 (user plane)	P-GW Tunnel Endpoint Identifier for the GTP Based S5/S8 interface for user plane.	X	X
EPS Bearer QoS Profile	ARP, GBR, MBR, QCI.	X	X
Charging Id	Charging identifier, identifies charging records generated by S-GW and PDN GW.	X	X
Charging Characteristics	Normal, prepaid, flat rate and/or hot billing	X	X

5.7.5   UE

The UE maintains the following context information. Table 5.7.5-1 shows the context fields. A GERAN or UTRAN capable UE maintains in addition the context information as described in a similar UE context table in TS 23.060 [7].

Table 5.7.5-1: UE context

Field	Description	Status
IMSI	IMSI (International Mobile Subscriber Identity) is the subscribers permanent identity.	
MSISDN	The basic MSISDN of the UE.	FFS
EMM State	Mobility management state EMM-REGISTERED, EMM-DEREGISTERED.	
GUTI	Globally Unique Temporary Identity.	
ME Identity	Mobile Equipment Identity – (e.g. IMEI/IMEISV) Software Version Number.	
Tracking Area List	Current Tracking area list.	
last visited TAI	A TAI which is contained in the TA list the UE registered to the network and which identifies the tracking area last visited by the UE.	
Selected NAS Algorithm	Selected NAS security algorithm.	
Selected AS Algorithm	Selected AS security algorithms.	
KSI_{ASME}	Key Set Identifier for the main key K_{ASME}.	
K_{ASME}	Main key for E-UTRAN key hierarchy based on CK, IK and Serving network identity.	
NAS Keys and COUNT	K_{NASint}, K_{NASenc}, and NAS COUNT parameter.	
Temporary Identity used in Next update (TIN)	This parameter is used internally by the UE to memorise which temporary ID it has to indicate in the next RAU/TAU (P-TMSI, GUTI or RAT-related TMSI, the latter means P-TMSI in RAU and GUTI in TAU).	
For each active PDN connection:		
APN in Use	The APN currently used. This APN shall be composed of the APN Network Identifier and the APN Operator Identifier.	
IP Address(es)	IPv4 and/or IPv6 address(es).	FFS if these are stored in MT.
For each EPS Bearer within the PDN connection		
EPS Bearer ID	An EPS bearer identity uniquely identifies an EPS bearer for one UE accessing via E-UTRAN.	
EPS bearer QoS parameters	GBR and MBR in case of GBR bearer.	
UL TFT	Uplink Traffic Flow Template.	

5.7a Charging

Accounting functionality is provided by the SGW and the PDN GW.

The Serving GW shall be able to collect for each UE accounting information, i.e. the amount of data transmitted in uplink and downlink direction categorized with the QCI and ARP pair per UE per PDN.

The PDN GW shall be able to provide charging functionality for each UE according to TS 23.203 [6].

A PDN GW without a Gx interface shall be able to support flow based online and offline charging based on local configuration and interaction with the Online and Offline Charging Systems.

Editor's note: It is FFS if the PDN GW in addition needs to receive charging characteristics from the Serving Gateway or another source.

5.8 MBMS

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

The Evolved MBMS supports two modes, MBMS Broadcast Mode and MBMS Enhanced Broadcast Mode as defined in TS 23.246 [13].

5.9 Interactions with other services

NOTE: Specific support for emergency access and location services are out of scope of this Release.

5.9.1 Location Reporting Procedure

This procedure is used by an MME to request the eNB to report where the UE is currently located. This procedure may be used for services that require accurate Cell ID (e.g. emergency calls, lawful intercept, charging).

The details of Location Service architecture and procedures for EPS are not descibed in this Realease.
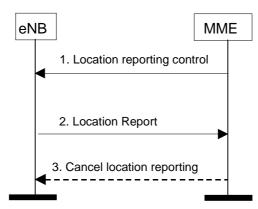
Figure 5.9.1-1: Location Reporting Procedure

1) The MME sends a Location Reporting Control message to the eNB. The Location Reporting Control message may contain information such as location information to be reported, reporting type, etc. Location information to be reported is Global Cell ID. Reporting Type indicates whether the message is intended to trigger a stand-alone report about the current Cell ID of the UE or start eNB report UE changed cell.

2) The eNB sends a Location Report message informing the MME about the location of the UE which shall include the requested location information, i.e. the Global Cell ID.

3) The MME can send a Cancel Location Reporting message to inform the eNB that it should terminate location reporting for a given UE. This message is needed only when the reporting was requested for a reporting period.

Editor's note: Location reporting procedure upon X2 handover and MME relocation is FFS.

Editor's note: The full usage of this procedure for chaging is FFS.

5.10 Multiple-PDN support

5.10.1 General

The EPS shall support simultaneous exchange of IP traffic to multiple PDNs through the use of separate PDN GWs or single PDN GW. The usage of multiple PDNs is controlled by network policies and defined in the user subscription.

The EPS shall support UE-initiated connectivity establishment in order to allow multiple PDN connections to one or more PDNs. It shall be possible for a UE to initiate disconnection from any PDN.

All simultaneous active PDN connections of a UE that are associated with the same APN shall be provided by the same P-GW.

UE support for multiple PDN connections is optional.

5.10.2 UE requested PDN connectivity

The UE requested PDN connectivity procedure for an E-UTRAN is depicted in figure 5.10.2-1. The procedure allows the UE to request for connectivity to a PDN including allocation of a default bearer. The PDN connectivity procedure may trigger one or multiple Dedicated Bearer Establishment procedures to establish dedicated EPS bearer(s) for that UE.
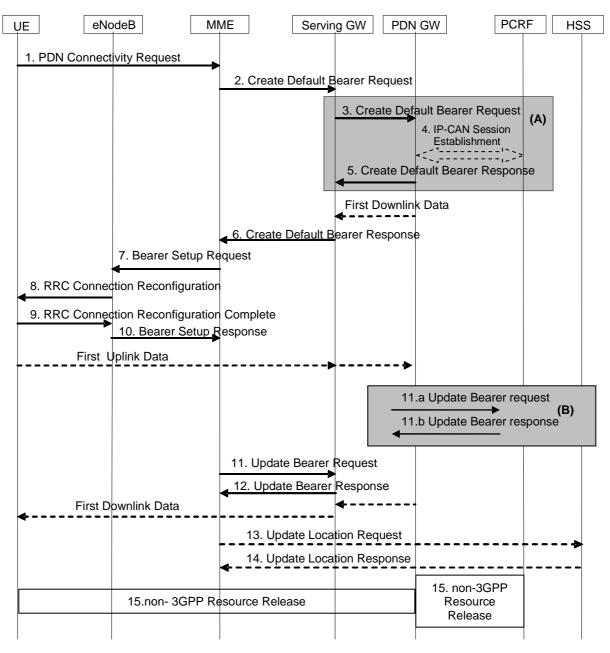
Figure 5.10.2-1: UE requested PDN connectivity

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) are defined in TS 23.402 [2]. Steps 3, 4, and 5 concern GTP based S5/S8.

NOTE 2: The UE also uses this procedure to request re-establishment of existing PDN connectivity upon handover from non-3GPP accesses.

NOTE 3: The steps in (B) and step 15 are executed only upon handover from non-3GPP access.

NOTE 4: Steps 13 and 14 are performed only if the Request Type indicates "Initial Request".

1. The UE initiates the UE Requested PDN procedure by the transmission of a PDN Connectivity Request (APN or Default APN indicator, PDN Type, Protocol Configuration Options, Request Type) message. If the UE was in ECM-IDLE mode, this NAS message is preceded by the Service Request procedure. PDN type indicates the requested IP version (IPv4, IPv4/v6, IPv6). The MME verifies that the APN provided by UE is allowed by subscription. If the UE provides an indicator requesting to use the Default APN instead of APN, the Default APN shall be used for the remainder of this procedure. Protocol Configuration Options (PCO) are used to transfer parameters between the UE and the PDN GW, and are sent transparently through the MME and the Serving GW. The Protocol Configuration Options may include the Address Allocation Preference, which indicates that the UE prefers to obtain an IPv4 address only after the default bearer activation by means of

DHCPv4. The Request Type indicates "initial request" if the UE requests new additional PDN connectivity over the 3GPP access network. In case of multiple PDN connections, the Request Type indicates "handover" when the UE is performing an handover from non-3GPP access and the UE has already established connectivity with the PDN over the non-3GPP access.

Editor's note: An indicator for requesting use of the Default APN is to be defined during stage 3 works. e.g. a pre-defined string such as 'default' or lack of APN. This indicator should be known to all UEs.

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

2. If the Request Type indicates "Handover", the MME uses the PDN GW stored in the Subscription Data retrieved by the MME during the authentication performed at attach. If the Request Type indicates "initial attach" the MME selects a PDN GW as described in clause 4.3.8.1 on PDN GW Selection Function (3GPP accesses), allocates a Bearer Id, and sends a Create Default Bearer Request (IMSI, MSISDN, MME TEID for control plane, RAT type, PDN GW address, PDN Address, Default Bearer QoS, PDN Type, PDN Address, APN-AMBR, APN, EPS Bearer Id, Protocol Configuration Options, Handover Indication, ME Identity, User Location Information (ECGI), Selection Mode, Charging Characteristics, Trace Reference, Trace Type, Trigger Id, OMC Identity, Maximum APN Restriction, Dual Address Bearer Flag) message to the Serving GW.

   The RAT type is provided in this message for the later PCC decision. The MSISDN is included if the MME has it stored for that UE. Handover Indication is included if the Request Type indicates "handover". Selection Mode indicates whether a subscribed APN was selected, or whether a non-subscribed APN sent by the UE or a non-subscribed APN chosen by the SGSN was selected. Selection Mode is set according to Annex A of TS 23.060 [7]. The P-GW may use Selection Mode when deciding whether to accept or reject the default bearer activation. For example, if an APN requires subscription, the P-GW is configured to accept only the default bearer activation that requests a subscribed APN as indicated by Selection Mode. Charging Characteristics indicates which kind of charging the bearer context is liable for.

   The charging characteristics for the PS subscription and individually subscribed APNs as well as the way of handling Charging Characteristics and whether to send them or not to the P-GW is defined in TS 32.251 [44]. The MME shall include Trace Reference, Trace Type, Trigger Id, and OMC Identity if S-GW and/or P-GW trace is activated. The MME shall copy Trace Reference, Trace Type, and OMC Identity from the trace information received from the HLR or OMC.

   The Maximum APN Restriction denotes the most stringent restriction as required by any already active bearer context. If there are no already active bearer contexts, this value is set to the least restrictive type (see clause 15.4 of TS 23.060 [7]). If the P-GW receives the Maximum APN Restriction, then the P-GW shall check if the Maximum APN Restriction value does not conflict with the APN Restriction value associated with this bearer context request. If there is no conflict the request shall be allowed, otherwise the request shall be rejected with sending an appropriate error cause to the UE.

   In case the PDN subscription context contains a subscribed IPv4 address and/or IPv6 prefix, the MME indicates it in the PDN address. The Dual Address Bearer Flag shall be set when the UE requests PDN type IPv4v6 and all SGSNs which the UE may be handed over to are Release 8 or above supporting dual addressing, which is determined based on node pre-configuration by the operator

3. The Serving GW creates a new entry in its EPS Bearer table and sends a Create Default Bearer Request (IMSI, MSISDN, Serving GW Address for the user plane, Serving GW TEID of the user plane, Serving GW TEID of the control plane, RAT type, Default Bearer QoS, PDN Type, PDN Address, APN-AMBR, APN, Bearer Id, Protocol Configuration Options, Handover Indication, ME Identity, User Location Information (ECGI), Selection Mode, Charging Characteristics, Trace Reference, Trace Type, Trigger Id, OMC Identity, Maximum APN Restriction, Dual Address Bearer Flag) message to the PDN GW indicated in the PDN GW address received in the previous step. After this step, the Serving GW buffers any downlink packets it may receive from the PDN GW until receives the message in step 11 below. The MSISDN is included if received from the MME. If the Handover Indication is included, the Serving GW includes it in the Create Default Bearer Request message.

4. If the Request Type indicates "Initial Request", the PDN GW may employ an IP-CAN Session Establishment procedure as defined in TS 23.203 [6] with the PCRF to get the default PCC rules for the UE if PCRF is applied in the network. This may optionally lead to the establishment of a number of dedicated bearers following the procedures defined in clause 5.4.1 in association with the establishment of the default bearer which is described in Annex F.

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

If the the Request Type indicates "Handover", the PDN GW executes a PCEF-Initiated IP-CAN Session Modification procedure with the PCRF as specified in TS 23.203 [6] to obtain the rules required for the PDN GW in the VPLMN or HPLMN to function as the PCEF for all the active sessions the UE has established with the new IP-CAN type as a result of the handover procedure.

If the updated PCC rules require establishment of dedicated bearer for the UE, the establishment of those bearers takes place before step 11. The establishment of dedicated bearers in combination with the default takes place as described in Annex F.

5. The P-GW creates a new entry in its EPS bearer context table and generates a Charging Id. The new entry allows the P-GW to route user plane PDUs between the S-GW and the packet data network, and to start charging. The way the P-GW handles Charging Characteristics that it may have received is defined in TS 32.251 [44].

   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 Type, PDN Address, EPS Bearer Id, Protocol Configuration Options, UL TFT, Charging Id, Prohibit Payload Compression, APN Restriction, Cause, CGI/SAI/RAI change report required, BCM) message to the Serving GW. The PDN GW takes into account the PDN type sent by the UE, the Dual Address Bearer Flag and the policies of operator when the PDN GW selects the PDN type to be used as follows. If the UE has requested PDN type IPv4v6 and both IPv4 and IPv6 addressing are possible in the PDN but the Dual Address Bearer Flag is not set, or only single IP version addressing is possible in the PDN, the PDN GW selects a single IP version (either IPv4 or IPv6). If the UE has requested PDN type IPv4 or IPv6, the PDN GW uses the PDN type supplied by the UE in case it is supported in the PDN, otherwise an appropriate error cause will be returned. The PDN GW allocates a PDN Address according to the selected PDN Type. In case the PDN GW has selected a PDN type different from the one sent by the UE, the PDN GW indicates together with the PDN type IE a reason cause (network preference, single address bearers only) to the UE why the PDN type has been modified. PDN Address may contain an IPv4 address for IPv4 and/or an IPv6 prefix and an Interface Identifier. If the PDN has been configured by the operator so that the PDN addresses for the requested APN shall be allocated by usage of DHCPv4 only, or if the PDN GW allows the UE to use DHCPv4 for address allocation according to the Address Allocation Preference received from the UE, the PDN Address shall be set to 0.0.0.0, indicating that the IPv4 address shall be negotiated by the UE with after completion of the Default Bearer Activation procedure. In case of external PDN addressing for IPv6, the PDN GW obtains the IPv6 prefix from the external PDN using either RADIUS or Diameter client function. In the PDN Address field of the Create Default Bearer Response, the PDN GW includes the Interface Identifer and IPv6 prefix. The PDN GW sends Router Advertisement to the UE after default bearer establishment with the IPv6 prefix information for all cases. If the PDN address is contained in the Create Default Bearer Request, the PDN GW shall allocate the IPv4 addresss and/or IP6 prefix contained in the PDN address to the UE. If Handover Indication indicates "Handover", the PDN Address Information shall contain the same IP address the UE obtained during PDN connectivity establishment over the non-3GPP access. Protocol Configuration Options contains the BCM as well as optional PDN parameters that the P-GW may transfer to the UE. BCM shall also be sent as a separate IE. These optional PDN parameters may be requested by the UE, or may be sent unsolicited by the P-GW. Protocol Configuration Options are sent transparently through the MME. According to the used RAT BCM is set to "UE/network".

6. If the CGI/SAI/RAI change report required is received for this bearer context, then the S-GW shall store this for the bearer context and the S-GW shall report to that P-GW whenever a CGI/SAI/RAI change occurs that meets the P-GW request, as described in clause 15.1.1a of TS 23.060 [7].

   The Serving GW returns a Create Default Bearer Response (PDN Type, PDN Address, Serving GW address for User Plane, Serving GW TEID for User Plane, Serving GW TEID for control plane, EPS Bearer Id, Protocol Configuration Options, UL TFT, DL TFT (for PMIP-based S5/S8), Charging Id, Prohibit Payload Compression, APN Restriction, Cause, CGI/SAI/RAI change report required, BCM) message to the MME. The DL TFT for PMIP-based S5/S8 is obtained from interaction between the Serving GW and the PCRF as described in clause 5.6.1 of TS 23.402 [2], when PCC is deployed; otherwise, the DL TFT IE is wildcarded, matching any downlink traffic. If the UE indicates the Request Type as "Handover", this message also serves as an indication to the MME that the S5 bearer setup and update has been successful. At this step the GTP tunnel(s) over S5 are established.

7. If an APN Restriction is received, then the MME shall store this value for the Bearer Context and the MME shall check this received value with the stored value for the Maximum APN Restriction to ensure there are no

conflicts between values. If the consequence of this check results in the PDN connectivity being rejected, the MME shall initiate a Bearer Deactivation and return an appropriate error cause. If the PDN Connectivity Request is accepted, the MME shall determine a (new) value for the Maximum APN Restriction. If there is no previously stored value for Maximum APN Restriction, then the Maximum APN Restriction shall be set to the value of the received APN Restriction.

If the CGI/SAI/RAI change report required is received for this bearer context, then the MME shall store this for the bearer context and the MME shall report whenever a CGI/SAI/RAI change occurs that meets the request, as described in clause 15.1.1a of TS 23.060 [7].

The MME sends PDN Connectivity Accept (APN, PDN Type, PDN Address, EPS Bearer Id) message to the eNodeB. This message is contained in an S1_MME control message Bearer Setup Request (Default EPS Bearer QoS, PDN Connectivity Accept, Session Management Configuration, S1-TEID, Protocol Configuration Options). This S1 control message includes the TEID at the Serving GW used for user plane and the address of the Serving GW for user plane. The MME includes the UL TFT and the EPS Bearer QoS parameter QCI into the Session Management Configuration IE. Furthermore, if the UE has UTRAN or GERAN capabilities, the MME uses the EPS bearer QoS information to derive the corresponding PDP context parameters QoS Negotiated (R99 QoS profile), Radio Priority and Packet Flow Id and includes them in the Session Management Configuration. If the UE indicated in the UE Network Capability it does not support BSS packet flow procedures, then the MME shall not include the Packet Flow Id. MME will not send the S1 Bearer Setup Request message until any outstanding S1 Bearer Setup Response message for the same UE has been received or timed out. If the APN-AMBR has changed the MME may update the used UE-AMBR if appropriate. The MME may provide the eNodeB with Handover Restriction List. Handover Restriction List is described in clause 4.3.5.7 "Mobility Restrictions".

8. The eNodeB sends RRC Connection Reconfiguration to the UE including the Session Management Configuration IE, and the PDN Connectivity Accept message will be sent along to the UE. The UE shall ignore the IPv6 prefix information in PDN Address. The UE uses the uplink packet filter (UL TFT) to determine the mapping of uplink packets to the radio bearer. The UE may provide EPS Bearer QoS parameters to the application handling the service data flow. The application usage of the EPS Bearer QoS is implementation dependent. The UE shall not reject the RRC Connection Reconfiguration on the basis of the EPS Bearer QoS parameters contained in the Session Management Configuration IE.

NOTE 2: The IP address allocation details are described in clause 5.3.1 on "IP Address Allocation".

9. The UE sends the RRC Connection Reconfiguration Complete to the eNodeB.

10. The eNodeB send an S1_MME control message Bearer Setup Response to the MME. The S1 control message includes the TEID of the eNodeB and the address of the eNodeB used for downlink traffic on the S1_U reference point.

After the PDN Connectivity Accept message and once the UE has obtained a PDN Address Information, the UE can then send uplink packets towards the eNodeB which will then be tunnelled to the Serving GW and PDN GW. If the UE requested for a dual address PDN type (IPv4v6) to a given APN and was granted a single address PDN type (IPv4 or IPv6) by the network with a reason cause "single address bearers only", the UE may request for the activation of a parallel PDN connection to the same APN with a single address PDN type (IPv4 or IPv6) other than the one already activated. If the UE receives no reason cause in step 8 in response to a IPv4v6 PDN type and it receives an IPv6 prefix and Interface Identifier apart from the IPv4 address or 0.0.0.0 in the PDN Address field, it considers that the request for a dual address PDN was successful. It can wait for the Router Advertisement from the network with the IPv6 prefix information or it may send Router Solicitation if necessary.

11. The MME sends an Update Bearer Request (eNodeB address, eNodeB TEID, Handover Indication) message to the Serving GW. If Request Type indicates "handover", the Handover Indication is also included.

11a. If the Handover Indication is included in step 11, the Serving GW sends an Update Bearer Request message to the PDN GW to prompt the PDN GW to tunnel packets from non 3GPP IP access to 3GPP access system and immediately start routing packets to the Serving GW for the default and any dedicated EPS bearers established.

11b. The PDN GW acknowledges by sending Update Bearer Response to the Serving GW.

12. The Serving GW acknowledges by sending Update Bearer Response (EPS Bearer Identity) to the MME. The Serving GW can then send its buffered downlink packets. EPS Bearer Identity is included if the Request Type indicates "handover".

13. After the MME receives Update Bearer Response in step 13, if an EPS bearer was established and if the subscription data indicates that the user is allowed to perform handover to non-3GPP accesses and if this is the first PDN connection associated with this APN, the MME shall send an Update Location Request including the PDN GW address and the APN to the HSS for mobility with non-3GPP accesses.

14. The HSS stores the PDN GW identity and the associated APN, and sends an Update Location Response to the MME.

15. If the Request Type indicates "handover", the PDN GW shall initiate resource allocation deactivation procedure in the trusted/untrusted non-3GPP IP access as specified in TS 23.402 [2].

5.10.3   UE requested PDN disconnection

The UE requested PDN disconnection procedure for an E-UTRAN is depicted in figure 5.10.3-1. The procedure allows the UE to request for disconnection from one PDN. Bearers including the default bearer of this PDN shall be deleted during this procedure.
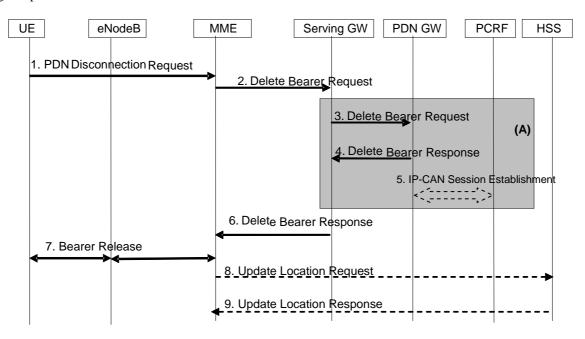
Figure 5.10.3-1: UE requested PDN disconnection

NOTE: For a PMIP-based S5/S8, procedure steps (A) are defined in TS 23.402 [2]. Steps 3, 4 and 5 concern GTP based S5/S8.

1. The UE initiates the UE requested PDN disconnection procedure by the transmission of a PDN Disconnection Request (LBI) message. The LBI indicates the default bearer associated with the PDN connection being disconnected. If the UE was in ECM-IDLE mode, this NAS message is preceded by the Service Request procedure.

2. The EPS Bearers in the Serving GW regarding this particular UE and the PDN are deactivated by the MME by sending Delete Bearer Request (TEID, LBI) to the Serving GW.

3. The Serving GW sends Delete Bearer Request (TEID, LBI) to the PDN GW.

4. The PDN GW acknowledges with Delete Bearer Response.

5. The PDN GW employs the PCRF-initiated IP-CAN Session Termination procedure as defined in TS 23.203 [6] with the PCRF to indicate to the PCRF that EPS Bearer is released if PCRF is applied in the network.

6. The Serving GW acknowledges with Delete Bearer Response.

7. The MME initiates the deactivation of the Bearers associated with the PDN to the eNodeB. The MME shall provide the UE-AMBR to the eNodeB unless all of the bearers belonging to the UE are released. The eNodeB

     releases the corresponding radio bearers, and sends an acknowledgement of the deactivation to the MME. PDN Disconnection Response is piggybacked to the UE in this step.

8.   If the subscription data indicates that the user is allowed to perform handover to non-3GPP accesses, the MME sends Update Location Request to the HSS to delete the PDN GW address information for the given APN if the PDN GW identity was dynamically alocated.

9. The HSS deletes PDN GW identity for the given APN and sends an Update Location Response to the MME.

If all the bearers belonging to a UE are released, the MME and the UE shall change the MM state to EMM-DEREGISTERED and the MME sends the S1 Release Command to the eNodeB, which initiates the release of the RRC connection for the given UE if it is not released yet, and returns an S1 Release Complete message to the MME.

5.11   UE Capability Handling

The UE Capability information is made up of the UE Radio Capability information and the UE Core Network Capability information.

The UE Radio Capability information contains information on RATs that the UE supports (e.g. power class, frequency bands, etc). Consequently, as this information can be sufficiently large (e.g. >50 octets) it is undesirable to send it across the radio interface at every transition from ECM-IDLE to ECM-CONNECTED. To avoid this radio overhead, the MME stores the UE Capability information during ECM-IDLE state and the MME shall send its most up to date UE Radio Capability information to the E-UTRAN in the S1 interface INITIAL CONTEXT SETUP REQUEST message.

> NOTE 1:   This means that for a signalling only procedure such as a periodic Tracking Area Update, the UE Radio Capability would not be sent to the E-UTRAN.

The UE Core Network Capability contains non radio-related capabilities, e.g. the NAS security algorithms etc. The UE Core Network Capability has the same format and content as the MS Network Capability specified in TS 24.008 [47]. The UE Core Network Capability is transferred between CN nodes at MME to MME, MME to SGSN, SGSN to SGSN, and SGSN to MME changes.

In order to ensure that the UE Core Network Capability information stored in the MME is up to date (e.g. to handle the situation when the USIM is moved into a different device while out of coverage, and the old device did not send the Detach message; and the cases of inter-RAT Tracking Area Update), the UE shall send the UE Core Network Capability information to the MME during the Attach and non-periodic Tracking Area Update procedure within the NAS message.

The MME shall store always the latest UE Core Network Capability received from the UE. Any UE Core Network Capability that an MME receives from an old MME/SGSN is replaced when the UE provides the UE Core Network Capability with the Tracking Area Update signalling.

In order to ensure that the UE Radio Capability information stored in the MME is up to date (e.g. to handle the situation when the USIM is moved into a different device while out of coverage, and the old device did not send the Detach message), the MME shall delete any stored UE Radio Capability everytime the UE performs the Attach procedure. In the Attach procedure the MME shall not send any UE Radio Capability information in the S1 interface INITIAL CONTEXT SETUP REQUEST message. This triggers the E-UTRAN to request the UE Radio Capability from the UE and upload them to the MME in the UE CAPABILITY INFO INDICATION message.

The UE Radio Capability is not transferred between CN nodes. It will be uploaded to the MME when the E-UTRAN requests the UE Radio Capability information from the UE.

During handover via the MME (both intra RAT and inter RAT), the UE Radio Capability is transferred in the "source to target transparent container" and uploaded from eNB to the MME.

To allow for the addition of future radio technologies, frequency bands, and other enhancements, the MME shall store the UE Capability Information even if it is larger than specified in TS 24.301 [46], up to a maximum size of [255] octets.

> NOTE 2:   The 255 octet value comes from the information element encoding rules described in TS 24.007 [45] and the assumption that this UE Radio Capability Information has to be signalled in GERAN NAS signalling for the case of GERAN to E-UTRAN PS handover.

The E-UTRAN stores the UE Radio Capability information, received in the S1 interface INITIAL CONTEXT SETUP REQUEST message or obtained from the UE, for the duration of the RRC connection for that UE.

If the UE's UE Core Network Capability information changes (in either ECM-CONNECTED or in ECM-IDLE state (including cases of being in GERAN/UTRAN coverage and having ISR active)), the UE shall perform a Tracking Area Update ('type' different to 'periodic') when it next returns to E-UTRAN coverage.

Annex A:
Void

Annex B:
Void

Annex C:
Void

Annex D (normative):
Interoperation with Gn/Gp SGSNs

D.1   General Considerations

This annex specifies interworking between the EPS and 3GPP 2G and/or 3G SGSNs, which provide only Gn and Gp interfaces but no S3, S4 or S5/S8 interfaces interfaces, i.e. these Gn/Gp SGSNs provide no functionality that is introduced specifically for the EPS or for interoperation with the E-UTRAN.

Interoperation scenarios for operating E-UTRAN with a PLMN maintaining Gn/Gp SGSNs are supported only with a GTP-based S5/S8.

> NOTE: PMIP-based S5/S8 may be used, but does not support handovers between the Gn/Gp SGSN and MME/SGW.

The S5/S8 interface for the Operator with Gn/Gp SGSNs will be GTP-based, but can be changed to PMIP-based S5/S8 when the Gn/Gp SGSNs evolve to S4 SGSNs.

For these interoperation scenarios the GERAN/UTRAN has to support interoperation with E-UTRAN.

D.2   Interoperation Scenario

D.2.1   Roaming interoperation scenario

In the roaming scenario the vPLMN operates Gn/Gp 2G and/or 3G SGSNs as well as MME and S-GW for E-UTRAN access. The hPLMN operates a P-GW.

Roaming and inter access mobility between Gn/Gp 2G and/or 3G SGSNs and an MME/S-GW are enabled by:

-    Gn functionality as specified between two Gn/Gp SGSNs, which is provided by the MME, and

-    Gp functionality as specified between Gn/Gp SGSN and Gn/Gp GGSN that is provided by the P-GW.

All this Gp and Gn functionality bases on GTP version 1 only.

The architecture for interoperation with Gn/Gp SGSNs in the non-roaming case is illustrated in Figure D.2.1-1.
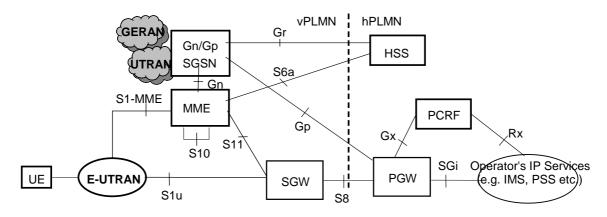
Figure D.2.1-1: Roaming architecture for interoperation with Gn/Gp SGSN

D.2.2 Non-roaming interoperation scenario

In the non-roaming scenario the PLMN operates Gn/Gp 2G and/or 3G SGSNs as well as MME and S-GW for E-UTRAN access.

Intra PLMN roaming and inter access mobility between Gn/Gp 2G and/or 3G SGSNs and an MME/S-GW are enabled by:

- Gn functionality as specified between two Gn/Gp SGSNs, which is provided by the MME, and

- Gn functionality as specified between Gn/Gp SGSN and Gn/Gp GGSN that is provided by the PGW.

All this Gn functionality is based on GTP version 1 only.

The architecture for interoperation with Gn/Gp SGSNs in the non-roaming case is illustrated in Figure D.2.2-1.
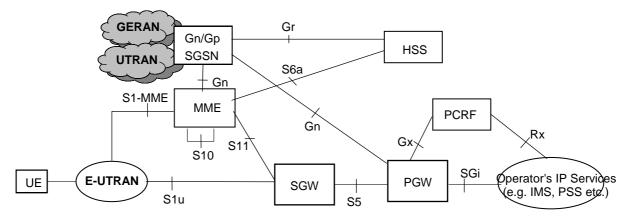
Figure D.2.2-1: Non-roaming Architecture for interoperation with Gn/Gp SGSNs

NOTE: If the Rel-7 SGSN applies Direct Tunnel there is a user plane connection between PGW and UTRAN.

D.3 Interoperation procedures

D.3.1 General

The interoperation procedures describe information flows for Gn/Gp SGSNs and other EPS network elements. All messages between SGSN and MME, between SGSN and HSS and between SGSN and P-GW as well as the therein contained information elements are the same as specified for the adequate TS 23.060 [7] procedures. These messages and procedure step descriptions are taken from TS 23.060 [7] for explanatory purposes only. These descriptions are in *italic text* and shall not be modified by the interoperation procedures. It cannot be assumed that the messages and procedure step descriptions that are taken from TS 23.060 [7] will be updated when modifications or corrections are performed for TS 23.060 [7]. If there are any discrepancies for these messages and procedure step descriptions TS 23.060 [7] takes precedence. The messages between the MME and any other node than the Gn/Gp SGSN as well as the therein contained information elements are the same as specified in the main body of this technical specification for the inter RAT Routeing Area Update procedure. If there are any discrepancies for these messages the descriptions from the main body of this Technical Specification take precedence.

An operator that has pre-Rel-8 SGSNs in its network should use separate EPS bearers for IPv4 and IPv6 adressing, such that both addresses can be maintained when moving to a pre-Rel-8 SGSN from a Rel-8 SGSN or MME (see clause 5.3.1). This is configured into the SGSN and MME nodes which set the Dual Address Bearer Flag depending on whether a UE may or may not be handed over to a pre-Rel-8 SGSN, as specified in clauses 5.3.2.1 and 5.10.2.

D.3.3 MME to 3G SGSN combined hard handover and SRNS relocation procedure

The MME to 3G SGSN Combined Hard Handover and SRNS Relocation procedure is illustrated in Figure D.3.3-1.

Any steps descriptions that are from TS 23.060 [7] are shown as *italic text* and remain unmodified. In those step descriptions an MS stands for UE, old SGSN for old MME and GGSN for PGW.

The same procedure applies for S4 SGSN to Gn/Gp SGSN Combined Hard Handover and SRNS Relocation procedure. In this case the old MME is an old S4 SGSN.

The procedure between E-UTRAN eNodeB and UE, and between E-UTRAN eNodeB and MME are copied from TS 23.401 unmodified.

Direct forwarding of payload PDUs is assumed in the scenarios below. The indirect forwarding is FFS for Gn/Gp 3GPP IRAT handovers.
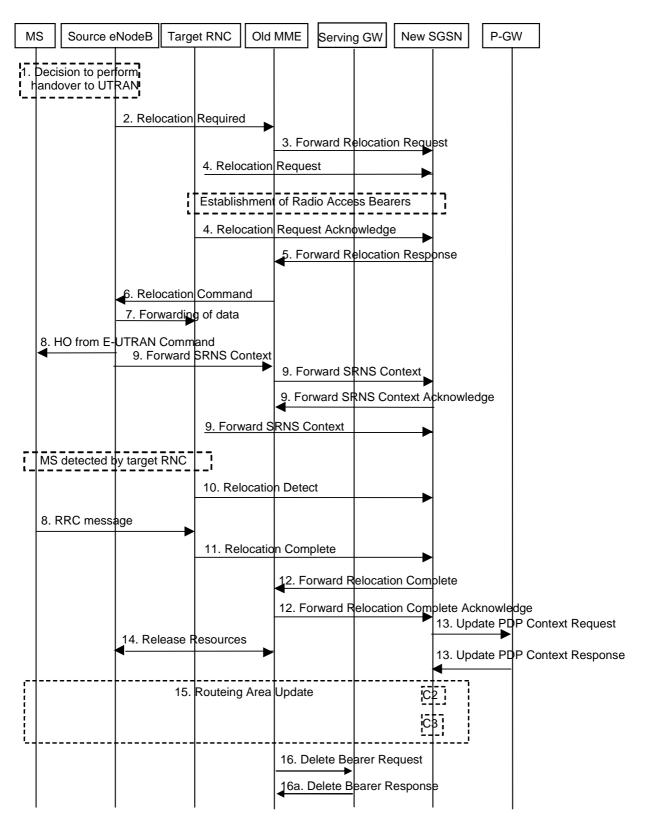
Figure D.3.3-1: MME to 3G SGSN combined hard handover and SRNS relocation procedure

1. The source eNodeB decides to initiate a handover to the target access network, UTRAN Iu mode. At this point both uplink and downlink user data is transmitted via the following: Bearer(s) between UE and source eNodeB, GTP tunnel(s) between source eNodeB, Serving GW and PDN GW.

NOTE 1: This step is unmodified compared to E-UTRAN functionality as described in TS 23.401. UE corresponds to MS.

2. The source eNodeB sends a Relocation Required (Cause, Target RNC Identifier, Source eNodeB Identifier, Source to Target Transparent Container, Bearers Requesting Data Forwarding List) message to the source MME to request the CN to establish resources in the target RNC, target SGSN and the Serving GW.

   Bearers Requesting Data Forwarding List contains that list of bearers for which the source eNodeB decided that data forwarding (direct) is necessary.

NOTE 2: The possibility for indirect forwarding of payload PDUs is omitted in the step above. Otherwise the step is unmodified compared to E-UTRAN functionality as described in TS 23.401.

3. The old MME sends a Forward Relocation Request message (IMSI, Tunnel Endpoint Identifier Signalling, MM Context, PDP Context, Target Identification, RAN Transparent Container, RANAP Cause, GCSI) to the new SGSN. For relocation to an area where Intra Domain Connection of RAN Nodes to Multiple CN Nodes is used, the old MME may have multiple new SGSNs for each relocation target in a pool area, in which case the old MME will select one of them to become the new SGSN, as specified in TS 23.236 [30]. PDP context contains GGSN Address for User Plane and Uplink TEID for Data (to this GGSN Address and Uplink TEID for Data, the old SGSN and the new SGSN send uplink packets). At the same time a timer is started on the MM and PDP contexts in the old MME (see Routeing Area Update procedure in subclause "Location Management Procedures (Iu mode)"). The old SGSN 'sets' the GCSI flag if the MM context contains GPRS CAMEL Subscription Information.

NOTE 3: The GGSN user plane address and uplink TEID are the old P-GW user plane address and TEID. The MME maps the EPS bearer parameters to PDP contexts.

4. *The new SGSN sends a Relocation Request message (Permanent NAS UE Identity, Cause, CN Domain Indicator, Source RNC To Target RNC Transparent Container, RAB To Be Setup) to the target RNC. For each RAB requested to be established, RABs To Be Setup shall contain information such as RAB ID, RAB parameters, Transport Layer Address, and Iu Transport Association. SGSN shall not establish RABs for PDP contexts with maximum bitrate for uplink and downlink of 0 kbit/s. The list of RABs requested by the new SGSN may differ from list of RABs established in the Source RNC contained in the Source-RNC to target RNC transparent container. The target RNC should not establish the RABs (as identified from the Source-RNC to target RNC transparent container) that did not exist in the source RNC prior to the relocation. The RAB ID information element contains the NSAPI value, and the RAB parameters information element gives the QoS profile. The Transport Layer Address is the SGSN Address for user data, and the Iu Transport Association corresponds to the uplink Tunnel Endpoint Identifier Data. The new SGSN may decide to establish Direct Tunnel unless it has received a 'set' GCSI flag from the old SGSN. If the new SGSN decides to establish Direct Tunnel, it provides to the target RNC the GGSN's Address for User Plane and TEID for Uplink data.*

   After all the necessary resources for accepted RABs including the Iu user plane are successfully allocated, the target RNC shall send the Relocation Request Acknowledge message (Target RNC To Source RNC Transparent Container, RABs Setup, RABs Failed To Setup) to the new SGSN. Each RAB to be setup is defined by a Transport Layer Address, which is the target RNC Address for user data, and the Iu Transport Association, which corresponds to the downlink Tunnel Endpoint Identifier for user data. The transparent container contains all radio-related information that the MS needs for the handover, i.e. a complete RRC message (e.g., Physical Channel Reconfiguration in UTRAN case, or Handover From UTRAN, or Handover Command in GERAN Iu mode case) to be sent transparently via CN and source SRNC to the MS. For each RAB to be set up, the target RNC may receive simultaneously downlink user packets both from the source SRNC and from the new SGSN.

NOTE 4: This step for the new SGSN is unmodified compared to pre-Rel-8. If the new SGSN decides to establish Direct Tunnel, it provides to the target RNC the PGW Address for User Plane and TEID for Uplink data. The UE acts as the MS; the old eNodeB acts as the source SRNC. The details of the transparent container are FFS.

5. *When resources for the transmission of user data between target RNC and new SGSN have been allocated and the new SGSN is ready for relocation of SRNS, the Forward Relocation Response (Cause, RAN Transparent Container, RANAP Cause, Target-RNC Information) message is sent from the new SGSN to the old SGSN. This message indicates that the target RNC is ready to receive from source SRNC the forwarded downlink PDUs, i.e., the relocation resource allocation procedure is terminated successfully. RAN transparent container and RANAP Cause are information from the target RNC to be forwarded to the source SRNC. The Target RNC Information, one information element for each RAB to be set up, contains the RNC Tunnel Endpoint Identifier and RNC IP address for data forwarding from the source SRNC to the target RNC. The Forward Relocation Response message is applicable only in case of inter-SGSN SRNS relocation.*

NOTE 5: This step is unmodified compared to pre-Rel-8. The old MME acts as the old SGSN, and the source eNodeB as the source SRNC.

6. The source MME completes the preparation phase towards source eNodeB by sending the message Relocation Command (Target to Source Transparent Container, Bearers Subject to Data Forwarding List). "Bearers Subject to Data forwarding list" may be included in the message and it shall be a list of 'Address(es) and TEID(s) for user traffic data forwarding' received from target side in the preparation phase (Step 5).

   The source eNodeB initiates data forwarding for bearers specified in the "Bearers Subject to Data Forwarding List". The data forwarding goes directly to target RNC.

NOTE 6: This step is unmodified compared to E-UTRAN functionality as described in TS 23.401.

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

NOTE 7: The details of the data forwarding between eNodeB and source SRNC are FFS.

8. The source eNodeB will give a command to the UE to handover to the target access network via the message HO from E-UTRAN Command. This message includes a transparent container including radio aspect parameters that the target RNC has set-up in the preparation phase. The details of this E-UTRAN specific signalling are described in TS 36.300 [5].

NOTE 8: This step is unmodified compared to E-UTRAN functionality as described in TS 23.401.

9. *The source SRNC continues the execution of relocation of SRNS by sending a Forward SRNS Context (RAB Contexts) message to the target RNC via the old and the new SGSN. The Forward SRNS Context message is acknowledged by a Forward SRNS Context Acknowledge message, from new to old SGSN. The purpose of this procedure is to transfer SRNS contexts from the source RNC to the target RNC, and to move the SRNS role from the source RNC to the target RNC. SRNS contexts are sent for each concerned RAB and contain the sequence numbers of the GTP PDUs next to be transmitted in the uplink and downlink directions and the next PDCP sequence numbers that would have been used to send and receive data from the MS. PDCP sequence numbers are only sent by the source RNC for the radio bearers which used lossless PDCP [57]. The use of lossless PDCP is selected by the RNC when the radio bearer is set up or reconfigured. For PDP context(s) using delivery order not required (QoS profile), the sequence numbers of the GTP-PDUs next to be transmitted are not used by the target RNC.*

   If delivery order is required (QoS profile), consecutive GTP-PDU sequence numbering shall be maintained throughout the lifetime of the PDP context(s). Therefore, during the entire SRNS relocation procedure for the PDP context(s) using delivery order required (QoS profile), the responsible GTP-U entities (RNCs and GGSN) shall assign consecutive GTP-PDU sequence numbers to user packets belonging to the same PDP context uplink and downlink, respectively.

   The target RNC establishes and/or restarts the RLC and exchanges the PDCP sequence numbers (PDCP-SNU, PDCP-SND) between the target RNC and the MS. PDCP-SND is the PDCP sequence number for the next expected in-sequence downlink packet to be received by the MS per radio bearer, which used lossless PDCP in the source RNC. PDCP-SND confirms all mobile terminated packets successfully transferred before the SRNC relocation. If PDCP-SND confirms reception of packets that were forwarded from the source SRNC, then the target SRNC shall discard these packets. PDCP-SNU is the PDCP sequence number for the next expected in-sequence uplink packet to be received in the RNC per radio bearer, which used lossless PDCP in the source RNC. PDCP-SNU confirms all mobile originated packets successfully transferred before the SRNC relocation. If PDCP-SNU confirms reception of packets that were received in the source SRNC, the MS shall discard these packets.

NOTE 9: This step is unmodified compared to pre-Rel-8. The old MME acts as the old SGSN, and the source eNodeB as the source SRNC. The forward SRNS Context message from source eNodeB to the old MME is defined in TS 23.401. The UE acts as the MS. The whole SRNS context handling including PDCP sequence number handling and GTP numbering is FFS.

10. *The target RNC shall send a Relocation Detect message to the new SGSN when the relocation execution trigger is received. For SRNS relocation type "UE Involved", the relocation execution trigger may be received from the Uu interface; i.e., when target RNC detects the MS on the lower layers. When the Relocation Detect message is sent, the target RNC shall start SRNC operation.*

NOTE 10: This step is unmodified compared to pre-Rel-8.

11. *When the target SRNC receives the appropriate RRC message, e.g. Physical Channel Reconfiguration Complete message or the Radio Bearer Release Complete message in UTRAN case, or the Handover To UTRAN Complete message or Handover Complete message in GERAN case, i.e. the new SRNC-ID + S-RNTI are successfully exchanged with the MS by the radio protocols, the target SRNC shall initiate a Relocation Complete procedure by sending the Relocation Complete message to the new SGSN. The purpose of the Relocation Complete procedure is to indicate by the target SRNC the completion of the relocation of the SRNS to the CN.*

NOTE 11: This step is unmodified compared to pre-Rel-8. The UE acts as the MS.

12. *Upon receipt of Relocation Complete message, if the SRNS Relocation is an inter SGSN SRNS relocation, the new SGSN signals to the old SGSN the completion of the SRNS relocation procedure by sending a Forward Relocation Complete message.*

   A timer in source MME is started to supervise when resources in Source eNodeB and Source Serving GW shall be released.

NOTE 12: For the SGSN this step is unmodified compared to pre-Rel-8. The old MME acts as the old SGSN, and the source eNodeB as the source SRNC.

13. *Upon receipt of the Relocation Complete message, the CN shall switch the user plane from the source RNC to the target SRNC. If the SRNS Relocation is an inter-SGSN SRNS relocation or if Direct Tunnel was established in intra-SGSN SRNS relocation, the new SGSN sends Update PDP Context Request messages (new SGSN Address, SGSN Tunnel Endpoint Identifier, QoS Negotiated, serving network identity, CGI/SAI, RAT type, CGI/SAI/RAI change support indication, NRSN, DTI) to the GGSNs concerned. The SGSN shall send the serving network identity to the GGSN. If Direct Tunnel is established the SGSN provides to GGSN the RNC's Address for User Plane and TEID for Downlink data and shall include the DTI to instruct the GGSN to apply Direct Tunnel specific error handling procedure as described in clause 13.8. NRSN indicates SGSN support of the network requested bearer control. The GGSNs update their PDP context fields and return an Update PDP Context Response (GGSN Tunnel Endpoint Identifier, Prohibit Payload Compression, APN Restriction, CGI/SAI/RAI change report required, BCM) message. The Prohibit Payload Compression indicates that the SGSN should negotiate no data compression for this PDP context.*

NOTE 13: This step is unmodified compared to pre-Rel-8. The P-GW acts as the GGSN.

14. When the timer started at Step 12 expires, the source MME sends a Release Resources message to the source eNodeB. When the Release Resources message has been received and there is no longer any need for the eNodeB to forward data, the Source eNodeB releases its resources.

NOTE 14: This step is unmodified compared to E-UTRAN functionality as described in TS 23.401.

15. *After the MS has finished the reconfiguration procedure and if the new Routeing Area Identification is different from the old one, the MS initiates the Routeing Area Update procedure. See subclause "Location Management Procedures (Iu mode)". Note that it is only a subset of the RA update procedure that is performed, since the MS is in PMM-CONNECTED state.*

NOTE 15: This step is unmodified compared to pre-Rel-8. The UE acts as the MS. The old EPS bearer information in Serving GW is removed as part of the Routeing Area Update procedure.

16. *When the timer started in step 12 expires, the source MME deletes the EPS bearer resources by sending Delete Bearer Request (Cause, TEID) messages to the Source Serving GW because the old SGSN is a Gn/Gp SGSN, which is derived from relocation signalling between SGSN and MME. Cause indicates to the old Serving GW that the Serving GW changes and the old Serving GW shall not initiate a delete procedure towards the PDN GW. The Source Serving GW acknowledges with Delete Bearer Response (TEID) messages. If ISR is established on the S-GW then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that CN node.*

If the SRNS Relocation is inter-SGSN, then the following CAMEL procedure calls shall be performed (see referenced procedures in TS 23.078 [29])

NOTE 16: The C1 CAMEL procedure call was omitted intentionally from this procedure since EPS does not support CAMEL procedure calls. The other CAMEL procedure calls are unmodified compared to pre-Rel-8.

The new SGSN shall determine the Maximum APN restriction based on the received APN Restriction of each PDP context from the GGSN and then store the new Maximum APN restriction value.

If the SRNS Relocation is intra-SGSN, then the above mentioned CAMEL procedures calls shall not be performed.

If Routeing Area Update occurs, the SGSN shall determine whether Direct Tunnel can be used based on the received GPRS CAMEL Subscription Information. If Direct Tunnel can not be maintained the SGSN shall re-establish RABs and initiate the Update PDP Context procedure to update the IP Address and TEID for Uplink and Downlink data.

If Routeing Area Update occurs, then the following CAMEL procedure calls shall be performed (see referenced procedures in TS 23.078 [29]):

> C2) *CAMEL_GPRS_Routeing_Area_Update_Session and CAMEL_PS_Notification.*
>
>> *They are called in the following order:*
>
>> - *The CAMEL_GPRS_Routeing_Area_Update_Session procedure is called. In Figure 42, the procedure returns as result "Continue".*
>
>> - *Then the CAMEL_PS_Notification procedure is called. The procedure returns as result "Continue".*
>
> C3) *CAMEL_GPRS_Routeing_Area_Update_Context.*

This procedure is called several times: once per PDP context. It returns as result "Continue".

For C2 and C3: refer to Routing Area Update procedure description for detailed message flow.

D.3.4   3G SGSN to MME combined hard handover and SRNS relocation procedure

The 3G SGSN to MME Combined Hard Handover and SRNS Relocation procedure is illustrated in Figure D.3.4-1.

Any steps descriptions that are from TS 23.060 [7] are shown as *italic text* and remain unmodified. In those step descriptions an MS stands for UE, new SGSN for new MME and GGSN for PGW.

The same procedure applies for Gn/Gp SGSN to S4 SGSN Combined Hard Handover and SRNS Relocation procedure. In this case the new MME is a new Rel-8 SGSN.

The procedure between E-UTRAN eNodeB and UE, and between E-UTRAN eNodeB and MME are copied from TS 23.401 unmodified.

Direct forwarding of payload PDUs is assumed in the scenarios below. The indirect forwarding is FFS for 3GPP IRAT handovers with Gn/Gp SGSNs.
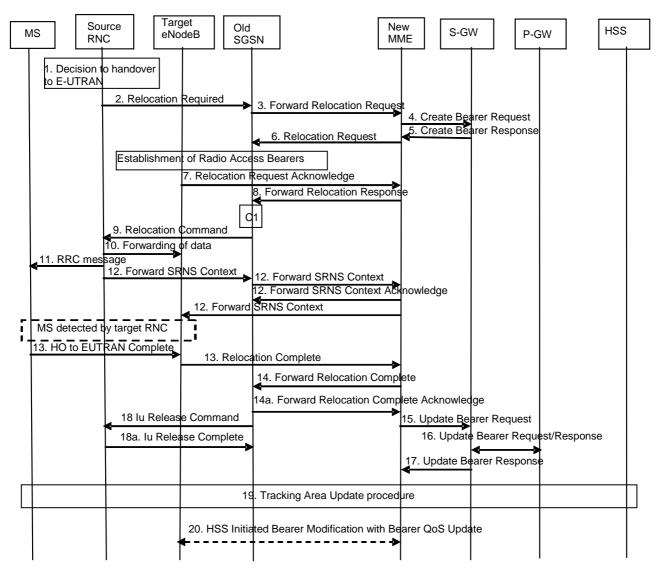
Figure D.3.4-1: 3G SGSN to MME combined hard handover and SRNS relocation procedure

1. The source RNC decides to initiate a handover to E-UTRAN.

2. *The source SRNC sends a Relocation Required message (Relocation Type, Cause, Source ID, Target ID, Source RNC To Target RNC Transparent Container) to the old SGSN. The source SRNC shall set Relocation Type to "UE Involved". Source RNC To Target RNC Transparent Container includes the necessary information for relocation co-ordination, security functionality and RRC protocol context information (including MS Capabilities).*

NOTE 1: This step is unmodified compared to pre-Rel-8. The target eNodeB acts as the target RNC.

3. *The old SGSN determines from the Target ID if the SRNS relocation is intra-SGSN SRNS relocation or inter-SGSN SRNS relocation. In case of inter-SGSN SRNS relocation the old SGSN initiates the relocation resource allocation procedure by sending a Forward Relocation Request message (IMSI, Tunnel Endpoint Identifier Signalling, MM Context, PDP Context, Target Identification, RAN Transparent Container, RANAP Cause, GCSI) to the new SGSN. For relocation to an area where Intra Domain Connection of RAN Nodes to Multiple CN Nodes is used, the old SGSN may – if it provides Intra Domain Connection of RAN Nodes to Multiple CN Nodes -have multiple target SGSNs for each relocation target in a pool area, in which case the old SGSN will select one of them to become the new SGSN, as specified in TS 23.236 [30]. PDP context contains GGSN Address for User Plane and Uplink TEID for Data (to this GGSN Address and Uplink TEID for Data, the old SGSN and the new SGSN send uplink packets). At the same time a timer is started on the MM and PDP contexts in the old SGSN (see Routeing Area Update procedure in subclause "Location Management Procedures (Iu mode)"). The Forward Relocation Request message is applicable only in case of inter-SGSN SRNS relocation. The old SGSN 'sets' the GCSI flag if the MM context contains GPRS CAMEL Subscription Information.*

NOTE 2: This step is unmodified compared to pre-Rel-8. The new MME acts the new SGSN, and the PGW as the GGSN. The GGSN user plane address and uplink TEID are the PGW user plane address and TEID. The MME maps the PDP context parameters to EPS bearers.

4. The MME selects a Serving GW and sends a Create Bearer Request (bearer context(s) with PDN GW addresses and TEIDs for uplink traffic, local AMBR) message to the target Serving GW. The AMBR is locally provided by the target MME.

5. The Serving GW allocates the S-GW addresses and TEIDs for the uplink traffic on S1_U reference point (one TEID per bearer). The target Serving GW sends a Create Bearer Response (Serving GW addresses and uplink TEID(s) for user plane) message back to the target MME.

6. The target MME requests the target eNodeB to establish the bearer(s) by sending the message Relocation Request (UE Identifier, Cause, CN Domain Indicator, K_eNB, Integrity protection information (i.e. selected Integrity Protection algorithm(s)), Encryption information (i.e. selected Ciphering algorithm(s)), EPS Bearers to be setup list, Source to Target Transparent Container, Serving GW Address(es) and TEID(s) for User Traffic Data, KSI, key derivation parameter).

If the MME has a security association with the UE, the earlier selected NAS and AS security algorithms and related keys will be utilized on handover to E-UTRAN. If the MME does not have a security association with the UE, then an operator configured default security algorithm is applied for NAS and AS (UP and RRC) security. KSI and key derivation parameters are targeted for UE. The KSI parameter informs the UE whether a security association exists with the MME and is used or whether it does not exist and UTRAN CK and IK based keys are used in target eNB and in the target MME.

The local AMBR shall be included in the 'EPS Bearers be setup list ' IE when AMBR is needed.

NOTE 3: This step is unmodified compared to TS 23.401. The MME derives the security parameters from the security parameters received from the SGSN.

7. The target eNodeB allocates the requested 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).

In addition to the information provided by the MME (KSI, key derivation parameter), the target eNodeB inserts eNB C-RNTI that is used to derive target eNB K_{eNB} as well as the RRC and UP keys into the UTRAN RRC message, which is contained in the Target to Source Transparent Container.

NOTE 4: This step is unmodified compared to TS 23.401.

8. *When resources for the transmission of user data between target RNC and new SGSN have been allocated and the new SGSN is ready for relocation of SRNS, the Forward Relocation Response (Cause, RAN Transparent Container, RANAP Cause, Target-RNC Information) message is sent from the new SGSN to the old SGSN. This message indicates that the target RNC is ready to receive from source SRNC the forwarded downlink PDUs, i.e., the relocation resource allocation procedure is terminated successfully. RAN transparent container and RANAP Cause are information from the target RNC to be forwarded to the source SRNC. The Target RNC Information, one information element for each RAB to be set up, contains the RNC Tunnel Endpoint Identifier and RNC IP address for data forwarding from the source SRNC to the target RNC. The Forward Relocation Response message is applicable only in case of inter-SGSN SRNS relocation.*

NOTE 5: This step is unmodified compared to pre-Rel-8. The new MME acts as the new SGSN, and the target eNodeB as the target SRNC.

9. *The old SGSN continues the relocation of SRNS by sending a Relocation Command message (Target RNC To Source RNC Transparent Container, RABs To Be Released, RABs Subject To Data Forwarding) to the source SRNC. The old SGSN decides the RABs to be subject for data forwarding based on QoS, and those RABs shall be contained in RABs subject to data forwarding. For each RAB subject to data forwarding, the information element shall contain RAB ID, Transport Layer Address, and Iu Transport Association. These are the same Transport Layer Address and Iu Transport Association that the target RNC had sent to new SGSN in Relocation Request Acknowledge message, and these are used for forwarding of downlink N-PDU from the source SRNC to the target RNC. The source SRNC is now ready to forward downlink user data directly to the target RNC over the Iu interface. This forwarding is performed for downlink user data only.*

NOTE 6: This step is unmodified compared to pre-Rel-8. The target eNodeB acts as the target RNC, and the new MME acts as the new SGSN. Note: <mark>The details of the data forwarding between eNodeB and source SRNC are FFS.</mark>

10. *The source SRNC may, according to the QoS profile, begins the forwarding of data for the RABs to be subject for data forwarding.*

NOTE 7: *The order of steps, starting from step 7 onwards, does not necessarily reflect the order of events. For instance, source RNC may start data forwarding (step 7), send the RRC message to MS (step 8) and forward SRNS Context message to the old SGSN (step 9) almost simultaneously.*

The data forwarding at SRNS relocation shall be carried out through the Iu interface, meaning that the GTP-PDUs exchanged between the source SRNC and the target RNC are duplicated in the source SRNC and routed at the IP layer towards the target RNC. For each radio bearer which uses lossless PDCP the GTP-PDUs related to transmitted but not yet acknowledged PDCP-PDUs are duplicated and routed at IP layer towards the target RNC together with their related downlink PDCP sequence numbers. The source RNC continues transmitting duplicates of downlink data and receiving uplink data.

Before the serving RNC role is not yet taken over by target RNC and when downlink user plane data starts to arrive to target RNC, the target RNC may buffer or discard arriving downlink GTP-PDUs according to the related QoS profile.

NOTE 8: This step is unmodified compared to pre-Rel-8. The new MME acts as the new SGSN, and the target eNodeB as the target SRNC. The data forwarding may go directly to target eNodeB or alternatively go via the Serving GW if so decided by new MME and or/ old SGSN in the preparation phase. <mark>The details of the data forwarding between eNodeB and source SRNC are FFS.</mark>

11. *Before sending the RRC message the uplink and downlink data transfer shall be suspended in the source SRNC for RABs, which require delivery order. The RRC message is for example Physical Channel Reconfiguration for RNS to RNS relocation, or Intersystem to UTRAN Handover for BSS to RNS relocation, or Handover from UTRAN Command for BSS relocation, or Handover Command for BSS to BSS relocation. When the source SRNC is ready, the source RNC shall trigger the execution of relocation of SRNS by sending to the MS the RRC message provided in the Target RNC to source RNC transparent container, e.g., a Physical Channel Reconfiguration (UE Information Elements, CN Information Elements) message. UE Information Elements include among others new SRNC identity and S-RNTI. CN Information Elements contain among others Location Area Identification and Routeing Area Identification.*

When the MS has reconfigured itself, it sends an RRC message e.g., a Physical Channel Reconfiguration Complete message to the target SRNC. If the Forward SRNS Context message with the sequence numbers is received, the exchange of packets with the MS may start. If this message is not yet received, the target RNC may start the packet transfer for all RABs, which do not require maintaining the delivery order.

NOTE 9: This step is unmodified compared to pre-Rel-8. This text is valid for the RRC message sent from source RNC to the UE. When the UE has got access to target eNodeB it sends the HO to E-UTRAN Complete message. This RRC message received as part of Target to Source Transparent Container, includes information about the selected security algorithms and related key information. Based on this information, the UE selects the same algorithms for the NAS in case the KSI value indicates that the MME has no security association with the UE. In case the KSI value indicates that the MME has a security association with the UE, but the UE has lost the security context of the E-UTRAN side (error case), the UE will start Attach procedure on the E-UTRAN side

12. *The source SRNC continues the execution of relocation of SRNS by sending a Forward SRNS Context (RAB Contexts) message to the target RNC via the old and the new SGSN. The Forward SRNS Context message is acknowledged by a Forward SRNS Context Acknowledge message, from new to old SGSN. The purpose of this procedure is to transfer SRNS contexts from the source RNC to the target RNC, and to move the SRNS role from the source RNC to the target RNC. SRNS contexts are sent for each concerned RAB and contain the sequence numbers of the GTP PDUs next to be transmitted in the uplink and downlink directions and the next PDCP sequence numbers that would have been used to send and receive data from the MS. PDCP sequence numbers are only sent by the source RNC for the radio bearers which used lossless PDCP [57]. The use of lossless PDCP is selected by the RNC when the radio bearer is set up or reconfigured. For PDP context(s) using delivery order not required (QoS profile), the sequence numbers of the GTP-PDUs next to be transmitted are not used by the target RNC.*

If delivery order is required (QoS profile), consecutive GTP-PDU sequence numbering shall be maintained throughout the lifetime of the PDP context(s). Therefore, during the entire SRNS relocation procedure for the PDP context(s) using delivery order required (QoS profile), the responsible GTP-U entities (RNCs and GGSN) shall assign consecutive GTP-PDU sequence numbers to user packets belonging to the same PDP context uplink and downlink, respectively.

The target RNC establishes and/or restarts the RLC and exchanges the PDCP sequence numbers (PDCP-SNU, PDCP-SND) between the target RNC and the MS. PDCP-SND is the PDCP sequence number for the next expected in-sequence downlink packet to be received by the MS per radio bearer, which used lossless PDCP in the source RNC. PDCP-SND confirms all mobile terminated packets successfully transferred before the SRNC relocation. If PDCP-SND confirms reception of packets that were forwarded from the source SRNC, then the target SRNC shall discard these packets. PDCP-SNU is the PDCP sequence number for the next expected in-sequence uplink packet to be received in the RNC per radio bearer, which used lossless PDCP in the source RNC. PDCP-SNU confirms all mobile originated packets successfully transferred before the SRNC relocation. If PDCP-SNU confirms reception of packets that were received in the source SRNC, the MS shall discard these packets.

NOTE 10: This step is unmodified compared to pre-Rel-8. The new MME acts as the new SGSN, and the target eNodeB as the target SRNC. The forward SRNS Context message from new MME to the target eNodeB is defined in TS 23.401. The whole SRNS context handling including PDCP sequence number handling and GTP numbering is FFS.

13. When the UE has successfully accessed the target eNodeB, the target eNodeB informs the target MME by sending the message Relocation Complete.

NOTE 11: This step is unmodified compared to TS 23.401.

14. *Upon receipt of Relocation Complete message, if the SRNS Relocation is an inter SGSN SRNS relocation, the new SGSN signals to the old SGSN the completion of the SRNS relocation procedure by sending a Forward Relocation Complete message.*

NOTE 12: This step is unmodified compared to pre-Rel-8. The new MME acts as the new SGSN.

15. The target MME will now complete the PS Handover procedure by informing the Serving GW that the target MME is now responsible for all the bearers the UE have established. This is performed in the message Update Bearer Request (Cause, Tunnel Endpoint Identifier Control Plane, NSAPI, MME Address for Control Plane, eNodeB Address(es) and TEID(s) for User Traffic, RAT type, local AMBR).

NOTE 13: This step is unmodified compared to TS 23.401.

16. The Serving GW informs the PDN GW the local AMBR and the change of for example the RAT type that e.g. can be used for charging, by sending the message Update Bearer Request (local AMBR). The PDN GW must acknowledge the request with the message Update Bearer Response. This is FFS.

NOTE 14: This step is unmodified compared to TS 23.401.

17. The Serving GW acknowledges the user plane switch to the target MME via the message Update Bearer Response (Cause, Tunnel Endpoint Identifier Control Plane, and Serving GW Address for Control Plane). At this stage the user plane path is established for all bearers between the UE, target eNodeB, Serving GW and PDN GW.

NOTE 15: This step is unmodified compared to TS 23.401.

18. *Upon receiving the Relocation Complete message or, if it is an inter-SGSN SRNS relocation, the Forward Relocation Complete message, the old SGSN sends an Iu Release Command message to the source RNC. When the RNC data-forwarding timer has expired, the source RNC responds with an Iu Release Complete message.*

NOTE 16: This step is unmodified compared to pre-Rel-8.

19. The eNB triggers the UE to initiate a Tracking Area Update procedure with the target MME. It is RAN functionality to provide the ECM-CONNECTED UE with the trigger information.

The target MME knows that an IRAT Handover has been performed for this UE as it received the bearer context(s) by handover messages and therefore the target MME performs only a subset of the TA update procedure, specifically it excludes the context transfer procedures between source SGSN and target MME.

20. The MME compares the AMBR from the 'EPS subscribed QoS profile' with the local AMBR it generated. If the two AMBRs are different, the MME shall initiate Subscribed QoS Modification procedure to notify the subscribed AMBR to the eNodeB, Serving GW and PDN GW.

If the SRNS Relocation is inter-SGSN, then the following CAMEL procedure calls shall be performed (see referenced procedures in TS 23.078 [29])

    C1)   CAMEL_GPRS_PDP_Context_Disconnection, CAMEL_GPRS_Detach and CAMEL_PS_Notification.

    They are called in the following order:

- *The CAMEL_GPRS_PDP_Context_Disconnection procedure is called several times: once per PDP context. The procedure returns as result "Continue".*

- *Then the CAMEL_GPRS_Detach procedure is called once. The procedure returns as result "Continue".*

- *Then the CAMEL_PS_Notification procedure is called once. The procedure returns as result "Continue".*

The new SGSN shall determine the Maximum APN restriction based on the received APN Restriction of each PDP context from the GGSN and then store the new Maximum APN restriction value.

If the SRNS Relocation is intra-SGSN, then the above mentioned CAMEL procedures calls shall not be performed.

If Routeing Area Update occurs, the SGSN shall determine whether Direct Tunnel can be used based on the received GPRS CAMEL Subscription Information. If Direct Tunnel can not be maintained the SGSN shall re-establish RABs and initiate the Update PDP Context procedure to update the IP Address and TEID for Uplink and Downlink data.

If Routeing Area Update occurs, then the following CAMEL procedure calls shall be performed (see referenced procedures in TS 23.078 [29]):

NOTE 17: This CAMEL handling is unmodified compared to pre-Rel-8.

NOTE 18: CAMEL procedure calls C2 and C3 were omitted intentionally from this procedure since EPS does not support CAMEL procedure calls.

D.3.5   Routeing Area Update

The Routeing Area Update procedure takes place when a UE that is registered with an MME or an S4-SGSN selects a UTRAN or GERAN cell served by a Gn/Gp SGSN. In this case, the UE changes to a Routeing Area that the UE has not yet registered with the network. This procedure is initiated by an idle state or by a connected state UE. The Routeing Area Update procedure is illustrated in Figure D.3.5-1.

Any step descriptions that are taken from TS 23.060 [7] for a Gn/Gp SGSN are shown as *italic* text and remain unmodified. In that step descriptions an MS stands for UE, old SGSN for old MME or old S4-SGSN and GGSN for P-GW. The old MME behave towards the new SGSN always like an old Gn/Gp 3G-SGSN, regardless whether the new SGSN is a 2G-SGSN or a 3G-SGSN.
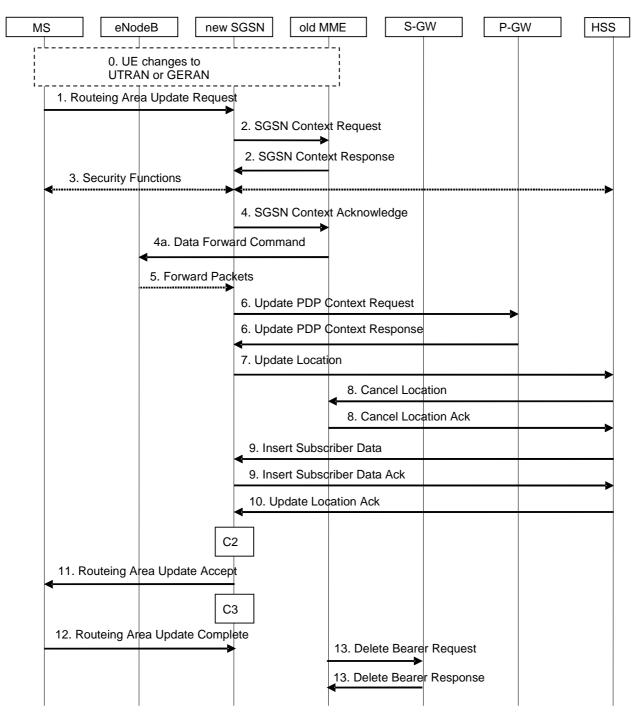
Figure D.3.5-1: Routeing Area Update procedure

0. The UE selects a UTRAN or GERAN cell. This cell is in a Routeing Area that is not yet registered with the network. The UE in ECM-CONNECTED state may change to the GERAN cell through Network Assisted Cell Change (NACC).

1. The MS sends a Routeing Area Update Request (old P-TMSI, old RAI, old P-TMSI Signature, Update Type, follow on request, Classmark, DRX parameters and MS Network Capability, additional P-TMSI/RAI) to the new SGSN. Update Type shall indicate RA update, periodic RA update, Combined RA / LA Update or Combined RA / LA Update with IMSI attach requested. The BSS shall add the Cell Global Identity including the RAC and LAC of the cell where the message was received before passing the message to the SGSN. The SRNC shall add the Routeing Area Identity before forwarding the message to the 3G-SGSN. Classmark contains the MS GPRS multislot capabilities and supported GPRS ciphering algorithms as defined in TS 24.008 [47]. DRX Parameters indicates whether or not the MS uses discontinuous reception and the DRX cycle length. The SGSN may use, as an implementation option, the follow-on request indication to release or keep the Iu connection after the completion of the RA update procedure.

If the UE's TIN indicates "GUTI" and the UE holds a valid GUTI then the UE indicates the GUTI as the old P-TMSI and old RAI. If the UE's TIN indicates "P-TMSI" or "RAT-related TMSI" and the UE holds a valid P-TMSI and related RAI then these two elements are indicated as old P-TMSI and old RAI. Mapping a GUTI to a P-TMSI and an RAI is specified in Annex H.

If the UE holds a valid P-TMSI and related RAI then the UE indicates these parameters as additional P-TMSI/RAI, regardless whether the old P-TMSI and old RAI indicate the same parameters or parameters mapped from a GUTI.

The old P-TMSI is indicated in the RAU Request message for Iu-mode only. For Gb mode the TLLI is derived from the value that is determined as the old P-TMSI according to the rules above. The routing parameter that is signalled in the RRC signalling to the RNC for routing to the SGSN is derived from the identifier that is signalled as the old P-TMSI according to the rules above. For a combined MME/SGSN the RAN is configured to route the NRI(s) of this combined node to the same combined node. The RAN is also configured to route NRI(s) of P-TMSIs that are generated by the UE's mapping of the GUTIs allocated by the combined node. Such a RAN configuration may also be used for separate nodes to avoid changing nodes in the pool caused by inter RAT mobility.

NOTE 1: This step is unmodified for an SGSN compared to pre-Rel-8.

2. *The new SGSN sends SGSN Context Request (old RAI, TLLI or old P-TMSI, old P-TMSI Signature, New SGSN Address) to the old SGSN to get the MM and PDP contexts for the MS. If the new SGSN provides functionality for Intra Domain Connection of RAN Nodes to Multiple CN Nodes, the new SGSN may derive the old SGSN from the old RAI and the old P-TMSI (or TLLI) and send the SGSN Context Request message to this old SGSN. Otherwise, the new SGSN derives the old SGSN from the old RAI. In any case the new SGSN will derive an SGSN that it believes is the old SGSN. This derived SGSN is itself the old SGSN, or it is associated with the same pool area as the actual old SGSN and it will determine the correct old SGSN from the P-TMSI (or TLLI) and relay the message to that actual old SGSN.*

NOTE 2: A GUTI mapped to a P-TMSI/RAI provides an old RAI that uniquely identifies an old MME then there is no need to relay between MME in the old pool, regardless whether the new SGSN supports such functionality or not. Mapping a GUTI to a P-TMSI and an RAI is specified in Annex H.

The old SGSN validates the old P-TMSI Signature and responds with an appropriate error cause if it does not match the value stored in the old SGSN. This should initiate the security functions in the new SGSN. If the security functions authenticate the MS correctly, the new SGSN shall send an SGSN Context Request (old RAI, TLLI, MS Validated, New SGSN Address) message to the old SGSN. MS Validated indicates that the new SGSN has authenticated the MS. If the old P-TMSI Signature was valid or if the new SGSN indicates that it has authenticated the MS, the old SGSN starts a timer. If the MS is not known in the old SGSN, the old SGSN responds with an appropriate error cause.

NOTE 3: For the new SGSN, this step is unmodified compared to pre-Rel-8. The MME (called old SGSN in above description) needs to provide SGSN functionality.

2b. *The old 3G SGSN responds with an SGSN Context Response (MM Context, PDP Contexts) message. For each PDP context the old 3G-SGSN shall include the GTP sequence number for the next uplink GTP PDU to be tunnelled to the GGSN and the next downlink GTP sequence number for the next PDU to be sent to the MS. Each PDP Context also includes the PDCP sequence numbers if PDCP sequence numbers are received from the old SRNS. The new 3G-SGSN shall ignore the MS Network Capability contained in MM Context of SGSN Context Response only when it has previously received an MS Network Capability in the Routeing Area Request. The GTP sequence numbers received from the old 3G-SGSN are only relevant if delivery order is required for the PDP context (QoS profile).*

NOTE 4: This step is for the Gn/Gp SGSN unmodified compared to pre-Rel-8. The MME or old S4-SGSN (old SGSN in this step) needs to map EPS bearer information to PDP contexts; this mapping is FFS. The Gn signalling between the new Gn/Gp SGSN and the old CN node has no capabilities to indicate ISR.

FFS whether and how to perform any data forwarding from eNodeB or S-GW to the SGSN.

3. *Security functions may be executed. These procedures are defined in clause "Security Function" in TS 23.060 [7]. Ciphering mode shall be set if ciphering is supported. If the SGSN Context Response message did not include IMEISV and ADD is supported by the SGSN, the SGSN retrieves the IMEISV from the MS.*

If the security functions fail (e.g. because the SGSN cannot determine the HLR address to establish the Send Authentication Info dialogue), the Inter SGSN RAU Update procedure fails. A reject shall be returned to the MS with an appropriate cause.

NOTE 5: This step is unmodified compared to pre-Rel-8.

4. *The new SGSN sends an SGSN Context Acknowledge message to the old SGSN.* The old MME (which is the old SGSN from the new SGSN's point of view) marks in its context that the information in the GWs and the HSS are invalid. This triggers the GWs, and the HSS to be updated if the UE initiates a Tracking Area Update procedure back to the old MME before completing the ongoing Routeing Area Update procedure. *If the security functions do not authenticate the MS correctly, then the routeing area update shall be rejected, and the new SGSN shall send a reject indication to the old SGSN.* The old MME shall continue as if the SGSN Context Request was never received.

NOTE 6: The new SGSN's operation is unmodified compared to pre-Rel-8. The handling within the MME may need further alignment with the Rel-8 inter RAT RAU, e.g. FFS whether this informs the old MME that the new SGSN is ready to receive data packets belonging to the activated PDP contexts and how to perform any data forwarding from eNodeB or S-GW to the SGSN.

4a. If the S1 user plane is established for the UE the old MME sends a Data Forward Command (Bearer ID, Transport Layer Address, S1 Transport Association) message to the eNodeB.

NOTE 7: This step describes pre-Rel-8 SGSN and RNC behaviour to be executed by the MME and eNodeB. Further evaluations needed, e.g. Data forwarding is FFS.

5. For each indicated Bearer ID the old eNodeB duplicates the buffered N-PDUs and starts tunnelling them to the new SGSN. For each Bearer ID which uses lossless PDCP the eNodeB shall start tunnelling the GTP-PDUs related to transmitted but not yet acknowledged PDCP-PDUs to the new SGSN together with their related downlink PDCP sequence numbers. Additional N-PDUs received from the SGW before the timer described in step 2 expires are also duplicated and tunnelled to the new SGSN. No N-PDUs shall be forwarded to the new SGSN after expiry of the timer described in step 2.

   The conversion of PDCP sequence numbers to SNDCP sequence numbers (the eight most significant bits shall be stripped off) is done by the new SGSN as defined in Rel-7 for GTPv1. This implies also that no N-PDU sequence numbers shall be indicated for these N-PDUs. GTPv0 at the SGSN would require a conversion by the SGW, which is not supported.

NOTE 8: This step describes pre-Rel-8 SGSN and RNC behaviour to be executed by the SGW and eNodeB. Further evaluations needed, e.g. Data forwarding is FFS.

6. *The new SGSN sends Update PDP Context Request (new SGSN Address, TEID, QoS Negotiated, serving network identity, CGI/SAI, RAT type, CGI/SAI/RAI change support indication, NRS) to the GGSNs concerned. The SGSN shall send the serving network identity to the GGSN. NRS indicates SGSN support of the network requested bearer control. The SGSN shall only indicate that it supports the procedure if it supports it and it is indicated that the MS also supports it in the SGSN Context Response message as described above. If the NRS is not included in the Update PDP Context Request message the GGSN shall, following this procedure, perform a GGSN-Initiated PDP Context Modification to change the BCM to 'MS-Only' for all PDP-Address/APN-pairs for which the current BCM is 'NW_Only'. The GGSNs update their PDP context fields and return Update PDP Context Response (TEID, Prohibit Payload Compression, APN Restriction, CGI/SAI/RAI change report required). The Prohibit Payload Compression indicates that the SGSN should negotiate no data compression for this PDP context.*

NOTE 9: This step is unmodified compared to pre-Rel-8.

7. *The new SGSN informs the HLR of the change of SGSN by sending Update Location (SGSN Number, SGSN Address, IMSI, IMEISV, Update Type) to the HLR. IMEISV is sent if the ADD function is supported.* Update Type indicates "normal update".

NOTE 10: This step is unmodified compared to pre-Rel-8. Clarifiaction about update type added to show that this is the trigger for the HSS to cancel only an old SGSN and not also an old MME.

8. The HLR sends Cancel Location (IMSI, Cancellation Type) to any old SGSN with Cancellation Type set to Update Procedure. The old SGSN removes the MM and EPS bearer contexts. The old SGSN acknowledges with Cancel Location Ack (IMSI).

NOTE 11: For the Gn/Gp SGSN the HSS interoperation is unmodified compared to earlier standards Releases. The handling within the MME may need further alignment with the Rel-8 inter RAT RAU, e.g. It is FFS whether the old MME or the eNodeB need to complete any forwarding of N-PDUs.

9. *The HLR sends Insert Subscriber Data (IMSI, GPRS Subscription Data) to the new SGSN. The new SGSN validates the UE's presence in the (new) RA. If due to regional subscription restrictions or access restrictions the MS is not allowed to be attached in the RA, the SGSN rejects the Routeing Area Update Request with an appropriate cause, and may return an Insert Subscriber Data Ack (IMSI, SGSN Area Restricted) message to the HLR. If the network supports the MOCN configuration for network sharing, the SGSN may, if the MS is not a 'Network Sharing Supporting MS', in this case decide to initiate redirection by sending a Reroute Command to the RNS, as described in TS 23.251 [24] instead of rejecting the Routeing Area Update Request. If all checks are successful, the SGSN constructs an MM context for the MS and returns an Insert Subscriber Data Ack (IMSI) message to the HLR.*

NOTE 12: This step is unmodified compared to pre-Rel-8.

10. *The HLR acknowledges the Update Location by sending Update Location Ack (IMSI) to the new SGSN.*

NOTE 13: This step is unmodified compared to pre-Rel-8.

11. If the new SGSN is a 2G-SGSN: *The new SGSN validates the MS's presence in the new RA. If due to roaming restrictions or access restrictions the MS, is not allowed to be attached in the SGSN, or if subscription checking fails, the new SGSN rejects the routeing area update with an appropriate cause. If all checks are successful, the new SGSN constructs MM and PDP contexts for the MS. A logical link is established between the new SGSN and the MS. The new SGSN responds to the MS with Routeing Area Update Accept (P-TMSI, P-TMSI Signature, Receive N-PDU Number). Receive N-PDU Number contains the acknowledgements for each acknowledged-mode NSAPI used by the MS, thereby confirming all mobile-originated N-PDUs successfully transferred before the start of the update procedure.*

If the new SGSN is a 3G-SGSN: *The new SGSN validates the MS's presence in the new RA. If due to roaming restrictions or access restrictions the MS is not allowed to be attached in the RA, or if subscription checking fails, the SGSN rejects the routeing area update with an appropriate cause. If the network supports the MOCN configuration for network sharing, the SGSN may, if the MS is not a 'Network Sharing Supporting MS', in this case decide to initiate redirection by sending a Reroute Command to the RNS, as described in TS 23.251 [24] instead of rejecting the routeing area update. If all checks are successful, the new SGSN establishes MM context for the MS. The new SGSN responds to the MS with Routeing Area Update Accept (P-TMSI, VLR TMSI, P-TMSI Signature).*

When receiving the RAU Accept message and there is no ISR indication the UE sets its TIN to "P-TMSI". As ISR is not indicated the UE sets in its internal data the update status of the GUTI to "update-needed".

NOTE 13a: A Gn/Gp SGSN never indicates ISR as it does not support ISR.

NOTE 14: For the SGSN this step is unmodified compared earlier standards Releases. It is FFS whether and how N-PDU numbers are used, e.g. the MME may set the numbers to 0 when creating a context for transferring to the SGSN.

12. If the new SGSN is a 2G-SGSN: *The MS acknowledges the new P-TMSI by returning a Routeing Area Update Complete (Receive N-PDU Number) message to the SGSN. Receive N-PDU Number contains the acknowledgements for each acknowledged-mode NSAPI used by the MS, thereby confirming all mobile-terminated N-PDUs successfully transferred before the start of the update procedure. If Receive N-PDU Number confirms reception of N-PDUs that were forwarded from the old SGSN, these N-PDUs shall be discarded by the new SGSN. LLC and SNDCP in the MS are reset.*

If the new SGSN is a 3G-SGSN: *The MS confirms the reallocation of the TMSIs by returning a Routeing Area Update Complete message to the SGSN.*

NOTE 15: This step is unmodified compared to pre-Rel-8. It is FFS whether and how N-PDU numbers are used, e.g. the UE might ignore any received N-PDU numbers. It is also FFS whether some sequence number handling is needed for the case of a 3G-SGSN, or whether continous sequence numbers can be used for UTRAN and E-UTRAN.

13. When the timer started in step 2) expires the old MME or the old S4-SGSN release any RAN and Serving GW resources.The old MME/old S4-SGSN deletes the EPS bearer resources by sending Delete Bearer Request

(TEID, cause) messages to the Serving GW. Cause indicates to the old Serving GW that the old Serving GW shall not initiate a delete procedure towards the PDN GW. The old MME/old S4-SGSN derives from the context transfer signalling that the new SGSN is a Gn/Gp SGSN and therefore any old S-GW resources are released by the old MME/old S4-SGSN. If the old S-GW has due to ISR a control connection with another CN node (MME or SGSN) then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that other old CN node.

NOTE 16: The new SGSN may initiate RAB establishment after execution of the security functions, or wait until completion of the RA update procedure. For the MS, RAB establishment may occur anytime after the Routeing Area Update Request is sent.

In the case of a rejected routeing area update operation, due to regional subscription, roaming restrictions, access restrictions (see TS 23.221 [27] and TS 23.008 [28]) or because the SGSN cannot determine the HLR address to establish the locating updating dialogue, the new SGSN shall not construct an MM context. A reject shall be returned to the MS with an appropriate cause. The MS does not re-attempt a routeing area update to that RA. The RAI value shall be deleted when the MS is powered-up. It is FFS whether the RAI value being deleted until power up as specified both here and in TS 23.060 [7] is correct.

If the network supports the MOCN configuration for network sharing, the SGSN may, if the MS is not a 'Network Sharing Supporting MS', in this case decide to initiate redirection by sending a Reroute Command to the RNS, as described in TS 23.251 [24] instead of rejecting the routeing area update.

If the new SGSN is unable to update the PDP context in one or more GGSNs, the new SGSN shall deactivate the corresponding PDP contexts as described in clause "SGSN-initiated PDP Context Deactivation Procedure". This shall not cause the SGSN to reject the routeing area update.

The PDP Contexts shall be sent from old to new SGSN in a prioritized order, i.e. the most important PDP Context first in the SGSN Context Response message. (The prioritization method is implementation dependent, but should be based on the current activity).

The new SGSN shall determine the Maximum APN restriction based on the received APN Restriction of each PDP context from the GGSN and then store the new Maximum APN restriction value.

If the new SGSN is unable to support the same number of active PDP contexts as received from old SGSN, the new SGSN should use the prioritisation sent by old SGSN as input when deciding which PDP contexts to maintain active and which ones to delete. In any case, the new SGSN shall first update all contexts in one or more GGSNs and then deactivate the context(s) that it cannot maintain as described in subclause "SGSN-initiated PDP Context Deactivation Procedure". This shall not cause the SGSN to reject the routeing area update.

NOTE 17: *In case MS was in PMM-CONNECTED state the PDP Contexts are sent already in the Forward Relocation Request message as described in subclause "Serving RNS relocation procedures" of TS 23.060 [7].*

If the routeing area update procedure fails a maximum allowable number of times, or if the SGSN returns a Routeing Area Update Reject (Cause) message, the MS shall enter IDLE state.

NOTE 18: The C1 CAMEL procedure call was omitted intentionally from this procedure since EPS does not support CAMEL procedure calls. The other CAMEL procedure calls are unmodified compared to pre-Rel-8.

The CAMEL procedure calls shall be performed, see referenced procedures in TS 23.078 [29]:

C2) *CAMEL_GPRS_Routeing_Area_Update_Session and CAMEL_PS_Notification.*

    They are called in the following order:

- *The CAMEL_GPRS_Routeing_Area_Update_Session procedure is called. The procedure returns as result "Continue".*

- *Then the CAMEL_PS_Notification procedure is called. The procedure returns as result "Continue".*

C3) *CAMEL_GPRS_Routeing_Area_Update_Context.*

D.3.6 Gn/Gp SGSN to MME Tracking Area Update

The Gn/Gp SGSN to E-UTRAN Tracking Area Update procedure takes place when a UE that is registered with a Gn/Gp SGSN selects an E-UTRAN cell. In this case, the UE changes to a Tracking Area that the UE has not yet registered with the network. This procedure is initiated by an ECM-IDLE state UE and may also be initiated if the UE is in ECM-CONNECTED state. The Pre-Rel-8 SGSN to MME Tracking Area Update procedure is illustrated in Figure D.3.6-1.

Any steps descriptions that are from TS 23.060 [7] are shown as italic text and remain unmodified. In those step descriptions an MS stands for UE, new SGSN for new MME, old SGSN for old Gn/Gp SGSN, GGSN for P-GW, and HLR for HSS.

UE | eNodeB | RNC BSC | MME | Gn/Gp SGSN | Serving GW | Old MME | PDN GW | PCRF | HSS

1. UE changes to an E-UTRAN TA

2. Tracking Area Update Request

3. Tracking Area Update Request

4. Context Request

5. Context Response

6. Security procedures

7. Context Acknowledge

C1

8. Forward packets

9. Create Bearer Request

10. Update Bearer Request (A)

11. PCEF Initiated IP-CAN Session Modification

12. Update Bearer Response

13. Create Bearer Response

14. Update Location

15. Cancel Location

16. Cancel Location Ack

17. Cancel Location

18. Iu Release Command

19. Iu Release Complete

20. Cancel Location Ack

21. Insert Subscriber Data

22. Insert Subscriber Data Ack

23. Update Location Ack

24. Tracking Area Update Accept

25. Tracking Area Update Complete

Figure D.3.6-1: Gn/Gp SGSN to MME Tracking Area Update procedure

NOTE 1: For a PMIP-based S5/S8, procedure steps (A) are defined in TS 23.402 [2]. Steps 13 and 15 concern GTP based S5/S8.

1. The UE selects an E-UTRAN cell of a Tracking Area that is not in the list of TAIs that the UE registered with the network or the UE reselects an E-UTRAN cell and is not registered or updated with the MME (e.g. periodic TAU timer expired while camping on GERAN or UTRAN) or the UE was in PMM_Connected state (e.g. URA_PCH) when it reselects an E-UTRAN cell.

2. The UE sends a Tracking Area Update Request (last visited TAI, P-TMSI Signature, old GUTI, UE Network Capability, active flag, EPS bearer status, additional GUTI, KSI, NAS sequence number, NAS-MAC) message together with an indication of the Selected Network to the eNodeB.

   If the UE's TIN indicates "GUTI" or "RAT-related TMSI" and the UE holds a valid GUTI then the old GUTI indicates this valid GUTI. If the UE's TIN indicates "P-TMSI" and the UE holds a valid P-TMSI and related RAI then these two elements are indicated as the old GUTI. Mapping a P-TMSI and an RAI to a GUTI is specified in Annex H.

   If the UE holds a valid GUTI then the UE indicates the GUTI as additional GUTI, regardless whether the old GUTI also indicates this GUTI or a GUTI mapped from a P-TMSI.

   The routing parameter that is signalled in the RRC signalling to the eNB for routing to the MME is derived from the identifier that is signalled as the old GUTI according to the rules above. For a combined MME/SGSN the eNB is configured to route the MME-code(s) of this combined node to the same combined node. This eNB is also configured to route MME-code(s) of GUTIs that are generated by the UE's mapping of the P-TMSIs allocated by the combined node. Such an eNB configuration may also be used for separate nodes to avoid changing nodes in the pool caused by inter RAT mobility.

NOTE 2: In the scenario of this flow the UE's TIN indicates "P-TMSI" and therefore the UE indicates a P-TMSI as the old GUTI.

   The last visited TAI is included if the UE has any in order to help the MME to produce a good list of TAIs for any subsequent TAU Accept message. Selected Network indicates the network that is selected. Active flag is a request by UE to activate the radio and S1 bearers for all the active EPS Bearers by the TAU procedure. The EPS bearer status indicates each EPS bearer that is active within the UE. The UE's ISR capability is included in the UE Network Capability element.

3. The eNodeB derives the MME from the old GUMMEI (contained within the old GUTI) and the indicated Selected Network. If that GUMMEI is not associated with the eNodeB, or the GUMMEI is not available, the eNodeB selects the MME as described in clause 4.3.8.3 on "MME Selection Function". The eNodeB forwards the TAU Request message together with the ECGI of the cell from where it received the message and with the Selected Network to the MME.

4. The new MME sends SGSN Context Request (old RAI, TLLI, old P-TMSI Signature, New SGSN Address) to the old SGSN to get the MM and PDP contexts for the UE.

   The new MME shall support functionality for Intra Domain Connection of RAN Nodes to Multiple CN Nodes, i.e. the MME derives the old SGSN from the old RAI and the old P-TMSI (or TLLI).

5. In case the old SGSN is a 2G-SGSN: *The old 2G-SGSN validates the old P TMSI Signature and responds with an appropriate error cause if it does not match the value stored in the old 2G SGSN. This should initiate the security functions in the new SGSN. If the security functions authenticate the MS correctly, the new SGSN shall send an SGSN Context Request (old RAI, old PTMSI, MS Validated, New SGSN Address) message to the old SGSN. MS Validated indicates that the new SGSN has authenticated the MS. If the old P-TMSI Signature was valid or if the new SGSN indicates that it has authenticated the MS, the old SGSN stops assigning SNDCP N-PDU numbers to downlink N-PDUs received, and responds with SGSN Context Response (MM Context, PDP Contexts). If the MS is not known in the old SGSN, the old SGSN responds with an appropriate error cause. The old SGSN stores New SGSN Address, to allow the old SGSN to forward data packets to the new SGSN. Each PDP Context includes the SNDCP Send N-PDU Number for the next downlink N-PDU to be sent in acknowledged mode to the MS, the SNDCP Receive N-PDU Number for the next uplink N-PDU to be received in acknowledged mode from the MS, the GTP sequence number for the next downlink N-PDU to be sent to the MS and the GTP sequence number for the next uplink N-PDU to be tunnelled to the GGSN. The old SGSN starts a timer and stops the transmission of N-PDUs to the MS. The new SGSN shall ignore the MS Network Capability contained in MM Context of SGSN Context Response only when it has previously received an MS Network Capability in the Routeing Area Request.*

   In case the old SGSN is a 3G-SGSN: *The old 3G-SGSN validates the old P TMSI Signature and responds with an appropriate error cause if it does not match the value stored in the old SGSN. This should initiate the security functions in the new SGSN. If the security functions authenticate the MS correctly, the new SGSN shall send an SGSN Context Request (IMSI, old RAI, MS Validated) message to the old 3G-SGSN. MS Validated indicates that the new SGSN has authenticated the MS. If the old P TMSI Signature was valid or if the new SGSN indicates that it has authenticated the MS, the old SGSN starts a timer. If the MS is not known in the old SGSN, the old 3G-SGSN responds with an appropriate error cause.*

The old 3G SGSN responds with an SGSN Context Response (MM Context, PDP Contexts) message. For each PDP context the old 3G SGSN shall include the GTP sequence number for the next uplink GTP PDU to be tunnelled to the GGSN and the next downlink GTP sequence number for the next PDU to be sent to the MS. Each PDP Context also includes the PDCP sequence numbers if PDCP sequence numbers are received from the old SRNS. The new 3G-SGSN shall ignore the MS Network Capability contained in MM Context of SGSN Context Response only when it has previously received an MS Network Capability in the Routeing Area Request. The GTP sequence numbers received from the old 3G-SGSN are only relevant if delivery order is required for the PDP context (QoS profile).

Editor note: It is FFS whether the NRI is also duplicated by the UE to be put in a separate MME field, it is expected that the UE will send NRI in the appropriate field depending on current RAT.

NOTE 3: In this step, the new "SGSN" shall be understood to be a new "MME" and the old SGSN stores new SGSN Address, to allow the old SGSN to forward data packets to the new "S-GW or eNodeB". This step describes both the 2G and 3G SGSN variants due to combining the 2G or 3G SGSN to MME TAU into a single procedure.

NOTE 4: For the old SGSN, this step is unmodified compared to pre-Rel-8. The MME (called new SGSN in above description) must provide SGSN functionality which includes mapping PDP contexts to EPS bearer information.

6. Security functions may be executed. Procedures are defined in clause 5.3.10 on Security Function. If the SGSN Context Response message from the old SGSN did not include IMEISV, the MME shall retrieve the ME Identity (the IMEISV) from the UE.

7. The new MME sends an SGSN Context Acknowledge message to the old SGSN. *This informs the old SGSN that the new SGSN is ready to receive data packets belonging to the activated PDP contexts. The old SGSN marks in its context that the MSC/VLR association and the information in the GGSNs and the HLR are invalid. This triggers the MSC/VLR, the GGSNs, and the HLR to be updated if the MS initiates a routeing area update procedure back to the old SGSN before completing the ongoing routeing area update procedure.*

If the security functions do not authenticate the UE correctly, then the Tracking area update shall be rejected, and the new MME shall send a reject indication to the old SGSN. *The old SGSN shall continue as if the SGSN Context Request was never received.*

NOTE 5: in the *italic* text of this step, new "SGSN" shall be understood as to be a new "MME".
The MME needs to map PDP contexts received from pre-Rel-8 SGSN into EPS bearer information. The GGSN address(es) and TEIDs map to the PDN GW address(es) and TEIDs respectively. Other aspects of this mapping is FFS.

NOTE 6: The SGSN operation is unmodified compared to pre-Rel-8. The handling within the MME may need further alignment with the Rel-8 inter RAT RAU, e.g. FFS whether this informs the old SGSN that the new MME is ready to receive data packets belonging to the activated PDP contexts and how to perform any data forwarding from BSS or SGSN to the eNodeB.

NOTE 7: The Gn signalling between the new MME and the old Gn/Gp SGSN has no capabilities to indicate ISR.

Editor's note: It is FFS when eNodeB resources are allocated and how transfer of data with the eNodeB will take place

If there is no PDP context suitable for default bearer or no PDP context at all, the MME rejects the TAU Request.

Editor's note: It is FFS whether a TAU Accept can be done instead with an indication that default bearer is not established.

8. The old SGSN or the old RNC forward data to the eNodeB (FFS).

9. The new MME adopts the bearer contexts received from the SGSN as the UE's EPS bearer contexts to be maintained by the new MME. The new MME maps the PDP contexts to the EPS bearers 1-to-1 and maps the pre-Rel-8 QoS parameter values of a PDP context to the EPS QoS parameter values of an EPS bearer as defined in Annex E. The MME establishes the EPS bearer(s) in the indicated order. The MME deactivates the EPS bearers which cannot be established.

The MME verifies the EPS bearer status received from the UE with the bearer contexts received from the old SGSN and releases any network resources related to EPS bearers that are not active in the UE. If the UE has no PDP context, the MME rejects the TAU Request.

The new MME selects a Serving GW and sends an Create Bearer Request (IMSI, MME Context ID, PDN GW address and TEID, QoS Negotiated converted FFS, serving network identity, ME Identity, CGI/SAI, RAT type, ECGI/SAI/RAI change support indication, NRS (received from the SGSN), ISR) message to the Serving GW. The MME shall send the serving network identity to the Serving GW. The information element ISR indicates that ISR is not established.

10. The Serving GW creates contexts and informs the PDN GW(s) about the change of the RAT type. The Serving GW sends an Update Bearer Request (Serving GW Address and TEID, RAT type, ME Identity) message to the PDN GW(s) concerned.

11. If dynamic PCC is deployed, and RAT type information needs to be conveyed from the PDN GW to the PCRF, then the PDN GW shall send RAT type information to the PCRF by performing an IP-CAN Session Establishment procedure as defined in TS 23.203 [6].

NOTE 8: The PDN GW does not need to wait for the PCRF response, but continues in the next step. If the PCRF response leads to an EPS bearer modification the PDN GW should initiate a bearer update procedure.

12. The PDN GW updates its context field and returns an Update Bearer Response (PDN GW address and TEID, MSISDN) message to the Serving GW. The MSISDN is included if the PDN GW has it stored in its UE context.

13. The Serving GW updates its context and returns an Create Bearer Response (MME Context ID, Serving GW address and TEID for user plane, PDN GW address and TEID, Serving GW Context ID) message to the new MME.

14. To ensure the release of all UE resources in the Gn/Gp SGSN the new MME informs the HSS of the change of the serving core network node by sending an Update Location (MME Address, IMSI, ME Identity, Update Type) message to the HSS. The ME Identity is included if the SGSN Context Response did not contain the IMEISV. Because of interoperation with an Gn/Gp SGSN, which the new MME identifies from the Context Response signalling, the Update Type is set to "MME only registration".

15. If the MME changes, then the HSS cancels any old MME as the Update Type indicates "MME only registration". The HSS sends a Cancel Location (IMSI, Cancellation type) message to the old MME, with a Cancellation Type set to Update Procedure.

16. The old MME removes the MM context.

The old MME releases any local bearer resources and it deletes the EPS bearer resources by sending Delete Bearer Request (Cause, TEID) messages to the Serving GW. Cause indicates that the S-GW shall not initiate a delete procedure towards the PDN GW. If ISR is active on the S-GW then the S-GW deletes the bearer resources on the other old CN node by sending Delete Bearer Request message(s) to that CN node.

The old MME acknowledges with a Cancel Location Ack (IMSI) message.

17. The HSS cancels any old SGSN node as the Update Type indicates "MME only registration". *The HSS sends a Cancel Location (IMSI, Cancellation Type) message to the old SGSN. The old SGSN removes the contexts.*

If the timer started in step 5 is not running, the old SGSN removes the MM context. Otherwise, the contexts are removed when the timer expires. It also ensures that the MM context is kept in the old SGSN for the case the UE initiates another TAU procedure before completing the ongoing TAU procedure to the new MME.

18. *On receipt of Cancel Location, if the MS is PMM CONNECTED in the old SGSN, the old SGSN sends an Iu Release Command message to the old SRNC.*

19. *When the data-forwarding timer has expired, the SRNS responds with an Iu Release Complete message.*

20. *The old SGSN acknowledges with a Cancel Location Ack (IMSI) message.*

21. The HSS sends Insert Subscriber Data (IMSI, Subscription Data) to the new MME.

22. 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 be attached in the TA, the MME rejects the Tracking Area Update Request with an appropriate cause, and may return an Insert Subscriber Data Ack (IMSI, MME Area Restricted) message

to the HSS. If all checks are successful, the MME constructs an MM context for the UE and returns an Insert Subscriber Data Ack (IMSI) message to the HSS.

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

24. The new MME responds to the UE with a Tracking Area Update Accept (GUTI, TAI-list, EPS bearer status, KSI, NAS sequence number, NAS-MAC, NAS security algorithm)) message. Restriction list shall be sent to eNodeB as eNodeB handles the roaming restrictions and access restrictions in the Intra E-UTRAN case.

    If the "active flag" is set in the TAU Request message the user plane setup procedure can be activated in conjunction with the TAU Accept message. The procedure is described in detail in TS 36.300 [5]. The messages sequence should be the same as for the UE triggered Service Request procedure specified in clause 5.3.4.1 from the step when MME establishes the bearer(s). If the active flag is set the MME may provide the eNodeB with Handover Restriction List. Handover Restriction List is described in clause 4.3.5.7 "Mobility Restrictions". The EPS bearer status indicates the active bearers in the network. The UE removes any internal resources related to bearers not marked active in the received EPS bearer status.

    When receiving the TAU Accept message and there is no ISR indication the UE sets its TIN to "GUTI". When ISR is not indicated the UE clears any internal ISR status by setting its internal update status for the P-TMSI to "update-needed".

NOTE 8: In the case of interoperation with Gn/Gp SGSNs ISR is never indicated by the MME as the SGSN does not support ISR, which the new MME recognises from Gn interface signalling that does not support ISR indications.

25. If the GUTI was included in the TAU Accept message, the UE acknowledges the message by returning a Tracking Area Update Complete message to the MME.

NOTE 9: The new MME may initiate RAB establishment after execution of the security functions (step 5), or wait until completion of the TA update procedure. For the UE, RAB establishment may occur anytime after the TA update request is sent (step 2).

In the case of a rejected tracking area update operation, due to regional subscription, roaming restrictions, or access restrictions (see TS 23.221 [27] and TS 23.008 [28]) the new MME shall not construct a bearer context. A reject shall be returned to the UE with an appropriate cause and the S1 connection shall be released. Upon return to idle, the UE shall act according to TS 23.122 [10].

If the new MME is unable to update the bearer context in one or more P-GWs, the new MME shall deactivate the corresponding bearer contexts as described in subclause "MME Initiated Dedicated Bearer Deactivation Procedure". This shall not cause the MME to reject the tracking area update.

The PDP Contexts shall be sent from old SGSN to new SGSN (MME) in a prioritized order, i.e. the most important PDP Context first in the SGSN Context Response message. (The prioritization method is implementation dependent, but should be based on the current activity).

The new MME shall determine the Maximum APN restriction based on the received APN Restriction of each bearer context from the P-GW and then store the new Maximum APN restriction value.

If the new MME is unable to support the same number of active bearer contexts as received from old SGSN, the new MME should use the prioritisation sent by old SGSN as input when deciding which bearer contexts to maintain active and which ones to delete. In any case, the new MME shall first update all contexts in one or more P-GWs and then deactivate the context(s) that it cannot maintain as described in subclause "MME Initiated Dedicated Bearer Deactivation Procedure". This shall not cause the MME to reject the tracking area update.

NOTE 10: In case MS (UE) was in PMM-CONNECTED state the PDP Contexts are sent already in the Forward Relocation Request message as described in subclause "Serving RNS relocation procedures" of TS 23.060 [7].

If the tracking area update procedure fails a maximum allowable number of times, or if the MME returns a Tracking Area Update Reject (Cause) message, the UE shall enter EMM DEREGISTERED state.

If the Update Location Ack message indicates a reject, this should be indicated to the UE, and the UE shall not access non-PS services until a successful location update is performed.

The CAMEL procedure calls shall be performed, see referenced procedures in TS 23.078 [29]:

   C1)   *CAMEL_GPRS_PDP_Context_Disconnection, CAMEL_GPRS_Detach and CAMEL_PS_Notification.*

   They are called in the following order:

   -   *The CAMEL_GPRS_PDP_Context_Disconnection procedure is called several times: once per PDP context. The procedure returns as result "Continue".*

   -   *Then the CAMEL_GPRS_Detach procedure is called once. The procedure returns as result "Continue".*

   -   *Then the CAMEL_PS_Notification procedure is called once. The procedure returns as result "Continue".*

NOTE 11: This CAMEL handling is unmodified compared to pre-Rel-8.

NOTE 12: CAMEL procedure calls C2 and C3 were omitted intentionally from this procedure since EPS does not support CAMEL procedure calls.

Annex E (normative):
Mapping between EPS and pre-Rel-8 QoS parameters

This annex specifies how the QoS parameter values of an EPS bearer (E-UTRAN access to the EPS) should be mapped to/from the pre-Rel-8 QoS parameter values of a PDP context (UTRAN/GERAN access to the EPS) before a procedure is triggered that executes a handover between E-UTRAN and UTRAN/GERAN.

The following mapping rules hold:

- There is a one-to-one mapping between an EPS bearer and a PDP context.

Editor's Note: The handling of this principle in case of "dual stack IPv4/IPv6 bearers" is FSS.

- The EPS bearer parameters ARP is mapped one-to-one to/from the pre-Rel-8 bearer parameter ARP.

Editor's Note: Note that in GPRS pre-Rel-8 the same UE/PDN connection, the system does not expect to have two or more PDP contexts with different ARP values. This is different in EPS. It is FFS whether this causes conflict / errors or whether a specific mapping rule for ARP is needed.

- The EPS bearer parameters GBR and MBR of a GBR EPS bearer are mapped one-to-one to/from the pre-Rel-8 bearer parameters GBR and MBR of a PDP context associated with Traffic class 'conversational' or 'streaming'.

Editor's Note: The details of the mapping of GBR, and MBR between GBR EPS bearers and conversational / streaming PDP contexts should be captured in stage 3 specs. Once done this editor's note will be replaced with a corresponding reference.

- At handover from E-UTRAN to UTRAN/GERAN the pre-Rel-8 bearer parameter MBR of PDP contexts associated with Traffic Class 'interactive' or 'background' is set based on MME operator policy.

NOTE 1: In order to apply the concept of AMBR in UTRAN/GERAN, one such policy may be to set the sum of those MBRs to not exceed the value of the EPS bearer parameter AMBR.

NOTE 2: In order to ensure that the MBR of PDP contexts associated with Traffic Class 'interactive' or 'background' are restored to their previous values when handing over again from E-UTRAN to UTRAN/GERAN, one such policy may be to have an MME store at handover from UTRAN/GERAN to E-UTRAN the pre-Rel-8 bearer parameter MBR of PDP contexts associated with Traffic Class 'interactive' or 'background'.

- At handover from UTRAN/GERAN to E-UTRAN the AMBR from the EPS subscribed QoS profile for the corresponding APN shall take precedence. In case of handover from a pre-Rel8 SGSN and if the MME has no subscribed AMBR value for the UE, the MME provides a local AMBR to the eNodeB, Serving GW and PDNGW until MME gets the EPS subscribed AMBR. This local AMBR may be for example based on the summing up of pre-Rel-8 bearer parameter MBR of all the interactive / background PDP contexts or on internal configuration. When the MME gets the subscribed AMBR value from the HSS, it compares it with the local AMBR and if the two AMBRs are different, the MME initiates HSS Initiated Subscribed QoS Modification procedure to notify the subscribed AMBR to the eNodeB, Serving GW and PDNGW.

Editor's note: Handling of AMBR in case of handover from Rel8 SGSN is FFS.

- A standardized value of the EPS bearer parameter QCI is mapped one-to-one to/from values of the pre-Rel-8 parameters Traffic Class, Traffic Handling Priority, Signalling Indication, and Source Statistics Descriptor as shown in Table E-1.

- At handover from E-UTRAN to UTRAN/GERAN the setting of the values of the pre-Rel-8 parameters Transfer Delay and SDU Error Ratio should be derived from the corresponding QCI's Packet Delay Budget and Packet Loss Rate, respectively. At handover from UTRAN/GERAN to E-UTRAN the values of the pre-Rel-8 parameters Transfer Delay and SDU Error Ratio should be ignored.

- The setting of the values of all other pre-Rel-8 QoS is based on operator policy pre-configured in the MME.

Table E-1: Mapping between standardized QCIs and pre-Rel-8 QoS parameter values

QCI	Traffic Class	Traffic Handling Priority	Signaling Indication	Source Statistics Descriptor
1	Conversational	N/A	N/A	Speech
2	Conversational	N/A	N/A	Unknown
FFS	Streaming	N/A	N/A	Speech
3	Streaming	N/A	N/A	Unknown
5	Interactive	1	Yes	N/A
7	Interactive	1	No	N/A
6	Interactive	2	No	N/A
8	Interactive	3	No	N/A
9	Background	N/A	N/A	N/A

Editor's Note: The mapping of QCI 4 is FFS.

Annex F (normative):
Dedicated bearer activation in combination with the default bearer activation at Attach and UE requested PDN connectivity procedures

It shall be possible for the PDN GW to initiate the activation of dedicated bearers (as specified in clause 5.4.1) as part of the attach procedure (as specified in clause 5.3.2.1) or as part of the UE requested PDN connectivity procedure (as specified in clause 5.10.2) over EUTRAN. However the result of the dedicated bearer activation procedure shall be logically separate from the Attach procedure, meaning that the result of the Attach procedure is not dependent on whether the Dedicated bearer activation procedure succeeds or not. On the other hand, the dedicated bearer activation may only be regarded as successful if the Attach procedure completes successfully.

The messages of the Dedicated bearer activation can be sent together with the messages of the Attach procedure or of the UE requested PDN connectivity procedure (i.e. Attach accept or PDN Connectivity Accept), as shown in the Figure and explanation below.

> Editor's note: It is considered a stage 3 question whether the Create Default Bearer Response message is piggybacked with the Create Dedicated Bearer Request on S5/S8 and S11, or alternatively other ways are used to tie those messages together such that the MME can recognize that a Create Default Bearer Response message is combined with a Create Dedicated Bearer Request message. However, it is necessary to ensure that the UE sees that the Dedicated Bearers are established at Attach in order to prevent the UE requesting establishment of the (the same) dedicated resources immediately following the Attach Accept message.

On the S1 and Uu interfaces the messages for the default bearer activation at Attach and UE requested PDN connectivity procedures and for the Dedicated Bearer Activation procedure are combined into a single message. If the MME has sent an Attach Accept message towards the eNodeB, and then the MME receives a Create Dedicated Bearer Request before the MME receives the Attach Complete message, the MME shall wait for the Attach procedure to complete before the MME continues with Dedicated Bearer Activation procedure.

It shall be possible that multiple dedicated bearers can simultaneously be activated in the signaling flow shown below.
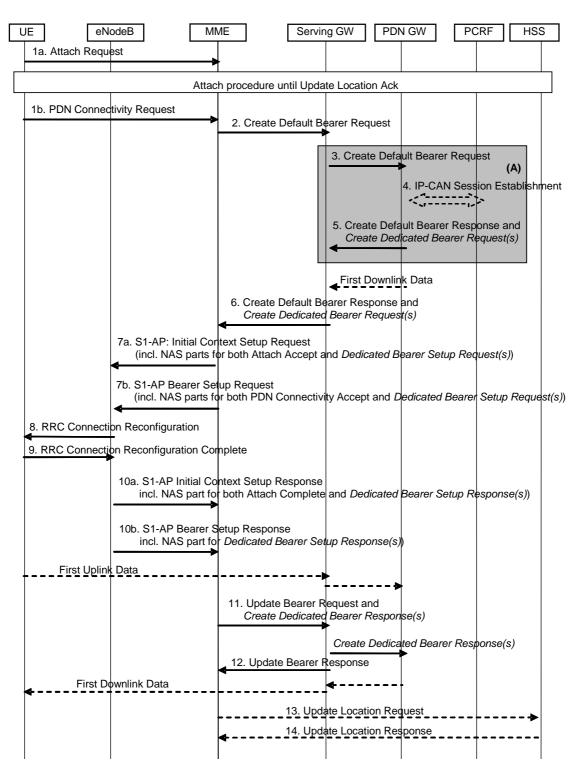
Figure F.1: Dedicated bearer activation in combination with the default bearer activation at attach or UE requested PDN connectivity

NOTE 1: Parameters related to dedicated bearer activation are written in italics.

Figure F.1 describes the activation of dedicated bearer(s) in combination with the default bearer activation either as part of the Attach procedure (with specific steps 1a, 7a, 10a) or as part of the UE requested PDN connectivity procedure (with specific steps 1b, 7b, 10b). The following steps below require special attention:

5. (On the P-GW-S-GW interface) Create Default Bearer Response message of the Attach procedure or UE-requested PDN connectivity procedure is combined with Create Dedicated Bearer Request message of the Dedicated Bearer Activation Procedure

6. (On the S-GW-MME interface) Create Default Bearer Response message of the Attach procedure or UE-requested PDN connectivity procedure is combined with the Create Dedicated Bearer Request message of the Dedicated Bearer Activation Procedure

7a. In case of Attach procedure: If the MME receives a Create Default Bearer Response message combined with a Create Dedicated Bearer Request message, the MME shall send the S1-AP Initial Context Setup Request message to the eNodeB, including the NAS parts for both the Attach Accept message of the Attach procedure and the Bearer Setup Request of the Bearer Activation Procedure.

NOTE 2: The MME shall not send a Bearer Setup Request message of a new Dedicated Bearer Activation procedure to the eNodeB before sending the Attach Accept message of the Attach procedure to the eNodeB. If the MME has already sent the Attach Accept message of the Attach procedure to the eNodeB, the MME shall wait for the Attach Complete message to arrive before sending a separate Bearer Setup Request of a Dedicated Bearer Activation procedure.

7b. In case of UE requested PDN connectivity procedure: If the MME receives a Create Default Bearer Response message combined with a Create Dedicated Bearer Request message, the MME shall send the S1-AP Bearer Setup Request message to the eNodeB, including the NAS parts for both the PDN Connectivity Accept message and the Bearer Setup Request of the Bearer Activation Procedure.

8-9. The radio bearer establishment of the default and dedicated bearer(s) is performed in the same RRC message.

10a. In case of Attach procedure: The eNodeB sends the S1-AP Initial Context Setup Response message to the MME, which contains the NAS parts for both the Attach Complete message of the Attach procedure and the Bearer Setup Response of the Dedicated Bearer Activation Procedure.

10b. In case of UE requested PDN connectivity procedure: The eNodeB sends the S1-AP Bearer Setup Response message to the MME, which contains the NAS parts for the Bearer Setup Response of the Dedicated Bearer Activation Procedure.

11. The Update Bearer Request message of the Attach procedure or UE requested PDN connectivity procedure is combined with the Create Dedicated Bearer Response message of the Dedicated Bearer Activation Procedure. After that, the Serving GW continues with sending a Create Dedicated Bearer Response message to the PDN GW.

Annex G:
Void

Annex H (normative):
Mapping between temporary and area identities

This annex provides information on the mapping of these identities, e.g. for the construction of the Routeing Area Update Request message in GERAN/UTRAN or Tracking Area Update Request message in E-UTRAN.

Clause 5.2 of this specification contains information on the EPS Identities.

In E-UTRAN,

<GUTI> = <GUMMEI><M-TMSI>,

where <GUMMEI> = <MCC><MNC><MME Identifier>

and <MME Identifier> = <MME Group ID><MME Code>

MCC and MNC have the same field size as in pre release 8 3GPP systems.

M-TMSI is aof 32 bits length.

MME Code is of 8 bits length.

MME Group ID is of 16 bits length.

In GERAN and UTRAN,

<RAI> = <MCC><MNC><LAC><RAC>

<P-TMSI>   Includes mapped NRI

P-TMSI is of 32 bits length where the two topmost bits are reserved and always set to 11. This is needed since the GERAN representation of P-TMSI, on the form TLLI, impose this restriction. Hence, for a UE which may handover to GERAN/UTRAN (based on subscription and UE capabilities), the corresponding bits in the M-TMSI are set to 11.

The NRI field is of variable length and is mapped into the P-TMSI starting at bit 23 and down to bit 14. The most significant bit of the NRI is located at bit 23 of the P-TMSI regardless of the configured length of the NRI.

The P-TMSI and NRI are defined by TS 23.003 [9].

In case of a combined MME-SGSN node, the NRI of the SGSN part and the MME code of the MME part refer to the same combined node. RAN configuration allows NAS messages on GERAN/UTRAN and E-UTRAN to be routed to the same combined node. The same or different values of NRI and MME code may be used for a combined node.

The mapping of the GUTI is done to the combination of RAI of GERAN / UTRAN and the P-TMSI:

E-UTRAN <MCC>   maps to GERAN/UTRAN <MCC>

E-UTRAN <MNC>   maps to GERAN/UTRAN <MNC>

E-UTRAN <MME Group ID> maps to GERAN/UTRAN <LAC>

E-UTRAN <S-TMSI>   maps as follows:

- E-UTRAN <MME Code> maps to GERAN/UTRAN <RAC> and is also copied into the 8 most significant bits of the NRI field within the P-TMSI;

- 22 bits of the E-UTRAN <M-TMSI> is mapped into the remaining 22 bits of the GERAN/UTRAN <P-TMSI>; and

- the remaining 8 bits of the E-UTRAN <M-TMSI> are copied into 8 bits of the <P-TMSI signature> field.

For UTRAN, the 10-bit long NRI bits are masked out from the P-TMSI and also supplied to the RAN node as IDNNS (Intra Domain NAS Node Selector).

The mapping of P-TMSI (TLLI) and RAI in GERAN/UTRAN to GUTI in E-UTRAN is performed as follows.

GERAN/UTRAN <MCC> maps to E-UTRAN <MCC>

GERAN/UTRAN <MNC> maps to E-UTRAN <MNC>

GERAN/UTRAN <LAC> maps to E-UTRAN <MME Group ID>

GERAN/UTRAN <RAC> maps to 8 bits of the M-TMSI

The 8 most significant bits of GERAN/UTRAN <NRI> maps to the MME code

GERAN/UTRAN <P-TMSI or TLLI> excluding the 8 most significant bits at the NRI position maps to the remaining bits of the M-TMSI.

The values of <LAC> and <MME group id> shall be disjoint so that they can be differentiated. It is recommended that the most significant bit of the <LAC> shall be set to zero; and the most significant bit of <MME group id> shall be set to one.

During RRC connection establishment for Attach Request and Tracking Area Update Request over E-UTRAN, the full PLMN id is signalled to the eNodeB in order to enable routing to the appropriate MME.

Annex I (informative): Guidance for contributors to this specification

The following guidance is provided for drafting figures for this specification TS 23.401 that contain specific steps which are different in TS 23.402 [2] due to the PMIP-based S5/S8 interface:

- Message flows to this specification will contain the complete procedures applicable for GTP-based S5/S8 only.

- In this specification, section(s) of a message flow that is different for PMIP-based S5/S8 interface are shown surrounded by shaded box indexed by an upper-case letter in ascending order, e.g. "A", "B", "C", etc.

For example, at the bottom of the flow, the following text should be included:

"NOTE: Procedure steps (A) and (B) for an PMIP-based S5/S8 interface are defined in TS 23.402 [2]."

- Further guidance for drafting procedures for TS 23.402 [2] can be found in that specification itself.

Annex J (informative): High Level ISR flows

The high level ISR flows show only the handling of the TMSIs for simplification. Related RAs/TAs are always signalled with the TMSIs when defined by the detailed procedures. Also other IEs are not shown when not necessary for the high level description.

This Annex will be removed once the ISR functionality is captured by the detailed procedures.

ISR follows following principles:

- UE registers to the MME and SGSN separately;

- MME and SGSN register to the HSS and the HSS maintain two PS registrations;

- UE needs to be informed by the CN nodes (SGSN and MME) if the ISR functionality is activated or deactivated for that UE;

- There is no "signaling free reselection" of an E-UTRAN cell by a UE in URA_PCH state (e.g. URA_PCH is treated as active mode by the UE/EPC when moving to E-UTRAN);

- When ISR is activated for 2G and/or 3G, Idle Mode UP Termination is in S-GW for that RAT;

- The Serving GW needs to be informed if the ISR functionality is activated or deactivated for a UE;

- Two periodic update timers, running separately in the UE for updating SGSN and MME separately:

- Functionality is needed in SGSN and MME to avoid the deletion of the PDP context/EPS Bearers because of missing periodic updates.

- HSS keeps double registration for MME and R8 SGSN.

- When a UE moves from a Pre-8 SGSN to MME, the SGSN registration at HSS is cancelled.

- When ISR is activated, the CN entity stores the control plane address of the other RAT CN entity.

- When an ISR deactivated UE (including URA_PCH UE) changes the RAT, the UE initiates update with Update Type "ISR synch".

- The ISR activated UE will set internally "ISR synch need" in case there is any bearer change in the currently used RAT. When the ISR activated UE with "ISR synch need" changes to another RAT, it will initiate update with Update Type "ISR synch". After the update with Update Type as "ISR synch", "ISR synch need" is unset in UE.

- When an ISR activated UE moves from URA_PCH into E-UTRAN, it initiates update. If there is no "ISR synch need", the Update Type is "URA_PCH handling"; else the Update Type is "ISR synch".

- In other cases (i.e. no ISR synch and no URA_PCH handling), the UE initiates update with Update Type as "RA updating" or "TA updating" when moving out of the registered area; and the UE initiates update with Update Type as "periodic updating" when the current RAT periodic timer expires or when the UE changes the RAT and it memorises that the current RAT periodic timer expired when the UE camped on the other RAT.
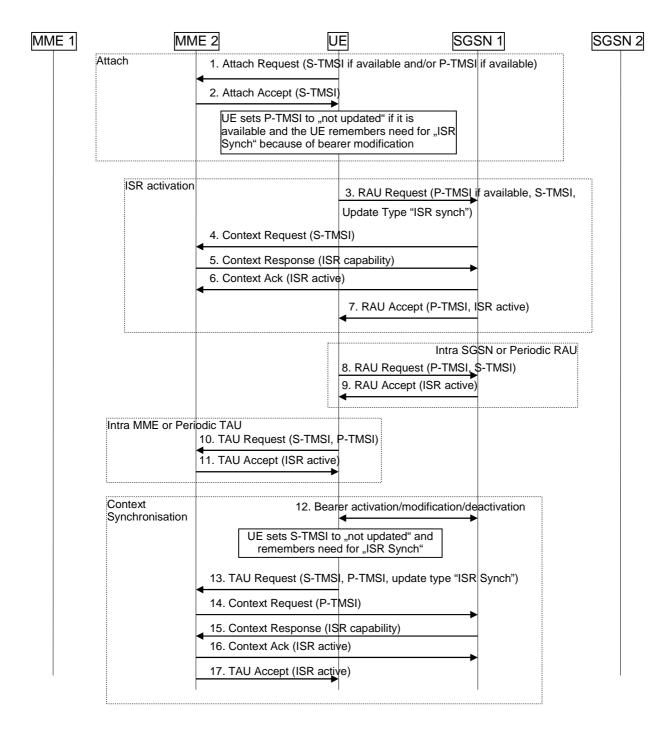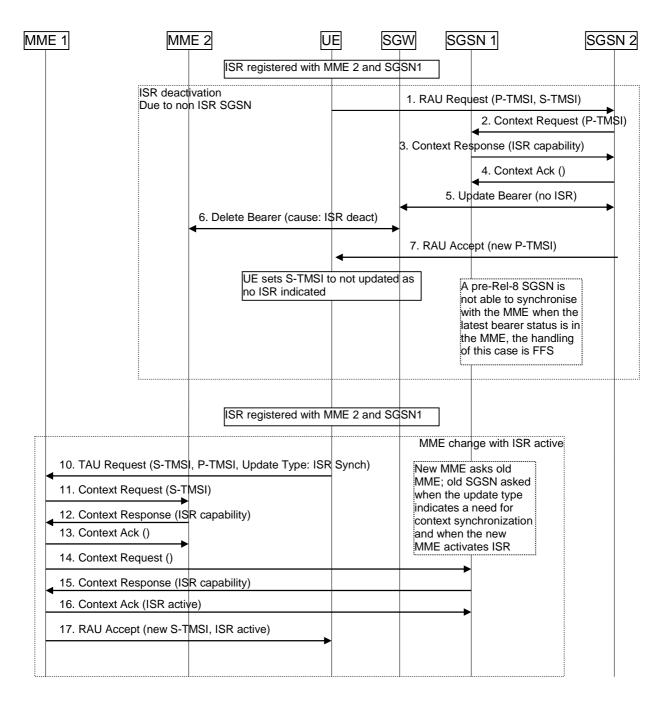
Figure J.1

Figure J.2

Annex K (informative): Change history

Date	TSG #	TSG Doc.	CR	Rev	Cat	Subject/Comment	Old	New
2007-12	SP-38	SP-070828	-	-	-	Editorial update by MCC to version 2.0.0 for presentation to TSG SA for approval	1.4.1	2.0.0
2007-12	SP-38	-	-	-	-	Release 8 Version created after approval at TSG SA #38	2.0.0	8.0.0
2008-03	SP-39	SP-080120	0191	1	F	Reference points renaming	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0190	2	C	Load balancing at MME selection	8.0.0	8.1.0
2008-03	SP-39	SP-080120	0186	1	F	Restructuring of RAU procedures	8.0.0	8.1.0
2008-03	SP-39	SP-080120	0184	1	F	Missing RAU/TAU functionality	8.0.0	8.1.0
2008-03	SP-39	SP-080120	0183	2	F	Removal of separate GERAN to E-UTRAN TAU description	8.0.0	8.1.0
2008-03	SP-39	SP-080120	0182	1	F	Combining pre-Rel-8 RAU procedures	8.0.0	8.1.0
2008-03	SP-39	SP-080120	0181	1	F	Correction of pre-Rel-8 SGSN to MME TAU procedure	8.0.0	8.1.0
2008-03	SP-39	SP-080120	0180	1	F	PMIP-S5/S8 Parameters in S10 and S11 Messages	8.0.0	8.1.0
2008-03	SP-39	SP-080127	0169	3	F	MME Overload handling	8.0.0	8.1.0
2008-03	SP-39	SP-080120	0162	-	F	Merge of CR0001R3 (Update of Attach procedure) and CR0042R3 (NAS security setup during the Attach procedure).	8.0.0	8.1.0
2008-03	SP-39	SP-080120	0154	2	F	Provision of UE identity in UE initiated NAS signalling.	8.0.0	8.1.0
2008-03	SP-39	SP-080120	0153	1	F	Provision of PDN GW address to the Serving GW	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0152	-	F	Clarification of PDN GWs involved in Initial Attach	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0151	1	F	Identification of the UE within the CN	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0148	1	F	Corrections to 23.401 Section 5.3.5 - S1 Release Procedure	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0143	1	F	Update and Additons to ME identity check procedure	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0142	1	F	Handover Restriction in eNodeB	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0141	-	F	Correction in the 2G to E-UTRAN IRAT Handover procedure	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0140	1	C	Add description of the MME Pool functionality	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0138	-	F	Integrity check of TAU Request message in the new MME	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0137	1	F	Security considerations in the TAU procedure	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0135	1	F	Corrections to Attach procedure related to the MME routeing information.	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0134	-	C	Merge of CR#0009 (IP address allocation and protocol configuration using DHCP) and CR#0069 (Update on IP address configuration procedures)	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0133	-	C	UE state handling in EUTRAN at non-3GPP handover	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0128	-	F	Correction of ECM-CONNECTED state	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0124	3	F	S-TMSI cleanup	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0123	2	C	PDN connectivity request without APN	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0122	3	C	Clarification of default APN	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0116	3	C	Downlink signalling messages triggered service request procedure	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0114	1	F	PCC aspect of attachment without IP allocation	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0113	2	F	Reject TAU from 2G/3G if the UE has no PDP Context	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0112	-	C	ISR Principle	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0111	2	C	Context transfer information for PMIP-based CN node Relocation	8.0.0	8.1.0
2008-03	SP-39	SP-080115	0110	1	B	Mechanism to support reordering in EUTRAN	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0103	1	F	Correction of TAU procedure without SGW change	8.0.0	8.1.0
2008-03	SP-39	SP-080119	0100	1	F	The editorial modification for IRAT HO procedures	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0097	4	F	AMBR handling during HO	8.0.0	8.1.0
2008-03	SP-39	SP-080115	0092	1	B	Possible HSS update even if there is no MME change	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0083	3	F	Add New EnodeB information onto handover related messages	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0082	-	F	Fixing misimplementation of Section 5.3.2.2, TS 23.401	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0079	2	F	Serving GW change notification	8.0.0	8.1.0
2008-03	SP-39	SP-080115	0072	1	B	Corrections to support multiple PDNs during HO	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0065	2	C	Rate adaptation with "MBR>GBR bearers"	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0064	1	C	Table of Standardized QCIs	8.0.0	8.1.0
2008-03	SP-39	SP-080126	0063	1	B	Subscriber Type on S1	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0061	2	F	Clean-up of QoS Sections in 23.401	8.0.0	8.1.0
2008-03	SP-39	SP-080115	0060	3	B	Recommended QCI to DiffServ Code Point Mapping	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0056	2	F	Selecting and signalling the security algorithms in handover from Rel-8 UTRAN to E-UTRAN	8.0.0	8.1.0
2008-03	SP-39	SP-080117	0055	2	D	The editorial modification for attach procedure	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0049	3	F	High level description of Tracking and Reachability Management for UE in ECM-IDLE state	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0044	1	F	Section on 'Security Function'	8.0.0	8.1.0
2008-03	SP-39	SP-080115	0041	4	B	A method to achieve load balancing	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0033	3	F	Several FFS clean-up	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0032	2	F	Correction of the MME Initiated Bearer procedures	8.0.0	8.1.0

						Change history		
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**Old**	**New**
2008-03	SP-39	SP-080118	0031	1	F	Relationship between EPS Bearer Identity and NSAPI/RAB ID	8.0.0	8.1.0
2008-03	SP-39	SP-080115	0030	2	B	PCC Rules update in ISR	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0029	2	C	Detach procedure with ISR	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0028	1	C	CR on TAU/RAU with ISR	8.0.0	8.1.0
2008-03	SP-39	SP-080115	0026	8	B	UE requested PDN disconnection procedure	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0020	2	C	Inclusion of EIR reference point in SAE architecture	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0019	3	F	Parameters used at PCRF interaction at Attach (E-UTRAN)	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0017	1	C	Default bearer modification without bearer QoS update	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0016	2	C	Refinements to handover between non-3GPP and 3GPP accesses	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0015	1	F	Serving GW relocation	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0007	2	C	GTP-PMIP roaming	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0004	-	F	Corrections 3G to E-UTRAN IRAT Handover	8.0.0	8.1.0
2008-03	SP-39	SP-080118	0003	1	F	Corrections 2G to E-UTRAN IRAT Handover	8.0.0	8.1.0
2008-03	SP-39	SP-080116	0002	3	C	3G to E-UTRAN IRAT Handover with non-3GDT Support	8.0.0	8.1.0
2008-06	SP-40	SP-080375	0011	15	C	Changes for dual stack in GERAN/UTRAN	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0038	2	F	Removal of references to 'blue text'	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0039	3	C	Correction of CAMEL details for several pre Rel-8 procedures	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0047	4	F	Network Assisted Cell Change from E-UTRAN to GERAN	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0118	8	C	AMBR per UE	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0171	7	F	Periodic TA update description	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0174	3	F	Authentication Vector Update	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0177	6	F	Simplify the trigger of Serving GW buffering	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0187	2	F	Corrections for bearer modification procedures	8.1.0	8.2.0
2008-06	SP-40	SP-080379	0201	-	F	Update of the S1 Release Procedure	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0208	2	C	Removal of Annex C	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0209	2	C	Removal of Annex B	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0210	2	F	Recommended QCI to DiffServ Code Point Mapping	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0214	1	C	S5/S8 Protocol Indication transferred over S11 Interface	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0217	2	C	downlink signalling triggered service request procedure in ISR	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0218	2	C	Bearer Management with ISR triggered by Subscription Data Changing	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0225	1	F	Clarification about TAI value being deleted when UE is powered up	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0229	2	F	Bearer Update Indication in Create Bearer Request message	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0232	1	F	Alignment of subscription data descriptions	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0233	2	F	Adding information elements to default bearer activations	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0253	3	C	Multi-PDN connectivity to one APN	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0259	3	F	EPS Mobility Management and Connection Management states	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0267	3	C	Clarify Service Request types	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0275	3	B	Acquisition of UE location	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0277	1	F	Correction of Local Breakout diagrams	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0281	6	C	Clarifications for static IP allocation during attach.	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0293	1	C	Load re-balancing solution	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0294	1	F	Clarification of IP address allocation requirements	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0295	1	C	Clarification of SDF QoS in UE initiated Bearer Resource Request	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0296	1	F	Lawful Interception of signalling traffic at MME	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0300	1	B	E-UTRAN to GERAN Network Assisted Cell Change	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0308	2	C	Support of EPC bearer model on S3 and S4 interfaces	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0309	3	C	Interoperability between UEs and different PS domain network configurations	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0312	2	C	PDN GW identification	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0314	2	F	ISR alignments for R7 interoperation procedures	8.1.0	8.2.0
2008-06	SP-40	SP-080379	0319	1	B	Updating pre-Rel-8 SGSN to Gn/Gp SGSN	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0320	2	F	QoS IE provided to the UE	8.1.0	8.2.0
2008-06	SP-40	SP-080379	0325	-	F	TAU Request Validation	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0326	1	F	Dedicated bearer activation in combination with UE requested PDN connectivity	8.1.0	8.2.0
2008-06	SP-40	SP-080379	0327	1	F	Updating TAU of HOV procedures	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0328	1	C	EPS bearer context information storage amendments	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0336	2	F	Storage of the PDN GW Address in HSS	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0338	2	C	Support for handover with multiple PDNs in TS 23.401	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0339	3	F	Clarification of Detach procedure in section 5.3.8.2	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0341	1	C	Clarification of retun of PDN GW address during Initial attach	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0346	2	F	Missing DL TFTs	8.1.0	8.2.0
2008-06	SP-40	SP-080377	0349	1	C	Operator's and user's preference on DHCPv4 usage	8.1.0	8.2.0
2008-06	SP-40	SP-080376	0352	1	B	Select the same PDN GW when simutaneous multiple PDN Connections are used for an APN	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0361	3	B	Static IP address provision	8.1.0	8.2.0
2008-06	SP-40	SP-080378	0370	1	F	Removing non-critical FFSs from 23.401	8.1.0	8.2.0
2008-06	SP-40	SP-080331	0372	4	B	UE capability handling in LTE/SAE	8.1.0	8.2.0

ETSI

Change history								
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**Old**	**New**
2008-06	SP-40	SP-080377	0383	3	B	Mapping between S-TMSI and P-TMSI	8.1.0	8.2.0
2008-06	SP-40	SP-080379	0385	-	C	TAU in connected mode	8.1.0	8.2.0
2008-06	SP-40	SP-080375	0386	2	B	Addition of AAA Server Network Element	8.1.0	8.2.0
2008-06	SP-40	SP-080381	0387	-	F	P-GW initiated bearer deactivation with ISR activated, ISR for Rel-8 TAU/RAU Procedures, Encryption for PAP/CHAP parameters at UE Attach, NAS/AS inter-actions and PCC Interaction (Merger of SA WG2 agreed CRs 0292, 0301, 0303, 0315, 0357)	8.1.0	8.2.0

History

Document history		
V8.2.0	October 2008	Publication