**3GPP TSG-WG SA2 Meeting #164 *S2-24xxxx***

**Maastricht, NL, 19th Aug – 23rd Aug, 2024**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network | **X** |

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| ***Title:*** | Introduction to S&F feature | | | | | | | | | |
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| ***Source to WG:*** | Samsung | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | 5GSAT\_Ph3\_ARCH | | | | |  | ***Date:*** | | | 2024-08-19 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | |  |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
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| ***Reason for change:*** | | Based on conclusions agreed in the TR 23.700-29 for KI#2 this CR proposes to introduce S&F features. This defines a mechanism for UE to perform NAS procedures with network in S&F mode, MME and HSS interactions, additionally the Annex to describe the example S&F architectures.  This paper proposes both the options MME split and whole CN on board the satellite. | | | | | | | | |
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| ***Summary of change:*** | | S&F feature is implemented based on the conclusions reached for KI#2 in TR 23.700-29. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | S&F features is not supported. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 4.13.X(new), 5.3.2.1, 5.3.3.1, 5.3.3.2, 5.11.3, Annex X(new), X.1(new), X.2(new), X.2.1(new), X.2.2(new) | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Start of Changes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

## 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 PDN represented by an APN and a UE, represented by one IPv4 address and/or one IPv6 prefix (for IP PDN Type) or by the UE Identity (for Non-IP and Ethernet PDN Types).

**Default Bearer:** The EPS bearer which is first established for a new PDN connection and remains established throughout the lifetime of the PDN connection.

**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 and the UE requested PDN connectivity procedure when no APN is provided by the UE.

**eCall Only Mode:** A UE configuration option that allows the UE to attach at EPS and register in IMS to perform only eCall Over IMS, and an IMS call to a non-emergency MSISDN or URI for test and/or terminal reconfiguration services. For a short period following either such call, an incoming call (e.g. callback from a PSAP or HPLMN operator) or other incoming session (e.g. for USIM reconfiguration) is possible. At other times when the UE is configured in this mode, the UE is required to refrain from any signalling to a network. Use of eCall Only Mode is configured in the USIM for the UE.

**PDN Connection to the SCEF:** The association between a UE, represented by the UE Identity, and a PDN represented by an APN to external packet data network via SCEF to allow transfer of Non-IP data. It includes establishment and persistence of T6 connection between MME and SCEF (see TS 29.128 [79]).

**Emergency attached UE:** A UE which only has bearer(s) related to emergency bearer service.

NOTE 1: The above term is equivalent to the term "attached for emergency bearer services" as specified in TS 24.301 [46].

**LIPA PDN connection:** a PDN Connection for local access (e.g. for IP or Ethernet access) for a UE connected to a HeNB.

**en-gNB:** As defined in TS 37.340 [85].

**SIPTO at local network PDN connection:** a PDN connection for SIPTO at local network for a UE connected to a (H)eNB.

**Correlation ID:** For a LIPA PDN connection, Correlation ID is a parameter that enables direct user plane path between the HeNB and L-GW.

**SIPTO Correlation ID:** For a SIPTO at local network PDN connection, SIPTO Correlation ID is a parameter that enables direct user plane path between the (H)eNB and L-GW when they are collocated.

**Local Home Network:** A set of (H)eNBs and L-GWs in the standalone GW architecture, where the (H)eNBs have IP connectivity for SIPTO at the Local Network via all the L-GWs.

**Local Home Network ID:** An identifier that uniquely identifies a Local Home Network within a PLMN.

**Presence Reporting Area:** An area defined within 3GPP Packet Domain for the purposes of reporting of UE presence within that area due to policy control and/or charging reasons. In the case of E-UTRAN, a Presence Reporting Area may consist in a set of neighbor or non-neighbor Tracking Areas, or eNodeBs and/or cells. There are two types of Presence Reporting Areas: "UE-dedicated Presence Reporting Areas" and "Core Network pre-configured Presence Reporting Areas" that apply to an MME pool.

**RAN user plane congestion:** RAN user plane congestion occurs when the demand for RAN resources exceeds the available RAN capacity to deliver the user data for a prolonged period of time.

NOTE 2: Short-duration traffic bursts is a normal condition at any traffic load level, and is not considered to be RAN user plane congestion. Likewise, a high-level of utilization of RAN resources (based on operator configuration) is considered a normal mode of operation and might not be RAN user plane congestion.

**IOPS-capable** eNodeB**:** an eNodeB that has the capability of IOPS mode operation, which provides local connectivity (e.g. for IP or Ethernet) and public safety services to IOPS-enabled UEs via a Local EPC when the eNodeB has lost backhaul to the Macro EPC or it has no backhaul to the Macro EPC.

**IOPS network:** an IOPS network consists of one or more eNodeBs operating in IOPS mode and connected to a Local EPC.

**Local EPC:** a Local EPC is an entity which provides functionality that eNodeBs in IOPS mode of operation use, instead of the Macro EPC, in order to support public safety services.

**Macro EPC:** the EPC which serves an eNodeB when it is not in IOPS mode of operation.

**Nomadic EPS:** a deployable system which has the capability to provide radio access (via deployable IOPS-capable eNodeB(s)), local connectivity (e.g. for IP or Ethernet) and public safety services to IOPS-enabled UEs in the absence of normal EPS

**Multi-USIM UE:** a UE with multiple USIMs, capable of maintaining a separate registration state with a PLMN for each USIM at least over 3GPP Access and supporting one or more of the features described in clause 4.3.33.

**IOPS-enabled UE:** is an UE that is configured to use networks operating in IOPS mode.

**Cellular IoT:** Cellular network supporting low complexity and low throughput devices for a network of Things. Cellular IoT supports IP, Ethernet and Non-IP traffic. Unless otherwise stated in this specification, Cellular IoT and all functionality applicable to Cellular IoT also apply to satellite access.

**Narrowband-IoT:** a 3GPP Radio Access Technology that forms part of Cellular IoT. It allows access to network services via E-UTRA with a channel bandwidth limited to 180 kHz (corresponding to one PRB). Unless otherwise indicated in a clause, Narrowband-IoT is a subset of E-UTRAN. Unless otherwise stated in this specification, Narrowband-IoT also includes satellite access.

**LTE-M:** a 3GPP RAT type Identifier used in the Core Network only, which is a sub-type E-UTRAN RAT type, and defined to identify in the Core Network the E-UTRAN when used by a UE indicating Category M in its UE radio capability. Unless otherwise stated in this specification, LTE-M also includes satellite access.

**WB-E-UTRAN:** in the RAN, WB-E-UTRAN is the part of E-UTRAN that excludes NB-IoT. In the Core Network, the WB-E-UTRAN also excludes LTE-M. Unless otherwise stated in this specification, WB-E-UTRAN also includes satellite access.

**DCN-ID:** DCN identity identifies a specific dedicated core network (DCN).

For the purposes of the present document, the following terms and definitions given in TS 23.167 [81] apply:

**eCall Over IMS:** See TS 23.167 [81].

**RLOS attached UE:** A UE is attached only for accessing Restricted Local Operator Services (see TS 23.221 [27]).

**IAB-donor:** For the purposes of this specification, this is a NR Secondary RAN node is further described in TS 37.340 [85] that supports Integrated access and backhaul (IAB) feature and provides connection to the core network to IAB-nodes. It supports the CU function of the CU/DU architecture for IAB defined in TS 38.401 [90].

**IAB-node:** A relay node that supports wireless in-band and out-of-band relaying of NR access traffic via NR Uu backhaul links. It supports the UE function and the DU function of the CU/DU architecture for IAB defined in TS 38.401 [90].

**Feeder link:** as defined in TS 36.300 [6].

**Service link:** as defined in TS 36.300 [6]

**Store and Forward operation:** Operation providing communication service to a UE in periods of time and/or geographical areas in which the serving satellite is not simultaneously connected to the UE via service link and ground network via feeder link or ISL. For the case of UL, "store" refers to on-board storage of UL information from UE and "forward" refers to forwarding of stored UL information to the ground network. For the case of DL, "store" refers to on-board storage of DL information from the ground network and "forward" refers to forwarding of stored DL information to the UE.

**Store and Forward mode:** The mode in which the UE, eNB and core network entities are performing Store and Forward operation.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Next Changes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

## 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].

5GS 5G System

AF Application Function

ARP Allocation and Retention Priority

AMBR Aggregate Maximum Bit Rate

CBC Cell Broadcast Centre

CBE Cell Broadcast Entity

CIoT Cellular IoT

CSG Closed Subscriber Group

CSG ID Closed Subscriber Group Identity

C-SGN CIoT Serving Gateway Node

CSS CSG Subscriber Server

DAPS Dual Active Protocol Stacks

DCN Dedicated Core Network

DeNB Donor eNode B

DL TFT DownLink Traffic Flow Template

DRX Discontinuous Reception

ECGI E-UTRAN Cell Global Identifier

ECM EPS Connection Management

ECN Explicit Congestion Notification

EMM EPS Mobility Management

eNodeB evolved Node B

EPC Evolved Packet Core

EPS Evolved Packet System

E-RAB E-UTRAN Radio Access Bearer

E-UTRAN Evolved Universal Terrestrial Radio Access Network

GBR Guaranteed Bit Rate

GUMMEI Globally Unique MME Identifier

GUTI Globally Unique Temporary Identity

GW Gateway

HeNB Home eNode B

HeNB GW Home eNode B Gateway

HFN Hyper Frame Number

IAB Integrated Access and Backhaul

IMEI/TAC IMEI Type Allocation Code

IOPS Isolated E-UTRAN Operation for Public Safety

IoT Internet of Things

ISR Idle mode Signalling Reduction

LAA Licensed Assisted Access

LBI Linked EPS Bearer Id

L-GW Local GateWay

LIPA Local IP Access

LWA LTE/WLAN Aggregation

LWIP LTE/WLAN Radio Level Integration with IPsec Tunnel

MBR Maximum Bit Rate

MME Mobility Management Entity

MMEC MME Code

MTC Machine-Type Communications

MT-EDT Mobile Terminated Early Data Transmission

M-TMSI M-Temporary Mobile Subscriber Identity

NB-IoT Narrowband IoT

NR New Radio

NR-U New Radio Unlicensed

NTN Non-Terrestrial Network

OCS Online Charging System

OFCS Offline Charging System

OMC-ID Operation and Maintenance Centre Identity

P‑GW PDN Gateway

PCC Policy and Charging Control

PCRF Policy and Charging Rules Function

PRA Presence Reporting Area

PDCP Packet Data Convergence Protocol

PMIP Proxy Mobile IP

PSAP Public Safety Answering Point

PSM Power Saving Mode

PTI Procedure Transaction Id

QCI QoS Class Identifier

RACS UE Radio Capability Signalling optimization

RCAF RAN Congestion Awareness Function

RFSP RAT/Frequency Selection Priority

RLOS Restricted Local Operator Services

RN Relay Node

RUCI RAN User Plane Congestion Information

S‑GW Serving Gateway

S-TMSI S-Temporary Mobile Subscriber Identity

SDF Service Data Flow

SIPTO Selected IP Traffic Offload

TAC Tracking Area Code

TAD Traffic Aggregate Description

TAI Tracking Area Identity

TAU Tracking Area Update

TI Transaction Identifier

TIN Temporary Identity used in Next update

UCMF UE radio Capability Management Function

URRP-MME UE Reachability Request Parameter for MME

UL TFT UpLink Traffic Flow Template

ULR-Flags Update Location Request Flags

S&F operation Store and Forward operation

S&F mode Store and Forward mode

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Next Changes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

### 4.13.X Support of Store and Forward operation

#### General

The S&F operation is intended to provide some level of communication service for UEs under satellite coverage with intermittent/temporary satellite connectivity (e.g. when the satellite is not connected via a feeder link or via ISL to the ground network and to the UE via service link) for delay-tolerant communication service.

To support S&F operation the eNB and at least some part of MME functions are deployed on board the satellite. Rest of the core network elements including additional MME functions, and all other core network entities can be on board the satellite or on the ground based on deployment choice of the operator. The interaction of on board functions with ground function is outside the scope of 3GPP in this release of the specification. Some architecture options to support the S&F operation are illustrated in Annex X.

When feeder link is not available and the network supports S&F operation, the eNB broadcast support of S&F operation as part of System Information. A UE can determine when an eNodeB is operating in S&F mode, as described in TS 36.300 [5].

NOTE 1: From system perspective if the network does not support S&F operation and the feeder link is not available then eNB switches off and does not broadcast any signal.

When UE initiates Attach or TAU procedure, it indicates support for S&F mode to the MME as described in clause 5.11.3, the MME may send Attach Reject, TAU Reject, or Service Rejectmessage to the UE if these procedures cannot be completed due to S&F operation.

As part of an Attach, TAU, Control Plane Service Request, or Service Request procedures for S&F operation, the MME may provide to the UE:

a) an indication with reject cause that the NAS procedure cannot be completed because of the S&F operation and that the UE can re-attempt the NAS procedure in this PLMN in a next satellite pass. This indicates to the UE that the information contained in the NAS message is stored by the MME and the network will be available to the UE after interaction with ground network.

b) the wait timer, indicates to the UE the time it should wait before re-attempting the Attach, TAU, Control Plane Service Request, or Service Request procedures in the current or another satellite of the same PLMN. During the wait timer the UE can search for another terrestrial or satellite PLMN to get normal service.

c) The list of Satellite IDs, over which the UE may re-attempt the NAS procedure, after wait timer expires (if available). The Satellite IDs are based on the SIB information broadcasted by eNB

d) Uplink S&F Delivery Time in an Attach Accept, TAU Accept, or Service Accept message. How UE uses this information is left for UE implementation.

Additionally as part of Detach procedure, network may indicate the wait timer and list of satellite IDs as described above.

The MME may indicate to HSS the "Request Time", allowing the HSS to check that no other (e.g., terrestrial) MME has sent an Update Location Request after the "Request Time", and fetches the authentication vector and other details from HSS following current Authentication and security procedures. The MME may trigger provisional Update location with the HSS and Update location ACK is received by MME. i.e. all the subscription details can be retrieved by MME before authenticating the UE. The Update Location Request may include an indication that this location update is provisional i.e. the HSS must not consider the UE as registered until it receives the final Update Location Request without such indication.

NOTE 2: The request time is used by the HSS to ensure that interactions with MME for a UE in S&F mode are handled in the correct order.

The MME may expose to the SCS/AS: that a UE is registered in S&F Mode, the Downlink S&F estimated Delivery Time. The exposure to the SCS/AS is described in clause 5.6.1.4 of TS 23.682 [74].

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Next Changes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

### 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 connectivity for UE/users of the EPS may be 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 is obtained from the UE. The MME operator may check the ME Identity with an EIR. The MME passes the ME Identity (IMEISV) to the HSS and to the PDN GW.

During the Initial Attach procedure, if the MME supports SRVCC and if any of the conditions described in step 8 in Figure 5.3.2.1-1 are satisfied, the MME informs the HSS with the UE SRVCC capability e.g. for further IMS registration.

The E-UTRAN Initial Attach procedure is used for Emergency Attach by UEs that need to perform emergency services but cannot gain normal services from the network. These UEs are in limited service state as defined in TS 23.122 [10]. Also UEs that had attached for normal services and do not have emergency bearers established and are camped on a cell in limited service state (e.g. restricted Tracking Area or not allowed CSG) shall initiate the Attach procedures indicating that the attach is to receive emergency services. UEs that camp normally on a cell, i.e. UEs that are not in limited service state, should initiate normal initial attach when not already attached and shall initiate the UE Requested PDN Connectivity procedure to receive emergency EPS bearer services.

The E-UTRAN Initial Attach procedure is used for RLOS Attach by UEs in limited service state as defined in TS 23.122 [10], as well as UEs attached for normal services but moved to a cell in limited service state (e.g. restricted Tracking Area or not allowed CSG).

NOTE 1: A UE that is emergency or RLOS attached performs initial attach procedure before being able to obtain normal services.

In order to limit load on the network, only when performing an E-UTRAN Attach with a new PLMN (i.e. not the registered PLMN or an equivalent PLMN of the registered PLMN), a UE configured to perform Attach with IMSI at PLMN change (see TS 24.368 [69]) shall identify itself by its IMSI instead of any stored temporary identifier.

This procedure is also used to establish the first PDN connection over E-UTRAN when the UE already has active PDN connections over a non-3GPP access network and wants to establish simultaneous PDN connections to different APNs over multiple accesses.

During the Attach procedure, a Multi-USIM UE may indicate to the MME a Requested IMSI Offset, as described in clause 4.3.33, with the aim of modifying the timing of the Paging Occasions to avoid paging collisions.

NOTE 2: As an exception, during the Attach procedure a Multi-USIM UE implementation can decide to indicate to the MME a Requested IMSI Offset even if it does not know whether the MME supports it.



Figure 5.3.2.1-1: Attach procedure

NOTE 3: For a PMIP-based S5/S8, procedure steps (A), (B), and (C) are defined in TS 23.402 [2]. Steps 7, 10, 13, 14, 15 and 23a/b concern GTP based S5/S8.

NOTE 4: The Serving GWs and PDN GWs involved in steps 7 and/or 10 may be different to those in steps 13‑15.

NOTE 5: The steps in (D) are executed only upon handover from non-3GPP access or if Presence Reporting Area Information is received from the MME.

NOTE 6: More detail on procedure steps (E) is defined in the procedure steps (B) in clause 5.3.8.3.

NOTE 7: More detail on procedure steps (F) is defined in the procedure steps (B) in clause 5.3.8.4.

1. A UE, camping on an E-UTRAN cell reads the related System Information Broadcast.

An E-UTRAN cell for a PLMN that supports CIoT enhancements shall broadcast:

For the NB-IoT case:

- Whether it can connect to an MME which supports EPS Attach without PDN Connectivity.

For the WB-E-UTRAN case:

- Whether it supports Control Plane CIoT EPS Optimisation and it can connect to an MME which supports Control Plane CIoT EPS Optimisation.

- Whether it supports User Plane CIoT EPS Optimisation and it can connect to an MME which supports User Plane CIoT EPS Optimisation.

- Whether it can connect to an MME which supports EPS Attach without PDN Connectivity.

If the PLMN does not advertise support of EPS attach without PDN connectivity and the UE can only attach without PDN connectivity, then the UE shall not attach to the PLMN in this cell and shall proceed as specified in TS 23.122 [10].

In the case of WB-E-UTRAN, if the PLMN does not support Control Plane CIoT EPS Optimisation, and the UE only supports Control Plane CIoT EPS Optimisation and cannot otherwise attach, then the UE shall not proceed with the Attach to the PLMN in this cell and shall proceed as specified in TS 23.122 [10].

An E-UTRAN cell for a PLMN that supports Restricted Local Operator Service shall broadcast:

- Whether it supports Restricted Local Operator Service.

If the PLMN does not advertise support for Restricted Local Operator Services, the UE shall not proceed with the Attach with indication that the attach is to receive Restricted Local Operator Services to the PLMN in this cell.

If a Service Gap timer is running in the UE (see clause 4.3.17.9) and the Attach Type is not Emergency Attach and it is not an Attach without PDN connectivity, then the UE shall not send Attach Requests to this PLMN or any other PLMN as long as the timer is running.

If the UE can proceed to attach, it initiates the Attach procedure by the transmission, to the eNodeB, of an Attach Request (IMSI or old GUTI, Old GUTI type, last visited TAI (if available), UE Core Network Capability, UE Specific DRX parameters, extended idle mode DRX parameters, UE paging probability information, Attach Type, ESM message container (Request Type, PDN Type, Protocol Configuration Options, Ciphered Options Transfer Flag, Header Compression Configuration), KSIASME, NAS sequence number, NAS-MAC, additional GUTI, P-TMSI signature, Voice domain preference and UE's usage setting, Preferred Network behaviour, MS Network Capability, Support for restriction of use of Enhanced Coverage, UE has UE Radio Capability ID assigned for the selected PLMN, Requested IMSI Offset) message together with RRC parameters indicating the Selected Network and the old GUMMEI.

In the RRC connection establishment signalling associated with the Attach Request, the UE indicates its support of the CIoT EPS Optimisations, relevant for MME selection.

The UE shall also include an IAB-Indication in the RRC connection establishment signalling, if the UE is an IAB-node, as defined in TS 36.331 [37].

If the UE identifies itself with the old GUTI, the UE shall set the Old GUTI Type to indicate whether the Old GUTI is a native GUTI or is mapped from a P-TMSI and RAI. The old GUTI may be derived from a P‑TMSI and RAI. IMSI shall be included if the UE does not have a valid GUTI or a valid P‑TMSI available, or if the UE is configured to perform Attach with IMSI at PLMN change and is accessing a new PLMN. The UE stores the TIN in detached state. 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 TS 23.003 [9]. If the UE holds a valid GUTI and the old GUTI indicates a GUTI mapped from a P-TMSI and RAI, then the UE indicates the GUTI as additional GUTI. If the old GUTI indicates a GUTI mapped from a P-TMSI and RAI and the UE has a valid P-TMSI signature associated to it, the P-TMSI signature shall be included. The UE sets the voice domain preference and UE's usage setting according to its configuration, as described in clause 4.3.5.9.

Alternatively, when a UE only supports E-UTRAN, if the UE has a GUTI available and the UE is accessing the same PLMN (or ePLMN), then it identifies itself with the old GUTI and sets the Old GUTI Type to 'native', otherwise the UE configuration determines whether the UE identifies itself with its IMSI or the Old GUTI.

The UE includes the extended idle mode DRX parameters information element if the UE needs to enable extended idle mode DRX.

The UE may include UE paging probability information if it supports the assignment of WUS Assistance Information from the MME to assist the eNodeB's Wake-Up Signal (WUS) group decision (see TS 36.300 [5]).

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. The RRC parameter "old GUMMEI" takes its value from the "old GUTI" contained in the Attach Request. UE Network Capability is described in UE capabilities, see clause 5.11.

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. KSIASME, NAS sequence number and NAS-MAC are included if the UE has valid EPS security parameters. NAS sequence number indicates the sequential number of the NAS message. If the UE does not have a valid EPS security association, then the Attach Request message is not integrity protected. 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). For a UE that support CIoT EPS Optimisations, the PDN type may also be "Non-IP". PDN type may also indicate Ethernet.

Protocol Configuration Options (PCO) are used to transfer parameters between the UE and the PDN GW, and 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 PCO which require ciphering (e.g., PAP/CHAP usernames and passwords) or send an APN, or both, the UE shall set the Ciphered Options Transfer Flag and send PCO or APN or both only after authentication and NAS security setup have been completed (see below).

NOTE 8: External network operators wanting to use PAP for authentication are warned that PAP is an obsolete protocol from a security point of view. CHAP provides stronger security than PAP.

If the UE supports 3GPP PS Data Off, it shall include in the PCO the 3GPP PS Data Off UE Status, which indicates whether the user has activated or deactivated 3GPP PS Data Off.

If the UE has UTRAN or GERAN capabilities, it shall send the NRSU in the PCO to indicate the support of the network requested bearer control in UTRAN/GERAN. The UE sends the ETFTU in the PCO to indicate the support of the extended TFT filter format. Request Type is included in the ESM message container and indicates "Handover" when the UE has already an activated PDN GW/HA due to mobility with non-3GPP accesses.

If a UE indicates support of CIoT EPS Optimisations in the RRC message, it may omit the ESM message container. If the ESM message container is omitted the MME shall not establish a PDN connection as part of the Attach procedure. In this case steps 6, 12 to 16 and 23 to 26 are not executed. In addition, for the case of UEs attaching with Control Plane CIoT EPS Optimisation with no user plane establishment, steps 17 to 22 are replaced by S1 AP NAS Transport and RRC Direct Transfer messages that just transport the NAS Attach Accept and NAS Attach Complete messages.

Attach Type indicates whether it is an EPS attach or a combined EPS/IMSI attach or an Emergency Attach or an RLOS Attach. Emergency Attach and RLOS Attach shall not be indicated when the UE is using NB-IoT. When using CIoT EPS Optimisations, the UE may indicate EPS attach and request SMS by setting the "SMS transfer without Combined Attach" flag in the Preferred Network Behaviour IE.

If a UE includes a Preferred Network Behaviour, this defines the Network Behaviour the UE is expecting to be available in the network as defined in clause 4.3.5.10.

If a UE indicated Control Plane CIoT EPS Optimisation supported in Preferred Network Behaviour, and the UE included the ESM message container, and the PDN type was IPv4 or IPv6 or IPv4v6, and the UE supports header compression, it shall include the Header Compression Configuration. The Header Compression Configuration includes the information necessary for the ROHC channel setup. Optionally, the Header Compression Configuration may include additional header compression context setup parameters if the UE already has the application traffic information, e.g. the target server IP address.

For an Emergency Attach the UE shall set both the Attach Type and the Request Type to "Emergency" and the IMSI shall be included if the UE does not have a valid GUTI or a valid P-TMSI available. The IMEI shall be included when the UE has no IMSI, no valid GUTI and no valid P-TMSI.

For RLOS attach, the UE shall set the Attach Type to "RLOS" and the Request Type to "RLOS", the IMSI shall be included if available and if the UE does not have a valid GUTI or a valid P-TMSI available. The IMEI shall be included when the UE has no IMSI, no valid GUTI and no valid P-TMSI.

If the UE supports RACS as defined in clause 5.11.3a, and if the UE is provisioned with a UE Radio Capability ID for use in the selected PLMN (i.e.PLMN-assigned for the specific PLMN or UE manufacturer-assigned), the UE includes a flag that indicates it has an assigned UE Radio Capability ID for use in the selected PLMN but the actual UE Radio Capability ID is provided to MME after security context is established in step 5a (see below).

If a Multi-USIM UE needs to modify the Paging Occasions in order to avoid paging collisions, it sends a Requested IMSI Offset to the MME, in order to signal an alternative IMSI as described in clause 4.3.33.

If the UE indicates support of S&F mode, the MME may provide Attach Reject to the UE if this procedure cannot be completed due to S&F operation. The MME may provide additional information as described in clause 4.13.x.

2. The eNodeB derives the MME address from the RRC parameters carrying the old GUMMEI, the indicated Selected Network and the RAT (NB-IoT or WB-E-UTRAN). If that MME is not associated with the eNodeB or the old GUMMEI is not available, the eNodeB selects an MME as described in clause 4.3.8.3 on "MME selection function". The eNodeB forwards the Attach Request message in a S1-MME control message (Initial UE message) together with the Selected Network, CSG access mode, CSG ID, L-GW address, TAI+ECGI of the cell from where it received the message to the new MME. CSG ID is provided if the UE attaches via a CSG cell or hybrid cell. CSG access mode is provided if the UE attaches via a hybrid cell. If the CSG access mode is not provided but the CSG ID is provided, the MME shall consider the cell as a CSG cell. If the eNodeB has a collocated L-GW, it includes the L-GW address in the Initial UE message to the MME.

If the IAB-Indication is received from the UE in step 1, the eNodeB selects an MME that supports IAB operation and includes the IAB-Indication in the Initial UE message to the MME.

If the MME is not configured to support Emergency Attach the MME shall reject any Attach Request that indicates Attach Type "Emergency".

If the MME is not configured to support RLOS Attach, the MME shall reject any Attach Request that indicates Attach Type "RLOS".

If the UE has included the Preferred Network Behaviour, and what the UE indicated it supports in Preferred Network Behaviour is incompatible with the network support e.g. the UE indicated support only for Control Plane CIoT EPS Optimisation and the MME only supports User Plane CIoT EPS Optimisation, the MME shall reject the Attach Request with an appropriate cause value (e.g. one that avoids retries on this PLMN).

To assist Location Services, the eNodeB indicates the UE's Coverage Level to the MME.

If the UE supports MT-EDT as indicated in the UE Network Capability, the MME shall consider this parameter to provide the MT-EDT indication towards Serving GW during PDN Connection establishment or mobility procedures, and handle the data size information that the MME may receive during Downlink Data Notification procedures as defined in clause 5.3.4B.6, and clause 5.3.5B.

In the case of satellite access for Cellular IoT, the MME may verify the UE location and determine whether the PLMN is allowed to operate at the UE location, as described in clause 4.13.4. If the UE receives an Attach Reject message with cause value indicating that the selected PLMN is not allowed to operate at the present UE location, the UE shall attempt to select a PLMN as specified in TS 23.122 [10].

3. If the UE identifies itself with GUTI and the MME has changed since detach, the new MME determines the type of the old node, i.e. MME or SGSN, as specified in clause 4.3.19, uses the GUTI received from the UE to derive the old MME/SGSN address, and sends an Identification Request (old GUTI, complete Attach Request message) to the old MME/SGSN to request the IMSI. If the request is sent to an old MME, the old MME first verifies the Attach Request message by NAS MAC and then responds with Identification Response (IMSI, MM Context). If the request is sent to an old SGSN, the old SGSN first verifies the Attach Request message by the P-TMSI signature and then responds with Identification Response (MM Context). If the UE is not known in the old MME/SGSN or if the integrity check or P-TMSI signature check for the Attach Request message fails, the old MME/SGSN responds with an appropriate error cause. The MM context contains security related information as well as other parameters (including IMSI) as described in clause 5.7.2 (Information Storage for MME).

The additional GUTI in the Attach Request message allows the new MME to find any already existing UE context stored in the new MME when the old GUTI indicates a GUTI mapped from a P-TMSI and RAI.

For an Emergency Attach or a RLOS Attach, if the UE identifies itself with a temporary identity that is not known to the MME the MME immediately requests the IMSI from the UE. If the UE identifies itself with IMEI, the IMSI request shall be skipped.

During inter PLMN mobility, the new MME shall delete the UE Radio Capability ID received from the old MME, unless the operator policy indicates that all UE Radio Capability IDs used in the old PLMN are also valid in the new PLMN.

NOTE 9: A SGSN always responds with the UMTS security parameters and the MME may store 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 to activate integrity protection and NAS ciphering are mandatory. Otherwise it is optional. If NAS security algorithm is to be changed, the NAS security setup is performed in this step. The authentication and NAS security setup functions are defined in clause 5.3.10 on "Security Function".

If the UE supports RACS as indicated in the UE Network Capability, and if the UE indicated that it has UE Radio Capability ID assigned for use in the selected PLMN in step 1, then authentication and NAS security setup to activate integrity protection and NAS ciphering are mandatory and the MME shall request the UE to provide the UE Radio Capability ID in Security Mode Command and the UE shall include the UE Radio Capability ID in Security Mode Command Accept for the supported UE radio capabilities.

For satellite access over NB-IoT, it the UE indicated support for reporting its Coarse Location Information, the MME may request the UE to send its Coarse Location Information by setting the Coarse Location Information Request in the Security Mode Command message and the UE then reports its Coarse Location Information in the Security Mode Complete message to the MME. To perform UE location verification as described in clause 4.13.4, the MME provides the reported Coarse Location Information to the E-SMLC as described in clause 9.1.17 of TS 23.271 [57].

If the MME is configured to support Emergency Attach for unauthenticated IMSIs and the UE indicated Attach Type "Emergency" the MME skips the authentication and security setup or the MME accepts that the authentication may fail and continues the attach procedure.

If the MME is configured to support RLOS Attach and the UE indicated Attach Type "RLOS", based on local regulation and operator policy, the MME may skip the authentication and security setup, or the MME may perform authentication if security information is available or obtainable from HSS and continues the attach procedure regardless of the authentication result.

In S&F mode, the MME may indicate to HSS the "Request Time" (see 4.13.X), allowing the HSS to check that no other MME(e.g., terrestrial) has sent the request after the "Request Time", and fetches the authentication vector and other details from HSS following current Authentication and security procedures. If there was a request from other MME after the "Request Time" indicated by MME, then this request is rejected by the HSS, the MME shall abort the Attach procedure and delete UE context (if available). The MME may trigger Update Location Request (see step 8) with the HSS and Update Location Ack (see step 8) is received by MME. i.e. all the subscription details can be retrieved by MME before authenticating the UE. The Update Location Request includes an indication that this location update is provisional i.e. the HSS must not consider the UE as registered until it receives the final Update Location Request without such indication.

After step 5a, all NAS messages shall be protected by the NAS security functions (integrity and ciphering) indicated by the MME unless the UE is emergency or RLOS attached and not successfully authenticated.

5b. The ME Identity (IMEISV) shall be retrieved from the UE. The ME identity shall be transferred encrypted unless the UE performs Emergency Attach or RLOS Attach and cannot be authenticated.

For an Emergency Attach or RLOS Attach, the UE may have included the IMEI in the Emergency Attach or RLOS Attach. If so, the ME Identity retrieval is skipped.

In order to minimise signalling delays, the retrieval of the ME Identity may be combined with NAS security setup in step 5a. 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.

For an Emergency Attach or RLOS Attach, the IMEI check to the EIR may be performed. If the IMEI is blocked, operator policies determine whether the Emergency Attach or RLOS Attach procedure continues or is stopped.

If the UE supports RACS, as indicated in the UE Core Network Capability IE, the MME shall use the IMEI of the UE to obtain the IMEI/TAC for the purpose of RACS operation.

6. If the UE has set the Ciphered Options Transfer Flag in the Attach Request message, the Ciphered Options i.e. PCO or APN or both, shall now be retrieved from the UE.

In order to handle situations where the UE may have subscriptions to multiple PDNs, if the Protocol Configuration Options contains user credentials (e.g. user name/password within PAP or CHAP parameters) then the UE should also send the APN to the MME.

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 Session Request (LBI) messages to the GWs involved. The GWs acknowledge with Delete Session Response (Cause) 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 UE provides an IMSI or the UE provides an old GUTI which doesn't refer to a valid context in the MME, or for some network sharing scenario (e.g. GWCN) if the PLMN-ID of the TAI supplied by the eNodeB is different from that of the GUTI in the UE's context, the MME sends an Update Location Request (MME Identity, IMSI, ME Identity (IMEISV), MME Capabilities, ULR-Flags, Homogeneous Support of IMS Voice over PS Sessions, UE SRVCC capability, equivalent PLMN list) message to the HSS. The MME capabilities indicate the MME's support for regional access restrictions functionality. ULR-Flags indicates "Initial-Attach-Indicator" as this is an Attach procedure. The inclusion of the equivalent PLMN list indicates that the MME supports the inter-PLMN handover to a CSG cell in an equivalent PLMN using the subscription information of the target PLMN. The "Homogenous Support of IMS Voice over PS Sessions" indication (see clause 4.3.5.8A) shall not be included unless the MME has completed its evaluation of the support of "IMS Voice over PS Session" as specified in clause 4.3.5.8.

NOTE 10: At this step, the MME may not have all the information needed to determine the setting of the IMS Voice over PS Session Supported indication for this UE (see clause 4.3.5.8). Hence the MME can send the "Homogenous Support of IMS Voice over PS Sessions" later on in this procedure.

If the UE performs Initial or Handover Attach in a VPLMN supporting Autonomous CSG Roaming and the HPLMN has enabled Autonomous CSG Roaming in the VPLMN (via Service Level Agreement) and the MME needs to retrieve the CSG subscription information of the UE from the CSS, the MME initiates the Update CSG Location Procedure with CSS as described in clause 5.3.12.

If the MME determines that only the UE SRVCC capability has changed, the MME sends a Notify Request to the HSS to inform about the changed UE SRVCC capability.

If there is a valid subscription context for the UE in the MME with a Service Gap timer running and the Attach Type is not Emergency Attach and it is not an Attach without PDN connectivity, the MME rejects the Attach Request from the UE with an appropriate cause value. In addition, MME may also provide a UE with a Mobility Management Back-off Timer set to the remaining value of the Service Gap timer.

For an Emergency Attach in which the UE was not successfully authenticated, the MME shall not send an Update Location Request to the HSS.

For an RLOS Attach the MME shall not send an Update Location Request to the HSS.

In S&F mode, the MME may indicate to HSS the "Request Time" (see 4.13.X), allowing the HSS to check that no other MME(e.g., terrestrial) has sent the request after the "Request Time". If there was a request from other MME after the "Request Time" indicated by MME, then this request is rejected by the HSS, the MME shall abort the Attach procedure and delete UE context (if available).

9. The HSS sends Cancel Location (IMSI, Cancellation Type) to the old MME. The old MME acknowledges with Cancel Location Ack (IMSI) and removes the MM and bearer contexts. If the ULR-Flags indicates "Initial-Attach-Indicator" and the HSS has the SGSN registration, then the HSS sends Cancel Location (IMSI, Cancellation Type) to the old SGSN. The Cancellation Type indicates the old MME/SGSN to release the old Serving GW resource.

10. If there are active bearer contexts in the old MME/SGSN for this particular UE, the old MME/SGSN deletes these bearer contexts by sending Delete Session Request (LBI) messages to the GWs involved. The GWs return Delete Session Response (Cause) message to the old MME/SGSN. 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 acknowledges the Update Location message by sending an Update Location Ack (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' and the subscribed APN-AMBR (see clause 4.7.3) and the WLAN offloadability indication (see clause 4.3.23). The new MME validates the UE's presence in the (new) TA.

If due to regional subscription restrictions or access restrictions (e.g. CSG restrictions) the UE is not allowed to attach in the TA or due to subscription checking fails for other reasons, the new MME rejects the Attach Request with an appropriate cause. If all checks are successful then the new MME constructs a context for the UE. If the APN provided by the UE is not allowed by subscription, based on operator policy, the MME may reject the Attach Request from the UE with an appropriate cause, or accept the Attach Request by replacing the UE requested APN with a network supported APN. The MME uses that network supported APN for the remainder of this procedure, except that the MME provides to the UE the same APN that the UE requested. If the Update Location is rejected by the HSS, the new MME rejects the Attach Request from the UE with an appropriate cause.

The Subscription Data may contain CSG subscription information for the registered PLMN and for the equivalent PLMN list requested by MME in step 8.

The Subscription Data may contain the IAB-Operation Allowed indication the IAB operation. The MME shall use the IAB-Opeation Allowed indication to authorize the UE's IAB operation.

The subscription data may contain Enhanced Coverage Restricted parameter. If received from the HSS, MME stores this Enhanced Coverage Restricted parameter in the MME MM context.

The subscription data may contain Service Gap Time parameter. If received from the HSS, MME stores this Service Gap Time in the MME MM context and passes it to the UE in the Attach Accept message.

The subscription data may contain Subscribed Paging Time Window parameter that applies to the UEs on a specific RAT, e.g. NB-IoT. If received from the HSS, MME stores this Subscribed Paging Time Window parameter in the MME MM context.

If the UE provided APN is authorized for LIPA according to the user subscription, the MME shall use the CSG Subscription Data to authorize the connection.

For an Emergency Attach or RLOS Attach, the MME shall not check for access restrictions, regional restrictions or subscription restrictions (e.g. CSG restrictions). For an Emergency Attach, the MME shall ignore any unsuccessful Update Location Response from HSS and continue with the Attach procedure.

12. If an ESM container was not included in the Attach Request, steps 12, 13,14,15,16 are skipped. If the attach type is not set to "Emergency" or "RLOS", and the ESM container was included in the Attach Request, and the UE has indicated support for Attach without PDN Connectivity, and the network supports Attach without PDN Connectivity, and the PDN Connection Restriction is set in the subscriber data, then the new MME shall not establish PDN connection, and steps 12, 13, 14, 15 and 16 are skipped.

For an Emergency Attach the MME applies the parameters from MME Emergency Configuration Data for the emergency bearer establishment performed in this step and any potentially stored IMSI related subscription data are ignored by the MME.

For a RLOS Attach, the MME applies the parameters from MME RLOS Configuration Data for the RLOS default bearer establishment performed in this step and any potentially stored IMSI related subscription data are ignored by the MME.

If the UE performs Initial or Handover Attach via a CSG cell and there is no subscription for that CSG or the CSG subscription is expired the MME shall reject the Attach Request with an appropriate cause. If the UE has this CSG ID and associated PLMN on its Allowed CSG list the UE shall remove the CSG ID and associated PLMN from the list when receiving this reject cause.

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. If the PDN subscription context contains a subscribed IPv4 address and/or IPv6 prefix, the MME indicates it in the PDN address. For Request Type indicating "Initial request", if the UE does not provide an APN, the MME shall use the PDN GW corresponding to the default APN for default bearer activation. If the UE provides an APN, this APN shall be employed for default bearer activation. For Request Type indicating "Handover", if the UE provides an APN, the MME shall use the PDN GW corresponding to the provided APN for default bearer activation, If the UE does not provide an APN, and the subscription context from HSS contains a PDN GW identity corresponding to the default APN, the MME shall use the PDN GW corresponding to the default APN for default bearer activation. The case where the Request Type indicates "Handover" and the UE does not provide an APN, and the subscription context from HSS does not contain a PDN GW identity corresponding to the default APN constitutes an error case. If the Request Type indicates "Initial request" and the selected 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 Request 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.

For initial and handover Emergency Attach the MME uses the PDN GW Selection function defined in clause 4.3.12.4 to select a PDN GW.

For initial RLOS Attach, the MME uses the PDN GW Selection function defined in clause 4.3.12a.4 to select a PDN GW.

If the subscription context does not indicate that the APN is for a PDN connection to an SCEF, 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 Session Request (IMSI, MSISDN, MME TEID for control plane, PDN GW address, PDN Address, APN, RAT type, LTE-M RAT type reporting to PGW flag, Default EPS Bearer QoS, PDN Type, APN-AMBR, EPS Bearer Identity, Protocol Configuration Options, Handover Indication, ME Identity (IMEISV), User Location Information (ECGI and TAI), UE Time Zone, User CSG Information, MS Info Change Reporting support indication, 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, Serving Network, APN Rate Control Status) message to the selected Serving GW. If Control Plane CIoT EPS Optimisation applies, then the MME shall also indicate S11-U tunnelling of NAS user data and send its own S11-U IP address and MME DL TEID for DL data forwarding by the SGW. User CSG Information includes CSG ID, access mode and CSG membership indication.

For PDN type "non-IP" when Control Plane CIoT EPS Optimisations are enabled for the UE, if APN subscription data indicate a SCEF connection needs to be used, then the MME allocates an EPS Bearer Identity for the Default Bearer associated with the UE and establishes a connection to the SCEF address indicated in subscription data as per TS 23.682 [74] and the steps 12,13,14,15,16 are not executed. The rest of the interactions with the UE apply as specified below.

If the MME determines the PDN connection shall only use the Control Plane CIoT EPS Optimisation, the MME shall include a Control Plane Only PDN Connection Indicator in Create Session Request.

If the Request Type indicates "Emergency" or "RLOS", Maximum APN restriction control shall not be performed.

For emergency attached or RLOS attached UEs IMSI is included if available and if the IMSI cannot be authenticated then the IMSI shall be marked as unauthenticated.

The RAT type is provided in this message for the later PCC decision. The RAT type shall distinguish between NB-IoT, LTE-M and WB-E-UTRA RAT types as specified in clause 4.3.5.3. The subscribed APN‑AMBR for the APN is also provided in this message. The MSISDN is included if provided in the subscription data from the HSS. Handover Indication is included if the Request Type indicates handover. Selection Mode indicates whether a subscribed APN was selected, or a non-subscribed APN sent by the UE was selected. Charging Characteristics indicates which kind of charging the bearer context is liable for. The MME may change the requested PDN type according to the subscription data for this APN as described in clause 5.3.1.1. The MME shall set the Dual Address Bearer Flag when the PDN type is set to 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.

If the MME requires the eNodeB to check whether the UE radio capabilities are compatible with the network configuration (e.g. whether the SRVCC or frequency support by the UE matches that of the network) to be able to set the IMS voice over PS Session Supported Indication (see clause 4.3.5.8), then the MME may send a UE Radio Capability Match Request to the eNodeB as defined in clause 5.3.14.

The MME includes the latest APN Rate Control status if it has stored it.

Based on UE and Serving GW capability of supporting MT-EDT, Communication Pattern parameters or local policy, the MME may indicate to Serving GW that MT-EDT is applicable for the PDN connection.

13. The Serving GW creates a new entry in its EPS Bearer table and sends a Create Session 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 EPS Bearer QoS, PDN Type, PDN Address, subscribed APN-AMBR, EPS Bearer Identity, Protocol Configuration Options, Handover Indication, ME Identity, User Location Information (ECGI), UE Time Zone, User CSG Information, MS Info Change Reporting support indication, PDN Charging Pause Support indication, Selection Mode, Charging Characteristics, Trace Reference, Trace Type, Trigger Id, OMC Identity, Maximum APN Restriction, Dual Address Bearer Flag, Serving Network, APN Rate Control Status) 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 without sending a Downlink Data Notification message to the MME until it receives the Modify Bearer Request message in step 23 below. The MSISDN is included if received from the MME.

If the Serving GW has received the Control Plane Only PDN Connection Indicator in step 12, the Serving GW informs the PDN GW this information in Create Session Request. The Serving GW and PDN GW shall indicate the use of CP only on their CDRs.

PDN GWs shall not perform any checks of Maximum APN Restriction if Create Session Request includes the emergency APN or RLOS APN.

For emergency attached or RLOS attached UEs IMSI is included if available and if the IMSI cannot be authenticated then the IMSI shall be marked as unauthenticated.

In the case of handover attach, and if the PDN GW detects that the 3GPP PS Data Off UE Status is active, the PDN GW shall indicate this status to the charging system for offline and online charging.

14. If dynamic PCC is deployed and the Handover Indication is not present, 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. If the UE is accessing over WB-E-UTRA, 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, APN, UE IP address, User Location Information (ECGI), UE Time Zone, Serving Network, RAT type, APN-AMBR, Default EPS Bearer QoS, ETFTU (if ETFTU is not provided it means UE and/or the PDN GW does not support the extended TFT filter format) are provided to the PCRF by the PDN GW if received by the previous message. The User Location Information and UE Time Zone are used for location based charging. For emergency attached or RLOS attached UEs which are unauthenticated the PDN GW provides the IMEI as the UE Identity instead of IMSI, to the PCRF. If the PCRF decides that the PDN connection may use the extended TFT filter format, it shall return the ETFTN indicator to the PDN GW for inclusion in the protocol Configuration Options returned to the UE.

The PCRF may modify the APN-AMBR and the QoS parameters (QCI and ARP) associated with the default bearer in the response to the PDN GW as defined in TS 23.203 [6].

If the PCC is configured to support emergency services and if dynamic PCC is deployed, the PCRF, based on the emergency APN, sets the ARP of the PCC rules to a value that is reserved for emergency services and the authorization of dynamic PCC rules as described in of TS 23.203 [6]. If dynamic PCC is not deployed, the PDN GW uses the ARP of the default emergency EPS bearer for any potentially initiated dedicated emergency EPS bearer. The P‑GW determines that emergency services are requested based on the emergency APN received in Create Session Request message.

If the PCC is configured to support Restricted Local Operator Services and if dynamic PCC is deployed, the PCRF, based on the RLOS APN, sets the ARP of the PCC rules to a value based on operator policy and the authorization of dynamic PCC rules as described in of TS 23.203 [6].

NOTE 11: 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.

NOTE 12: If the IP address is not available when the PDN GW performs the IP-CAN Session Establishment procedure with the PCRF, the PDN GW initiates an IP-CAN Session Modification procedure to inform the PCRF about an allocated IP address as soon as the address is available. In this version of the specification, this is applicable only to IPv4 address allocation.

If dynamic PCC is deployed and the Handover Indication is present, the PDN GW executes a PCEF Initiated IP‑CAN Session Modification procedure with the PCRF as specified in TS 23.203 [6] to report the new IP‑CAN type. Depending on the active PCC rules, the establishment of dedicated bearers for the UE may be required. The establishment of those bearers shall take place in combination with the default bearer activation as described in Annex F. This procedure can continue without waiting for a PCRF response. If changes to the active PCC rules are required, the PCRF may provide them after the handover procedure is finished.

In both cases (Handover Indication is present or not), if dynamic PCC is not deployed, the PDN GW may apply local QoS policy. If the UE is accessing over WB-E-UTRA, this may lead to the establishment of a number of dedicated bearers for the UE following the procedures defined in clause 5.4.1 in combination with the establishment of the default bearer, which is described in Annex F.

If the CSG information reporting triggers are received from the PCRF, the PDN GW should set the CSG Information Reporting Action IE accordingly.

If 3GPP PS Data Off status is received in the PCO from the UE and PDN GW supports 3GPP PS Data Off, the PDN GW shall provide the 3GPP PS Data Off status to the PCRF. If the PCRF supports 3GPP PS Data Off, it shall return 3GPP PS Data Off support to the PDN GW for inclusion in the PCO returned to the UE.

The additional behaviour of the PDN GW for 3GPP PS Data Off is defined in TS 23.203 [6].

If received, the PDN GW may take the APN Rate Control Status into account when encoding the APN Rate Control parameters in Protocol Configuration Options and when enforcing the APN Rate Control as described in clause 4.7.7.3.

15. The P‑GW creates a new entry in its EPS bearer context table and generates a Charging Id for the Default Bearer. 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 Session 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, EPS Bearer QoS, Protocol Configuration Options, Charging Id, Prohibit Payload Compression, APN Restriction, Cause, MS Info Change Reporting Action (Start) (if the PDN GW decides to receive UE's location information during the session), CSG Information Reporting Action (Start) (if the PDN GW decides to receive UE's User CSG information during the session), Presence Reporting Area Action (if the PDN GW decides to receive notifications about a change of UE presence in Presence Reporting Area), PDN Charging Pause Enabled indication (if PDN GW has chosen to enable the function), APN-AMBR, Delay Tolerant Connection) message to the Serving GW.

The PDN GW takes into account the received PDN type, 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 received PDN type is 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 for this APN is possible in the PDN, the PDN GW selects a single IP version (either IPv4 or IPv6). If the received PDN type is IPv4 or IPv6 or "Non-IP" or "Ethernet", the PDN GW uses the received PDN type if it is supported in the PDN, otherwise an appropriate error cause will be returned. For IPv4, IPv6 and IPv4v6, the PDN GW allocates a PDN Address according to the selected PDN type. If the PDN GW has selected a PDN type different from the received PDN Type, the PDN GW indicates together with the PDN type IE a reason cause to the UE why the PDN type has been modified, as described in clause 5.3.1.1. The PDN GW shall either accept or reject (but not modify) the PDN type if the PDN type is set to "Non-IP" or "Ethernet". PDN Address may contain an IPv4 address for IPv4 and/or an IPv6 prefix and an Interface Identifier, or be omitted for PDN types "Non-IP" and "Ethernet". 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. For 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 Session Response, the PDN GW includes the Interface Identifier 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 Session Request, the PDN GW shall allocate the IPv4 address and/or IPv6 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". The PDN GW derives the BCM based on the NRSU and operator policy. The PDN GW derives whether the extended TFT filter format is to be used based on the ETFTU, ETFTN received from the PCRF and operator policy. Protocol Configuration Options contains the BCM, ETFTN as well as optional PDN parameters that the P‑GW may transfer to the UE. 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.

The PDN GW includes a Delay Tolerant Connection indication if the PDN GW supports receiving a rejection cause from the SGW indicating that the UE is temporarily not reachable due to power saving and holding mobile terminated procedures, until the PDN GW receives a message indicating that the UE is available for end to end signalling.

When the Handover Indication is present, the PDN GW does not yet send downlink packets to the S‑GW; the downlink path is to be switched at step 23a.

If the PDN GW is an L-GW, it does not forward downlink packets to the S-GW. The packets will only be forwarded to the HeNB at step 20 via the direct user plane path.

If the 3GPP PS Data Off UE Status was present in the Create Session Request PCO and the network supports 3GPP PS Data Off feature, the PDN GW shall include the 3GPP PS Data Off Support Indication in the Create Session Response PCO.

16. The Serving GW returns a Create Session Response (PDN Type, PDN Address, Serving GW address for User Plane, Serving GW TEID User Plane, Serving GW TEID for control plane, EPS Bearer Identity, EPS Bearer QoS, 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, Prohibit Payload Compression, APN Restriction, Cause, MS Info Change Reporting Action (Start), Presence Reporting Area Action, CSG Information Reporting Action (Start), APN-AMBR, Delay Tolerant Connection) message to the new MME.

If Control Plane CIoT EPS Optimisation applies, and if the MME does not include Control Plane Only PDN Connection Indicator in the Create Session Request:

- If separation of S11-U from S1-U is required, the Serving GW shall include the Serving GW IP address and TEID for S11-U and additionally the Serving GW IP address and TEID for S1-U in Create Session Response.

- Otherwise, if separation of S11-U from S1-U is not required, the Serving GW includes the Serving GW IP address and TEID for S11-U in Create Session Response.

17. 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. MME shall not deactivate bearer(s) with emergency ARP, if present, to maintain valid APN restriction combination.

The P-GW shall ignore Maximum APN restriction if the request includes the Emergency APN.

If the MS Info Change Reporting Action (Start) and/or the CSG Information Reporting Action (Start) are received for this bearer context, then the MME shall store this for the bearer context and the MME shall report to that P-GW via the S-GW whenever a UE's location and/or User CSG information change occurs that meets the P-GW request, as described in clause 15.1.1a of TS 23.060 [7]. If Presence Reporting Area Action is received for this bearer context, the MME shall store this information for the bearer context and shall report to that P-GW via the S-GW whenever a change of UE presence in a Presence Reporting Area is detected, as described in clause 5.9.2.2.

The MME determines the UE AMBR to be used by the eNodeB based on the subscribed UE-AMBR and the APN‑AMBR for the default APN, see clause 4.7.3.

For emergency attach or RLOS attach the MME determines the UE-AMBR to be used by the eNodeB from the APN AMBR received from the S-GW.

If new MME hasn't received, from Step 12, Voice Support Match Indicator for the UE from the eNodeB then, based on implementation, the MME may set IMS Voice over PS session supported Indication and update it at a later stage.

The new MME sends an Attach Accept (GUTI, TAI List, Session Management Request (APN, PDN Type, PDN Address, EPS Bearer Identity, Protocol Configuration Options, Header Compression Configuration, Control Plane Only Indicator, Connection Release Supported, Paging Cause Indication for Voice Service Supported, Reject Paging Request Supported, Paging Restriction Supported, Paging Timing Collision Control Supported), NAS sequence number, NAS-MAC, IMS Voice over PS session supported Indication, Emergency Service Support indicator, LCS Support Indication, Supported Network Behaviour, Service Gap Time, Enhanced Coverage Restricted, Indication for support of 15 EPS bearers per UE, PLMN-assigned UE Radio Capability ID, indication for PLMN-assigned UE Radio Capability ID deletion, Accepted IMSI Offset, Forbidden TAI(s), Enhanced Discontinuous Coverage Support, Return To Coverage Notification Not Required, Maximum Time Offset, Start of Unavailability Period, Unavailability Period Duration) message to the eNodeB. GUTI is included if the new MME allocates a new GUTI. PDN Type and PDN Address are omitted if the Attach Request (step 1) did not contain an ESM message container. The MME indicates the CIoT EPS Optimisations it accepts in the Supported Network Behaviour information as defined in clause 4.3.5.10. Service Gap Time is included if Service Gap Time is present in the subscription information (step 11) and the UE has indicated UE Service Gap Control Capability. This message is contained in an S1\_MME control message Initial Context Setup Request, unless the MME has selected to use the Control Plane CIoT EPS Optimisation, or, the UE did not include the ESM message container in the Attach Request (step 1), in which case an S1-AP Downlink NAS transport message is used. The S1-AP Initial Context Setup Request 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 and whether User Plane CIoT EPS Optimisation is allowed for the UE. If the PDN type is set to "Non-IP" the MME includes it in the S1-AP Initial Context Setup Request so that the eNodeB disables header compression. If the PDN type is set to "Ethernet" the MME includes it in the S1-AP Initial Context Setup Request so that any eNodeB header compression functionality can act appropriately. In addition, if the PDN connection is established for Local IP Access, the corresponding S1 Initial Context Setup Request message includes a Correlation ID for enabling the direct user plane path between the HeNB and the L-GW. If the PDN connection is established for SIPTO at the Local Network with L-GW function collocated with the (H)eNB, the corresponding S1-AP Initial Context Setup Request message includes a SIPTO Correlation ID for enabling the direct user plane path between the (H)eNB and the L-GW. LIPA and SIPTO do not apply to Control Plane CIoT EPS Optimisation.

NOTE 13: In this release of the 3GPP specification the Correlation ID and SIPTO Correlation ID is set equal to the user plane PDN GW TEID (GTP-based S5) or GRE key (PMIP-based S5) that the MME has received in step 16.

If Control Plane CIoT EPS Optimisation applies for an IP PDN connection, and the UE has sent in the Attach Request the Header Compression Configuration, and the MME supports the header compression parameters, the MME shall include the Header Compression Configuration in the PDN Connectivity Accept message. The MME also binds the uplink and downlink ROHC channels to support header compression feedback signalling. If the UE has included header compression context setup parameters in Header Compression Configuration in the Attach Request, the MME may acknowledge the header compression context setup parameters. If the ROHC context is not established during the attach procedure for the PDN connection, before using the compressed format for sending the data, the UE and the MME need to establish the ROHC context with ROHC IR packet based on Header Compression Configuration.

If the MME based on local policy determines the PDN connection shall only use the Control Plane CIoT EPS Optimisation, the MME shall include a Control Plane Only Indicator in the Session Management Request. For PDN connections with an SCEF, the MME shall always include the Control Plane Only Indicator. A UE receiving the Control Plane Only Indicator, for a PDN connection shall only use the Control Plane CIoT EPS Optimisation for this PDN connection.

If the ESM container was not included in the Attach Request in step 1, then the Attach Accept message shall not include PDN related parameters, and the Downlink NAS transfer S1-AP message shall not include Access stratum context related information but may include CSG related information.

If the attach type is not set to "Emergency", and the ESM container was included in Attach Request in step 1, and the UE indicated support of Attach without PDN Connection in the Attach Request, and the MME supports Attach without PDN Connection, and PDN connection restriction is set in subscriber data, then the MME shall discard the ESM container in the Attach Request message, and shall not include PDN related parameters in the Attach Accept, but may include CSG related information.

In the Attach Accept message, the MME does not include the IPv6 prefix within the PDN Address. The MME includes the EPS Bearer QoS parameter QCI and APN-AMBR into the Session Management Request. Furthermore, if the UE has UTRAN or GERAN capabilities and the network supports mobility to UTRAN or GERAN, the MME uses the EPS bearer QoS information to derive the corresponding PDP context parameters QoS Negotiated (R99 QoS profile), Radio Priority, Packet Flow Id and TI and includes them in the Session Management Request. 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". The MME sets the IMS Voice over PS session supported Indication as described in clause 4.3.5.8. LCS Support Indication indicates whether the network supports the EPC-MO-LR and/or CS-MO-LR as described in TS 23.271 [57]. The MME may include an indication whether the traffic of this PDN Connection is allowed to be offloaded to WLAN, as described in clause 4.3.23. Indication for support of 15 EPS bearers per UE indicates the network support for up to 15 EPS bearers per UE as defined in clause 4.12.

If the UE initiates the Attach procedure at a hybrid cell, the MME shall check whether the CSG ID is contained in the CSG subscription and is not expired. The MME shall send an indication whether the UE is a CSG member to the RAN along with the S1-MME control message. Based on this information, the RAN may perform differentiated treatment for CSG and non-CSG members.

If the MME or PDN GW has changed the PDN Type, an appropriate reason cause shall be returned to the UE as described in clause 5.3.1.1. If the UE has indicated PDN type "Non-IP" or "Ethernet", the MME and PDN GW shall not change PDN type.

For an emergency attached UE, i.e. for UEs that have only emergency EPS bearers established, there is no AS security context information included in the S1 control messages and there is no NAS level security when the UE cannot be authenticated. The Emergency Service Support indicator informs the UE that Emergency bearer services are supported, i.e. the UE is allowed to request PDN connectivity for emergency services.

For RLOS attached UEs, i.e. for UEs that have only RLOS PDN connection established, there is no AS security context information included in the S1 control messages and there is no NAS level security when the UE cannot be successfully authenticated.

If the UE included extended idle mode DRX parameters information element, the MME includes extended idle mode DRX parameters information element if it decides to enable extended idle mode DRX with Paging Time Window length assigned considering Subscribed Paging Time Window (if available) and the local policy. Additionally, for a UE using an eNodeB that provides discontinuous coverage (e.g. for satellite access with discontinuous coverage), the MME may consider the use of discontinuous coverage as described in clause 4.13.8.2 when determining extended idle mode DRX parameters.

If the UE provided the UE paging probability information in Step 1, the MME takes it into account when generating the WUS Assistance Information. If the MME has determined WUS Assistance Information for the UE, the MME shall send the WUS Assistance Information to the UE (see TS 36.300 [5]).

If the UE included support for restriction of use of Enhanced Coverage in step 1, the MME sends Enhanced Coverage Restricted parameter to the eNodeB in S1-AP Initial Context Set-up Request message. MME also sends Enhanced Coverage Restricted parameter to the UE in the Attach Accept message.

If the UE has indicated support for dual connectivity with NR in the Attach Request and the UE is not allowed to use NR as Secondary RAT, the MME indicates that to the UE in the Attach Accept message.

If RACS is supported in the MME and MME has received UE Radio Capability ID earlier in this procedure, it signals the UE Radio Capability ID to the eNodeB in S1-AP Initial Context Set-up Request message. If the eNodeB does not have mapping between the specific UE Radio Capability ID and the UE radio capabilities, it shall use the procedure described in TS 36.413 [36] to retrieve the mapping from the MME.

When the UE supports RACS, and the MME needs to configure the UE with a UE Radio Capability ID, and the MME already has the UE radio capabilities for the UE, the MME may provide the UE with the UE Radio Capability ID for the UE radio capabilities the UCMF returns to the MME for this UE.

If MME has authorized the UE's IAB operation in step 11 based on the IAB-Operation Allowed indication, it shall include an "IAB Authorized" indication in the S1-AP Initial Context Set-up Request message to the eNodeB.

If the UE had included a UE Specific DRX parameter for NB-IoT in the Attach Request, the MME includes the Accepted NB-IoT DRX parameter.

If the UE provided a Requested IMSI Offset in step 1, but the network prefers a different value, the MME provides the UE with an Accepted IMSI Offset different from the one provided in step 1. Otherwise the value of the Accepted IMSI Offset the MME sends is the value of the Requested IMSI Offset sent by the UE in step 1. The MME stores the value of the alternative IMSI derived from the Accepted IMSI Offset (see clause 4.3.33) provided to the UE in the UE context.

If a Multi-USIM mode UE does not provide a Requested IMSI Offset in step 1, the MME erases any Alternative IMSI value in the UE context.

If the Multi-USIM UE has indicated one or more Multi-USIM specific capabilities are supported in the UE Core Network Capability in step 1, the MME shall indicate whether the corresponding one or more Multi-USIM specific features described in clause 4.3.33 are supported based on network capability and preference by the network (i.e. based on local network policy) by providing one or more of the Connection Release Supported, Paging Cause Indication for Voice Service Supported, Reject Paging Request Supported, Paging Restriction Supported and Paging Timing Collision Control Supported indications. The MME shall only indicate Paging Restriction Supported together with either Connection Release Supported or Reject Paging Request Supported. The UE shall only use Multi-USIM specific features that the MME indicated as being supported. In the case of Emergency Attach, the MME shall not indicate support for any Multi-USIM feature to the UE.

If the MME receives multiple TAIs from E-UTRAN in step 2 and determines that some, but not all, TAIs in the received list of TAIs are forbidden by subscription or by operator policy, the MME shall include the forbidden TAI(s) in the Attach Accept message.

If both UE and network support discontinuous coverage, the MME provides the Enhanced Discontinuous Coverage Support indication as described in clause 4.13.8.1. The MME may provide Start of Unavailability Period and/or Unavailability Period Duration to UE in the Attach Accept message as described in clause 4.13.8.2.

For a UE using a eNodeB that provides discontinuous coverage (e.g. for satellite access with discontinuous coverage), the MME may provide Return To Coverage Notification Not Required, which requests the UE in ECM\_IDLE state to not perform the TAU procedure when it returns to coverage as described in clause 4.13.8.2. The MME may also provide a Maximum Time Offset as described in clause 4.13.8.6.

If the UE and MME are in S&F mode, the MME may include the wait timer, the list of Satellite IDs or Uplink S&F Delivery Time as described in clause 4.13.X.

18. If the eNodeB received an S1-AP Initial Context Setup Request 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.

If the eNodeB received an S1-AP Downlink NAS Transport message (e.g. containing the Attach Accept message), the eNode B sends a RRC Direct Transfer message to the UE.

The UE shall store the QoS Negotiated, Radio Priority, Packet Flow Id and TI, which it received in the Session Management Request, for use when accessing via GERAN or UTRAN. The APN is provided to the UE to notify it of the APN for which the activated default bearer is associated. For further details, see TS 36.331 [37]. The UE may provide EPS Bearer QoS parameters to the application handling the traffic flow(s). 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 Request.

If the UE receives Enhanced Coverage Restricted parameter in the Attach Accept message, UE shall store this information and shall use the value of Enhanced Coverage Restricted parameter to determine if enhanced coverage feature should be used or not. If the UE receives a Service Gap Time in the Attach Accept message, the UE shall store this parameter and apply Service Gap Control (see clause 4.3.17.9).

If the attach procedure is initiated by manual CSG selection and occurs via a CSG cell, the UE upon receiving the Attach accept shall check if the CSG ID and associated PLMN of the cell where the UE has sent the Attach Request message is contained in its Allowed CSG list. If the CSG ID and associated PLMN is not in the UE's Allowed CSG list, the UE shall add the CSG ID and associated PLMN to its Allowed CSG list. Manual CSG selection is not supported when an emergency service has been initiated.

NOTE 14: If the UE receives an Attach Accept message via a hybrid cell, the UE does not add the corresponding CSG ID and associated PLMN to its Allowed CSG list. Adding a CSG ID and associated PLMN to the UE's local Allowed CSG list for a hybrid cell is performed only by OTA or OMA DM procedures.

When receiving the Attach Accept message the UE shall set its TIN to "GUTI" as no ISR Activated is indicated.

If the UE receives an IPv4 address set to 0.0.0.0, it may negotiate the IPv4 address with DHCPv4 as specified in TS 29.061 [38]. If the UE receives an IPv6 interface identifier, it may wait for the Router Advertisement from the network with the IPv6 prefix information or it may send a Router Solicitation if necessary.

NOTE 15: The IP address allocation details are described in clause 5.3.1 on "IP Address Allocation".

If Control Plane CIoT EPS Optimisation applies or the UE has not included the ESM message container in the Attach Request in step 1, then the steps 19 and 20 are not executed.

19. The UE sends the RRC Connection Reconfiguration Complete message to the eNodeB. For further details, see TS 36.331 [37].

20. The eNodeB sends the Initial Context Response message to the new MME. This Initial Context Response message includes the TEID of the eNodeB and the address of the eNodeB used for downlink traffic on the S1\_U reference point.

The MME shall be prepared to receive this message either before or after the Attach Complete message (sent in step 22).

If the Correlation ID or SIPTO Correlation ID was included in the Initial Context Setup Request message, the eNodeB shall use the included information to establish direct user plane path with the L-GW and forward uplink data for Local IP Access or SIPTO at the Local Network with L-GW function collocated with the (H)eNB accordingly.

21. The UE sends a Direct Transfer message to the eNodeB, which includes the Attach Complete (EPS Bearer Identity, NAS sequence number, NAS-MAC) message. If the UE omitted the ESM message container from the Attach Request message in step 1, then the EPS Bearer Identity is omitted from the Attach Complete message.

22. The eNodeB forwards the Attach Complete message to the new MME in an Uplink NAS Transport message.

If the ESM message container was included in step 1, after the Attach Accept message and once the UE has obtained (if applicable to the PDN type) 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 Control Plane CIoT EPS Optimisations apply, UL data is sent as specified in clause 5.3.4B. 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 indicating that only single IP version per PDN connection is allowed sent together with the PDN type, the UE should 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 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.

23. Upon reception of both, the Initial Context Response message in step 20 and the Attach Complete message in step 22, the new MME sends a Modify Bearer Request (EPS Bearer Identity, eNodeB address, eNodeB TEID, Handover Indication, Presence Reporting Area Information, RAT type, LTE-M RAT type reporting to PGW) message to the Serving GW. If the Control Plane CIoT EPS Optimisation applies and the PDN connection is not served by a SCEF and if the MME does not need to report a change of UE presence in Presence Reporting Area, sending of Modify Bearer Request and steps 23a, 23b and 24 are skipped; otherwise if the PDN connection is served by SCEF, steps 23,24, 25, and 26 are not executed. If the MME has been requested to report a change of UE presence in Presence Reporting Area, the MME includes in this message the Presence Reporting Area Information comprising the PRA identifier(s) and indication(s) on whether the UE is inside or outside the area(s). When receiving the request for reporting change of UE presence in Presence Reporting Area, and the MME decides not to activate reporting UE presence in one or more of the received Presence Reporting Area(s), the MME reports also the inactive Presence Reporting Area(s) in this message. The RAT type information element is included if the UE is using the LTE-M RAT type. If PDN GW expects the LTE-M RAT type reporting as specified in clause 5.11.5, the MME also includes the LTE-M RAT type reporting to PGW flag to indicate that the Serving GW needs to forward the LTE-M RAT type to the PGW.

23a. If the Handover Indication is included in step 23, the Serving GW sends a Modify Bearer Request (Handover Indication) 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. If Presence Reporting Area Information is included in step 23, the Serving GW sends a Modify Bearer Request (Presence Reporting Area Information) message to the PDN GW. If the LTE-M RAT type and the LTE-M RAT type reporting to PGW flag were received at step 23, the Serving GW shall include the LTE-M RAT type in the Modify Bearer Request message to the PGW. Otherwise the Serving GW includes RAT type WB-E-UTRAN.

NOTE 16: The PDN GW is expected to handle the uplink packets sent by the UE via 3GPP access after step 22, even if they arrive before path switch in step 23.

NOTE 17: The PDN GW forwards the Presence Reporting Area Information to the PCRF, to the OCS or to both as defined in TS 23.203 [6].

23b. The PDN GW acknowledges by sending Modify Bearer Response to the Serving GW.

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

If there is a "Availability after DDN Failure" monitoring event or a "UE Reachability" monitoring event configured for the UE in the EMM Context of the MME, the MME sends an event notification (see TS 23.682 [74] for further information).

25. After the MME receives Modify Bearer Response (EPS Bearer Identity) message, if Request Type does not indicate handover and 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 a Notify Request including the APN and PDN GW identity to the HSS for mobility with non-3GPP accesses. The message shall include information that identifies the PLMN in which the PDN GW is located.

If the ME identity of the UE has changed and step 8 has not been performed, the MME sends a Notify Request (ME Identity) message to inform the HSS of the updated ME identity.

For an unauthenticated or roaming UE, if the Request Type of the UE requested connectivity procedure indicates "Emergency", the MME shall not send any Notify Request to an HSS. For a non-roaming authenticated UE, based on operator configuration (e.g. on whether Voice over WLAN is supported or not by the operator, on whether the operator uses a fixed PDN GW for emergency calls, etc.), if the Request Type indicates "Emergency", the MME may send a Notify Request to the HSS including the "PDN GW currently in use for emergency services", which comprises the PDN GW address and an indication that the PDN connection is for emergency services. The HSS shall store it as part of the UE context for emergency services.

For any UEs, if Request Type of the UE requested connectivity procedure indicates "RLOS", the MME shall not send any Notify Request to an HSS.

After step 8, and in parallel to any of the preceding steps, the MME shall send a Notify Request (Homogeneous Support of IMS Voice over PS Sessions) message to the HSS:

- If the MME has evaluated the support of IMS Voice over PS Sessions, see clause 4.3.5.8, and

- If the MME determines that it needs to update the Homogeneous Support of IMS Voice over PS Sessions, see clause 4.3.5.8A.

26. In the case of non-emergency services, the HSS stores the APN and PDN GW identity pair. In the case of emergency services, the HSS stores the "PDN GW currently in use for emergency services". The HSS then sends a Notify Response to the MME.

NOTE 18: For handover from non-3GPP access, the PDN GW initiates resource allocation deactivation procedure in the trusted/untrusted non-3GPP IP access as specified in TS 23.402 [2].

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Next Changes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#### 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.

NOTE 2: In the case of Tracking Area Update without MME change the signalling in steps 4, 5, 7 and steps 12-17 are skipped.

1. One of the triggers described in clause 5.3.3.0 for starting the TAU procedure occurs.

2. The UE initiates the TAU procedure by sending, to the eNodeB, a TAU Request (UE Core Network Capability, MS Network Capability, Preferred Network behaviour, Support for restriction of use of Enhanced Coverage, old GUTI, Old GUTI type, last visited TAI, active flag, signalling active flag, EPS bearer status, P‑TMSI Signature, additional GUTI, eKSI, NAS sequence number, NAS-MAC, KSI, Voice domain preference and UE's usage setting, UE has UE Radio Capability ID assigned for the selected PLMN, Requested IMSI Offset, Release Request indication, Paging Restriction Information, Unavailability Period Duration, Start of Unavailability Period) message together with RRC parameters indicating the Selected Network and the old GUMMEI. An exception is that, if the TAU was triggered for load re-balancing purposes (see clause 4.3.7.3), the old GUMMEI is not included in the RRC parameters. The UE shall set the Old GUTI Type to indicate whether the Old GUTI is a native GUTI or is mapped from a P-TMSI and RAI.

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. When the UE is in connected mode (e.g. in URA\_PCH) when it reselects to E‑UTRAN, the UE shall set its TIN to "P‑TMSI".

If the UE holds a valid GUTI and the old GUTI indicates a GUTI mapped from a P-TMSI and RAI, then the UE indicates the GUTI as additional GUTI. If the old GUTI indicates a GUTI mapped from a P-TMSI and RAI, and the UE has a valid P-TMSI signature, the P-TMSI signature shall be included.

The additional GUTI in the Tracking Area Update Request message allows the new MME to find any already existing UE context stored in the new MME when the old GUTI indicates a value mapped from a P-TMSI and RAI.

Alternatively, when a UE only supports E-UTRAN, it identifies itself with the old GUTI and sets the Old GUTI Type to 'native'.

The RRC parameter "old GUMMEI" takes its value from the identifier that is signalled as the old GUTI according to the rules above. For a combined MME/SGSN the eNodeB is configured to route the MME‑code(s) of this combined node to the same combined node. This eNodeB 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 eNodeB 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. Signalling active flag is a request by UE using Control Plane CIoT EPS Optimisation to maintain the NAS signalling connection after Tracking Area Update Procedure is completed in order to transmit pending Data using the Data Transport in Control Plane CIoT EPS Optimisation or NAS signalling. The EPS bearer status indicates each EPS bearer that is active in the UE. The TAU Request message shall be integrity protected by the NAS-MAC as described in TS 33.401 [41]. eKSI, NAS sequence number and NAS-MAC are included if the UE has valid EPS security parameters. NAS sequence number indicates the sequential number of the NAS message. KSI is included if the UE indicates a GUTI mapped from a P‑TMSI in the information element "old GUTI".

In the RRC connection establishment signalling associated with the TAU Request, the UE indicates its support of the CIoT EPS Optimisations relevant for MME selection.

For UE using CIoT EPS Optimisation without any activated PDN connection, there is no active flag or EPS bearer status included in the TAU Request message. For a UE with a running Service Gap timer in the UE the UE shall not set the active flag and the signalling active flag in the TAU request message (see clause 4.3.17.9) except for network access for regulatory prioritized services like Emergency services or exception reporting.

If the UE has any PDN connection of PDN Type "non-IP" or "Ethernet", the UE shall send the EPS bearer status in the TAU Request message.

The UE sets the voice domain preference and UE's usage setting according to its configuration, as described in clause 4.3.5.9.

The UE includes extended idle mode DRX parameters information element if it needs to enable extended idle mode DRX, even if extended idle mode DRX parameters were already negotiated before.

The UE may include UE paging probability information if it supports the assignment of WUS Assistance Information from the MME to assist the eNodeB's Wake-Up Signal (WUS) group decision (see TS 36.300 [5]).

If a UE includes a Preferred Network Behaviour, this defines the Network Behaviour the UE is expecting to be available in the network as defined in clause 4.3.5.10.

If the UE supports RACS as defined in clause 5.11.3a, and if the UE is provisioned with a UE Radio Capability ID for use in the selected PLMN (i.e. PLMN-assigned for the specific PLMN or manufacturer-assigned), the UE includes a flag that indicates it has an assigned UE Radio Capability ID for use in the selected PLMN but the actual UE Radio Capability ID is provided to MME after security context is established in step 6 (see below).

If a Multi-USIM UE wants to enter ECM-IDLE state it includes the Release Request indication and optionally provides Paging Restriction Information.

If a Multi-USIM UE needs to modify the Paging Occasions in order to avoid paging collisions, it sends a Requested IMSI Offset to the MME, in order to signal an alternative IMSI as described in clause 4.3.33

In the case of satellite access for Cellular IoT, the MME may verify the UE location and determine whether the PLMN is allowed to operate at the UE location, as described in clause 4.13.4. If the UE receives a TAU Reject message with cause value indicating that the selected PLMN is not allowed to operate at the present UE location, the UE shall attempt to select a PLMN as specified in TS 23.122 [10].

If the UE is using a eNodeB that provides discontinuous coverage (e.g. for satellite access with discontinuous coverage), the UE may include an Unavailability Period Duration and Start of Unavailability Period, see clause 4.13.8.2.

If the UE indicates support of S&F mode, the MME may provide TAU Reject to the UE if this procedure cannot be completed due to S&F operation. The MME may provide additional information as described in clause 4.13.x.

3. The eNodeB derives the MME address from the RRC parameters carrying the old GUMMEI, the indicated Selected Network and the RAT (NB-IoT or WB-E-UTRAN). If that MME is not associated with that eNodeB or the GUMMEI is not available or the UE indicates that the TAU procedure was triggered by load re-balancing, 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 the CSG access mode, CSG ID, TAI+ECGI of the cell from where it received the message and with the Selected Network to the new MME. CSG ID is provided by RAN if the UE sends the TAU Request message via a CSG cell or a hybrid cell. CSG access mode is provided if the UE sends the TAU Request message via a hybrid cell. If the CSG access mode is not provided but the CSG ID is provided, the MME shall consider the cell as a CSG cell. For SIPTO at the Local Network with stand-alone GW architecture the eNodeB includes the Local Home Network ID in the Initial UE Message and in Uplink NAS Transport message if the target cell is in a Local Home Network.

To assist Location Services, the eNodeB indicates the UE's Coverage Level to the MME.

If the MME supports RACS, and the MME detects that the selected PLMN is different from the currently registered PLMN for the UE, the MME provides the UE Radio Capability ID of the newly selected PLMN in the UE context to the eNodeB as described in clause 5.11.3a.

4. The new MME differentiates the type of the old node, i.e. MME or SGSN, as specified in clause 4.3.19, uses the GUTI received from the UE to derive the old MME/S4 SGSN address, and sends a Context Request (old GUTI, complete TAU Request message, P‑TMSI Signature, MME Address, UE validated, CIoT EPS Optimisation support indication) message to the old MME/old S4 SGSN to retrieve user information. UE Validated indicates that the new MME has validated the integrity protection of the TAU message, e.g. based on native EPS security context for the UE. To validate the Context Request the old MME uses the complete TAU Request message and the old S4 SGSN uses the P‑TMSI Signature and responds with an appropriate error if integrity check fails in old MME/S4 SGSN. This shall initiate the security functions in the new MME. If the security functions authenticate the UE correctly, the new MME shall send a Context Request (IMSI, complete TAU Request message, MME Address, UE Validated) message to the old MME/S4 SGSN with the UE Validated set. If the new MME indicates that it has authenticated the UE or if the old MME/old S4 SGSN correctly validates the UE, then the old MME/old S4 SGSN starts a timer.

If the UE with emergency bearers is not authenticated in the old MME/old S4 SGSN (in a network supporting unauthenticated UEs) the old MME/old S4 SGSN continues the procedure with sending a Context Response and starting the timer also when it cannot validate the Context Request.

If a RLOS attached UE is not successfully authenticated in the old MME, the old MME continues the procedure with sending a Context Response and starting the existing timer also when it cannot validate the Context Request.

If the new MME supports CIoT EPS Optimisation, CIoT EPS Optimisation support indication is included in the Context Request indicating support for various CIoT EPS Optimisations (e.g. support for header compression for CP CIoT EPS Optimisation, etc.).

5. If the Context Request is sent to an old MME the old MME responds with a Context Response (IMSI, MSISDN, ME Identity (IMEISV), MM Context, EPS Bearer Context(s), Serving GW signalling Address and TEID(s), ISR Supported, MS Info Change Reporting Action (if available), CSG Information Reporting Action (if available), UE Time Zone, UE Core Network Capability, UE Specific DRX Parameters, Remaining Running Service Gap timer, LTE-M UE Indication) message. If the new MME supports CIoT EPS Optimisation and the use of header compression has been negotiated between the UE and the old MME, the Context Response also includes the Header Compression Configuration which includes the information necessary for the ROHC channel setup but not the RoHC context itself.

If the Context Request is sent to an old S4 SGSN the old S4 SGSN responds with a Context Response (MM Context, EPS Bearer Context(s), Serving GW signalling Address and TEID(s), ISR Supported, MS Info Change Reporting Action (if available), CSG Information Reporting Action (if available), UE Time Zone, UE Core Network Capability, UE Specific DRX Parameters). If the source MME has not yet reported a non-zero MO Exception Data Counter to the PDN GW, the Context Response also includes the MO Exception Data Counter as described in TS 29.274 [43].

The MM Context contains security related information as well as other parameters (including IMSI and ME Identity (if available)) as described in clause 5.7.2 (Information Storage for MME). The unused Authentication Quintets in the MM Context are also maintained in the SGSN. TS 33.401 [41] gives further details on the transfer of security related information.

If the MM Context received with the Context Response message did not include IMEISV and the MME does not already store the IMEISV of the UE, the MME shall retrieve the ME Identity (IMEISV) from the UE.

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) and the TI(s), is part of the EPS Bearer Context. If the UE is not known in the old MME/old S4 SGSN or if the integrity check for the TAU Request message fails, the old MME/old S4 SGSN responds with an appropriate error cause. ISR Supported is indicated if the old MME/old S4 SGSN and associated Serving GW are capable to activate ISR for the UE.

If the UE receives emergency bearer services from the old MME/old S4 SGSN and the UE is UICCless, IMSI can not be included in the Context Response. For emergency attached UEs, if the IMSI cannot be authenticated, then the IMSI shall be marked as unauthenticated. Also, in this case, security parameters are included only if available.

For a RLOS attached UE, the old MME includes an RLOS indication to the new MME. If the RLOS attached UE in the old MME does not have a USIM, IMSI can not be included in the Context Response. If the RLOS attached UE has USIM but the IMSI cannot be successfully authenticated, then the IMSI shall be marked as unauthenticated. Also, in this case, security parameters are included only if available.

If SIPTO at the Local Network is active for a PDN connection in the architecture with stand-alone GW, the old MME/old S4 SGSN shall include the Local Home Network ID of the old cell in the EPS Bearer context corresponding to the SIPTO at the Local Network PDN connection.

For UE using CIoT EPS Optimisation without any activated PDN connection, there is no EPS Bearer Context(s) included in the Context Response message.

Based on the CIoT EPS Optimisation support indication, old MME only transfers the EPS Bearer Context(s) that the new MME supports. If the new MME does not support CIoT EPS Optimisation, EPS Bearer Context(s) of non-IP PDN connection are not transferred to the new MME. If the new MME does not support Ethernet PDN Type, EPS Bearer Context(s) of Ethernet PDN type are not transferred to the new MME. If the EPS Bearer Context(s) of a PDN connection has not been transferred, the old MME shall consider all bearers of that PDN connection as failed and release that PDN connection by triggering the MME requested PDN disconnection procedure specified in clause 5.10.3. The buffered data in the old MME is discarded after receipt of Context Acknowledgement.

If the EPS Bearer Context(s) are to be transferred to the new MME, the old MME also includes the Serving GW IP address and TEID for both S1-U and S11-U, if available.

If the Old MME is aware the UE is a LTE-M UE, it provides the LTE-M UE Indication to the new MME. During inter PLMN mobility, the new MME shall delete the UE Radio Capability ID received from the old MME, unless the operator policy indicates that all UE Radio Capability IDs used in the old PLMN are also valid in the new PLMN.

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.

If this TAU request is received for a UE which is already in ECM\_CONNECTED state and the PLMN-ID of the TAI sent by the eNodeB in Step 3 is different from that of the GUTI, included in the TAU Request message, the MME shall delay authenticating the UE until after Step 21 (TAU Complete message).

NOTE 3: The MME delays the authentication such that the UE first updates its registered PLMN-ID to the new PLMN-ID selected by the RAN during handover. The new PLMN-ID is provided by the MME to the UE as part of the GUTI in the TAU accept message in Step 20. Doing this ensures that the same PLMN-ID is used in the derivation of the Kasme key by both the network and the UE.

If the new MME is configured to allow emergency bearer services for unauthenticated UE the new MME behave as follows:

- where a UE has only emergency bearer services, the MME either skip the authentication and security procedure or accepts that the authentication may fail and continues the Tracking Area Update procedure; or

- where a UE has both emergency and non-emergency bearer services and authentication fails, the MME continues the Tracking Area Update procedure and deactivates all the non-emergency PDN connections as specified in clause 5.10.3.

If the new MME is configured to allow Restricted Local Operator Services, the new MME, based on local regulation and operator policy, may skip the authentication and security procedure, or may perform authentication if security parameters are available, or obtainable from HSS, and continues the Tracking Area Update procedure regardless of the authentication result.

If the UE indicated it has a UE Radio Capability ID assigned for use in the selected PLMN in step 2, the MME may request the UE to provide the UE Radio Capability ID in Security Mode Command, if the MME needs to get the UE Radio Capability ID from the UE e.g. at inter-PLMN mobility. If enquired by the MME the UE shall include the UE Radio Capability ID in Security Mode Command Accept for the supported UE radio capabilities.

In the case of satellite access for NB-IoT, if the UE indicated support for reporting its Coarse Location Information, the MME may request the UE to report its Coarse Location Information by setting the Coarse Location Information Request in the Security Mode Command message and the UE then reports its Coarse Location Information in the Security Mode Complete message. To perform UE location verification as described in clause 4.13.4, the MME provides the reported Coarse Location Information to the E-SMLC as described in clause 9.1.17 of TS 23.271 [57].

In S&F mode, the MME may indicate to HSS the "Request Time" (see 4.13.X), allowing the HSS to check that no other MME(e.g., terrestrial) has sent the request after the "Request Time", and fetches the authentication vector and other details from HSS following current Authentication and security procedures. If there was a request from other MME after the "Request Time" indicated by MME, then this request is rejected by the HSS, the MME shall abort the Attach procedure and delete UE context (if available). The MME may trigger Update Location Request (see step 12) with the HSS and Update Location Ack (see step 17) is received by MME. i.e. all the subscription details can be retrieved by MME before authenticating the UE. The Update Location Request includes an indication that this location update is provisional i.e. the HSS must not consider the UE as registered until it receives the final Update Location Request without such indication.

7. The MME (if the MME has changed then it is the new MME) determines to relocate the Serving GW. The Serving GW is relocated when the old Serving GW cannot continue to serve the UE. The MME (if the MME has changed then it is the new MME) may also decide to relocate the Serving GW if a new Serving GW is expected to serve the UE longer and/or with a more optimal UE to PDN GW path, or if 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".

If the MME has changed 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 UE context that the information in the GWs is invalid. And, if the old node is an MME, the old MME marks in its UE context that the information in the HSS is invalid. This ensures that the old MME/old S4 SGSN updates the GWs, and the old MME updates the HSS, if the UE initiates a TAU or RAU procedure back to the old MME/old S4 SGSN before completing the ongoing TAU procedure.

NOTE 4: Updating the GWs refers to deletion of session(s) on the Serving GW followed by re-creation of session(s) on the Serving GW. The re-creation of session(s) on the Serving GW will result in successful re-establishment of the S5/S8 tunnel between the selected Serving GW and the PDN GW.

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.

For UE using CIoT EPS Optimisation without any activated PDN connection, the steps 8, 9, 10, 11, 18 and 19 are skipped.

8. If the MME has changed the new MME verifies the EPS bearer status received from the UE with the bearer contexts received from the old MME/old S4 SGSN. If the MME has not changed the MME verifies EPS bearer status from the UE with the bearer contexts available in the MM context. The MME releases any network resources related to EPS bearers that are not active in the UE. If there is no bearer context at all, the MME rejects the TAU Request.

If the MME selected a new Serving GW it sends a Create Session Request (IMSI, MSISDN, bearer contexts, MME Address and TEID, Type, the Protocol Type over S5/S8, RAT type, LTE-M RAT type reporting to PGW flag, Serving Network, UE Time Zone, MO Exception data counter) message per PDN connection to the selected new Serving GW. The PDN GW address and TFT (for PMIP-based S5/S8) are indicated in the bearer Contexts. Type indicates to the Serving GW to send the Modify Bearer Request to the PDN GW. The Protocol Type over S5/S8 is provided to Serving GW which protocol should be used over S5/S8 interface. RAT type indicates a change in radio access. If it is a mobility from a SGSN to a MME and if the MME supports location information change reporting, the MME shall include the User Location Information (according to the supported granularity) in the Create Session Request, regardless of whether location information change reporting had been requested in the previous RAT by the PDN GW. If it is an inter MME mobility and if the PDN GW requested location information change reporting, the MME includes the User Location Information IE in this message if it is different compared to the previously sent information. If the PDN GW requested User CSG information, the MME also includes the User CSG Information IE in this message. If Control Plane CIoT EPS Optimisation applies, the MME may also indicate S11-U tunnelling of NAS user data and send its own S11-U IP address and MME DL TEID for DL data forwarding by the SGW. The MME shall include the MO Exception data counter if it has received the counter for RRC cause "MO Exception data" in the Context Response message.

If only the Control Plane CIoT EPS Optimisation is used, the MME shall include a Control Plane Only PDN Connection Indicator in Create Session Request.

If the new MME receives the EPS bearer context with SCEF, then the new MME updates the SCEF as defined in TS 23.682 [74].

If the UE is using the LTE-M RAT type and the PDN GW expects the LTE-M RAT type reporting as specified in clause 5.11.5, the MME also includes the LTE-M RAT type reporting to PGW flag to indicate to the Serving GW to forward the LTE-M RAT type to the PDN GW.

9. 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 Modify Bearer Request (Serving GW Address and TEID, RAT type, Serving Network, PDN Charging Pause Support Indication) per PDN connection to the PDN GW(s) concerned. User Location Information IE and/or UE Time Zone IE and/or User CSG Information IE and/or MO Exception data counter are also included if they are present in step 8. The Serving GW and PDN GW indicate each use of the RRC establishment cause "MO Exception Data" by the related counter on its CDR.

If the Serving GW has received the Control Plane Only PDN Connection Indicator in step 8, the Serving GW indicates the use of CP only on its CDR.

If LTE-M RAT type and the LTE-M RAT type reporting to PGW flag were received at step 8, the Serving GW shall include the LTE-M RAT type in the Modify Bearer Request message to the PGW. Otherwise the Serving GW includes RAT type WB-E-UTRAN.

9a 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 5: 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 bearer contexts and returns a Modify Bearer Response (MSISDN, Charging Id, PDN Charging Pause Enabled Indication (if PDN GW has chosen to enable the function)) message. The MSISDN is included if the PDN GW has it stored in its UE context. If there has been a RAT change towards E-UTRAN and location information change reporting is required and supported in the target MME, the PDN GW shall provide MS Info Change Reporting Action in the Modify Bearer Response.

If the Serving GW is relocated, the PDN GW shall send one or more "end marker" packets on the old path immediately after switching the path in order to assist the reordering function in the target eNodeB. If the Serving GW has no downlink user plane established, the Serving GW shall discard the "end marker" received from the PDN GW and shall not send Downlink Data Notification. Otherwise the Serving GW shall forward the "end marker" packets to the source eNodeB or source S4 SGSN.

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 Session Response (Serving GW address and TEID for user plane and control plane and PDN GW TEIDs (for GTP-based S5/S8) or GRE keys (for PMIP-based S5/S8) for uplink traffic and control plane, MS Info Change Reporting Action) message to the new MME.

If Control Plane CIoT EPS Optimisation applies and if the MME does not include Control Plane Only PDN Connection Indicator in the Create Session Request:

- If separation of S11-U from S1-U is required, the Serving GW shall include the Serving GW IP address and TEID for S11-U and additionally the Serving GW IP address and TEID for S1-U in the Create Session Response.

- Otherwise, if separation of S11-U from S1-U is not required, the Serving GW includes the Serving GW IP address and TEID for S11-U in Create Session Response.

When the MME receives the Create Session Response message, the MME checks if there is a "Availability after DDN Failure" monitoring event or a "UE Reachability" monitoring event configured for the UE in the MME and in such a case sends an event notification (see TS 23.682 [74] for further information).

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, or for some network sharing scenario (e.g. GWCN) if the PLMN-ID of the TAI supplied by the eNodeB is different from that of the GUTI in the UE's context, then the new MME sends an Update Location Request (MME Identity, IMSI, ULR-Flags, MME Capabilities, Homogeneous Support of IMS Voice over PS Sessions, UE SRVCC capability, equivalent PLMN list, ME Identity (IMEISV)) message to the HSS. ULR-Flags indicates that update location is sent from an MME and the MME registration shall be updated in HSS. The HSS does not cancel any SGSN registration. The MME capabilities indicate the MME's support for regional access restrictions functionality. The inclusion of the equivalent PLMN list indicates that the MME supports the inter-PLMN handover to a CSG cell in an equivalent PLMN using the subscription information of the target PLMN. The "Homogenous Support of IMS Voice over PS Sessions" indication (see clause 4.3.5.8A) shall not be included unless the MME has completed its evaluation of the support of "IMS Voice over PS Session" as specified in clause 4.3.5.8. The ME Identity is included if step 5 caused the MME to retrieve the IMEISV from the UE.

NOTE 6: At this step, the MME may not have all the information needed to determine the setting of the IMS Voice over PS Session Supported indication for this UE (see clause 4.3.5.8). Hence the MME can send the "Homogenous Support of IMS Voice over PS Sessions" later on in this procedure.

If the UE initiates the TAU procedure in a VPLMN supporting Autonomous CSG Roaming and the HPLMN has enabled Autonomous CSG Roaming in the VPLMN (via Service Level Agreement) and the MME needs to retrieve the CSG subscription information of the UE from the CSS, the MME initiates the Update CSG Location Procedure with CSS as described in clause 5.3.12.

If the MME determines that only the UE SRVCC capability has changed, the MME sends a Notify Request to the HSS to inform about the changed UE SRVCC capability.

If all the EPS bearers of the UE have emergency ARP value, the new MME may skip the update location procedure or proceed even if the update location fails.

If the UE is RLOS attached, the new MME skips the Update Location procedure.

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. When old S4 SGSN receives the Context Acknowledge message and if the UE is in Iu Connected, the old S4 SGSN sends an Iu Release Command message to the RNC after the timer started in step 4 has expired.

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

17. The HSS acknowledges the Update Location Request message by sending an Update Location Ack (IMSI, Subscription Data) message to the new MME. The Subscription Data may contain the CSG subscription data for the registered PLMN and for the equivalent PLMN list requested by MME in step 12.

The subscription data may contain Enhanced Coverage Restricted parameter. If received from the HSS, MME stores this Enhanced Coverage Restricted parameter in the MME MM context.

The subscription data may contain a Service Gap Time. If received from the HSS, the MME stores this Service Gap Time in the MME MM context for the UE and passes it to the UE in the Tracking Area Update Accept message.

The subscription data may contain Subscribed Paging Time Window parameter that applies to the UEs on a specific RAT, e.g. NB-IoT. If received from the HSS, MME stores this Subscribed Paging Time Window parameter in the MME MM context.

If the Update Location is rejected by the HSS, the new MME rejects the TAU Request from the UE with an appropriate cause. In such cases, the new MME releases any local MME EPS Bearer contexts for this particular UE, and additionally deletes the EPS bearer resources in the new Serving GW by sending the Delete Session Request (Cause, Operation Indication) messages to the new Serving GW. The Operation Indication flag shall not be set. Therefore, the new Serving GW receiving this request shall not initiate a delete procedure towards the PDN GW.

If the UE initiates the TAU procedure at a CSG cell, the new MME shall check whether the CSG ID and associated PLMN is contained in the CSG subscription and is not expired. If the CSG ID and associated PLMN is not present or expired, the MME shall send a Tracking Area Update reject message to the UE with an appropriate cause value. The UE shall remove the CSG ID and associated PLMN from its Allowed CSG list if present. If the UE has ongoing emergency bearer services no CSG access control shall be performed.

In S&F mode, the MME may indicate to HSS the "Request Time" (see 4.13.X), allowing the HSS to check that no other MME(e.g., terrestrial) has sent the request after the "Request Time". If there was a request from other MME after the "Request Time" indicated by MME, then this request is rejected by the HSS, the MME shall abort the TAU procedure.

If all checks are successful then the new MME constructs a context for the UE.

18. If the MME has changed, when the timer started in step 4 expires the old MME/old S4 SGSN releases any local MME or SGSN bearer resources and additionally the old MME/old S4 SGSN deletes the EPS bearer resources by sending the Delete Session Request (Cause, Operation Indication) messages to the old Serving GW if it received the Serving GW change indication in the Context Acknowledge message in step 7. When the Operation Indication flag is not set, that indicates to the old Serving GW that the old Serving GW shall not initiate a delete procedure towards the PDN GW. If ISR is activated the Cause indicates to the old S‑GW that the old S‑GW shall delete 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 the EPS bearer resources at the old Serving GW.

19. The Serving GW acknowledges with Delete Session Response (Cause) messages. The Serving GW discards any packets buffered for the UE.

20. If due to regional subscription restrictions or access restrictions (e.g. CSG restrictions) (received in update location procedure in step 17) the UE is not allowed to access the TA:

- The MME rejects the Tracking Area Update Request with an appropriate cause to the UE.

- For UEs with emergency EPS bearers, i.e. at least one EPS bearer has an ARP value reserved for emergency services, the new MME accepts the Tracking Area Update Request and deactivates all non-emergency PDN connections as specified in clause 5.10.3. If the Tracking Area Update procedure is initiated in ECM-IDLE state, all non-emergency EPS bearers are deactivated by the Tracking Area Update procedure without bearer deactivation signalling between the UE and the MME.

If the TAU request message includes Paging Restriction Information, the MME may accept or reject the Paging Restriction Information requested by the UE based on operator policy. If the MME rejects the Paging Restriction Information, the MME removes any stored Paging Restriction Information from the UE context and discards the UE requested Paging Restriction Information. If the MME accepts the Paging Restriction Information from the UE, the MME stores the Paging Restriction Information from the UE in the UE context and then enforces it in the Network Triggered Service Request procedure as described in clause 5.3.4.3. The MME informs the UE about the acceptance/rejection of the requested Paging Restriction Information in the TAU Accept message. If the TAU Request message does not include any Paging Restriction Information, the MME shall delete any stored Paging Restriction Information for this UE and stop restricting paging accordingly.

If the TAU Request message includes a Release Request indication, the MME does not activate the user plane setup procedure in the subsequent steps and triggers the S1 release procedure as described in clause 5.3.5 after the completion of TAU procedure.

The MME sends a TAU Accept (GUTI, TAI list, EPS bearer status, NAS sequence number, NAS-MAC, IMS Voice over PS session supported, Emergency Service Support indicator, LCS Support Indication, Supported Network Behaviour, Service Gap Time, Enhanced Coverage Restricted, Indication of support of 15 EPS bearers per UE, PLMN-assigned UE Radio Capability ID, indication for PLMN-assigned UE Radio Capability ID deletion, Accepted IMSI Offset, Connection Release Supported, Paging Cause Indication for Voice Service Supported, Reject Paging Request Supported, Paging Restriction Supported, Paging Timing Collision Control Supported, Paging Restriction Information acceptance/rejection, Forbidden TAI(s), Enhanced Discontinuous Coverage Support, Return To Coverage Notification Not Required, Unavailability Period Duration, Start of Unavailability Period, Maximum Time Offset) 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. If the DL Data Buffer Expiration Time for the UE in the MME has not expired, the user plane setup procedure is activated even if the MME did not receive the active flag in the TAU Request message. If the new MME receives the Downlink Data Notification message or any downlink signalling message while the UE is still connected, the user plane setup procedure may be activated even if the new MME did not receive the active flag in the TAU Request 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. If the EPS bearer status information was in the TAU Request, the MME shall indicate the EPS bearer status to the UE. Handover Restriction List is described in clause 4.3.5.7 "Mobility Restrictions". The MME sets the IMS Voice over PS session supported as described in clause 4.3.5.8.

For UE using CIoT EPS Optimisation without any activated PDN connection, there is no EPS bearer status included in the TAU Accept message.

The MME indicates the CIoT EPS Optimisations it supports and prefers in the Supported Network Behaviour information as defined in clause 4.3.5.10.

If there is a Service Gap timer running for the UE in the MME, and the active flag or the signalling active flag is received in the TAU Request message, the MME shall ignore the active flag and signalling active flag and not perform any of the actions related to these flags except if the TAU Request message has been received when the UE has a PDN connection for emergency bearer services established or is establishing a PDN connection for emergency bearer services or if the UE is configured to use high priority access (AC 11-15) in selected PLMN.

The MME shall include the Service Gap Time in the TAU Accept message if the UE has indicated Service Gap Control capability and either if Service Gap Time was received in step 17 from HSS in the subscription information or if the Service Gap Time in the subscription information has been updated by HSS User Profile management (i.e. the Insert Subscriber Data procedure in clause 5.3.9.2).

If the UE included support for restriction of use of Enhanced Coverage in step 1, the MME sends Enhanced Coverage Restricted parameter to the eNodeB in the S1-AP message as defined in clause 4.3.28. The MME also sends the Enhanced Coverage Restricted parameter to the UE in the TAU Accept message. UE shall store Enhanced Coverage Restricted parameter and shall use the value of Enhanced Coverage Restricted parameter to determine if enhanced coverage feature should be used or not.

If the MME successfully obtained Header Compression Configuration parameters in step 5 it indicates the continued use of previous negotiated configuration to the UE in the Header Compression Context Status for each EPS Bearer of the UE. When Header Compression Context Status indicates that the previous negotiated configuration can no longer be used for some EPS bearers, the UE shall stop performing header compression and decompression, when sending or receiving data using Control Plane CIoT EPS Optimisation on these EPS bearers.

If the MME did not receive the Voice Support Match Indicator in the MM Context, then the MME may send a UE Radio Capability Match Request to the eNodeB as described in clause 5.3.14. If the MME hasn't received Voice Support Match Indicator from the eNodeB then, based on implementation, MME may set IMS Voice over PS session supported Indication and update it at a later stage. After step 12, and in parallel to any of the preceding steps, the MME shall send a Notify Request (Homogeneous Support of IMS Voice over PS Sessions) message to the HSS:

- If the MME has evaluated the support of IMS Voice over PS Sessions, see clause 4.3.5.8, and

- If the MME determines that it needs to update the Homogeneous Support of IMS Voice over PS Sessions, see clause 4.3.5.8A.

The Emergency Service Support indicator informs the UE that Emergency bearer services are supported. LCS Support Indication indicates whether the network supports the EPC-MO-LR and/or CS-MO-LR as described in TS 23.271 [57]. Indication for support of 15 EPS bearers per UE indicates the network support for up to 15 EPS bearers per UE as defined in clause 4.12.

If the UE included extended idle mode DRX parameters information element, the MME includes extended idle mode DRX parameters information element if it decides to enable extended idle mode DRX with Paging Time Window length assigned considering Subscribed Paging Time Window (if available) and the local policy. Additionally, for a UE using an eNodeB that provides discontinuous coverage (e.g. for satellite access with discontinuous coverage), the MME may consider Unavailability Period Duration and/or Start of Unavailability Period as described in clause 4.13.8.2 when determining idle mode DRX parameters.

If the UE provided the UE paging probability information in Step 2, the MME takes it into account when generating the WUS Assistance Information. If the MME has determined WUS Assistance Information for the UE, the MME shall send the WUS Assistance Information to the UE (see TS 36.300 [5]).

When receiving the TAU Accept message and there is no ISR Activated indication the UE shall set its TIN to "GUTI".

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

If the TAU procedure is initiated by manual CSG selection and occurs via a CSG cell, the UE upon receiving the TAU Accept message shall add the CSG ID and associated PLMN to its Allowed CSG list if it is not already present. Manual CSG selection is not supported if the UE has emergency bearers established.

If the user plane setup is performed in conjunction with the TAU Accept message and the TAU is performed via a hybrid cell, then the MME shall send an indication whether the UE is a CSG member to the RAN along with the S1-MME control message. Based on this information, the RAN may perform differentiated treatment for CSG and non-CSG members.

NOTE 7: If the UE receives a TAU Accept message via a hybrid cell, the UE does not add the corresponding CSG ID and associated PLMN to its Allowed CSG list. Adding a CSG ID and associated PLMN to the UE's local Allowed CSG list for a hybrid cell is performed only by OTA or OMA DM procedures.

If the UE receives a Service Gap Time in the TAU Accept message, the UE shall store this parameter and apply Service Gap Control (see clause 4.3.17.9).

If the UE has indicated support for dual connectivity with NR in the TAU Request and the UE is not allowed to use NR as Secondary RAT, the MME indicates that to the UE in the TAU Accept message.

If the user plane setup is performed and if RACS is supported and MME has UE Radio Capability ID in UE context, valid for the PLMN the UE is currently in, it signals the UE Radio Capability ID to the eNodeB as defined in clause 5.11.3a. If the eNodeB does not have mapping between the specific UE Radio Capability ID and the UE radio capabilities, it shall use the procedure described in TS 36.413 [36] to retrieve the mapping from the Core Network.

When the UE supports RACS, and the MME needs to configure the UE with a UE Radio Capability ID, and the MME already has the UE radio capabilities for the UE, the MME may provide the UE with the UE Radio Capability ID for the UE radio capabilities the UCMF returns to the MME for this UE.

If the UE had included a UE Specific DRX parameter for NB-IoT in the Tracking Area Update Request, the MME includes the Accepted NB-IoT DRX parameter.

If the UE provided a Requested IMSI Offset in step 2, but the network prefers a different value, the MME provides the UE with an Accepted IMSI Offset different from the one provided in step 2. Otherwise the value of the Accepted IMSI Offset the MME sends is the value of the Requested IMSI Offset sent by the UE in step 2. The MME stores the value of the alternative IMSI derived (see clause 4.3.33) from the Accepted IMSI Offset provided to the UE in the UE context.

If a Multi-USIM UE does not provide a Requested IMSI Offset in step 1, the MME erases any alternative IMSI value in the UE context.

NOTE 8: The MME does not remove IMSI Offset value if the Tracking Area Update Request is for periodic Tracking Area Update.

If the Multi-USIM UE has indicated one or more Multi-USIM specific Capabilities are supported in the UE Core Network Capability in step 2, the MME shall indicate whether the corresponding one or more Multi-USIM specific features described in clause 4.3.33 are supported based on network capability and preference by the network (based on local network policy) by providing one or more of the Connection Release Supported, Paging Cause Indication for Voice Service Supported, Reject Paging Request Supported, Paging Restriction Supported and Paging Timing Collision Control Supported indications. The MME shall only indicate Paging Restriction Supported together with either Connection Release Supported or Reject Paging Request Supported. The UE shall only use Multi-USIM specific features that the MME indicated as being supported. In the case of Emergency attached UE, the MME shall not indicate support for any Multi-USIM feature to the UE.

If the MME receives multiple TAIs from E-UTRAN in step 3 and determines that some, but not all, TAIs in the received list of TAIs are forbidden by subscription or by operator policy, the MME shall include the forbidden TAI(s) in the TAU Accept message.

If both UE and network support discontinuous coverage, the MME provides the Enhanced Discontinuous Coverage Support indication as described in clause 4.13.8.1.

For a UE using an eNodeB that provides discontinuous coverage (e.g. for satellite access with discontinuous coverage), the MME may provide Return To Coverage Notification Not Required, which requests the UE in ECM\_IDLE state to not perform the TAU procedure when it returns to coverage, and/or provide the UE with an Unavailability Period Duration and/or Start of Unavailability Period if available, as described in clause 4.13.8.2. The MME may also provide a Maximum Time Offset as described in clause 4.13.8.6.

If the UE and MME are in S&F mode, the MME may include the wait timer, the list of Satellite IDs or Uplink S&F Delivery Time as described in clause 4.13.X.

21. If GUTI was included in the TAU Accept, or the MME indicates an Accepted IMSI Offset to the UE in step 20, the UE acknowledges the received message by returning a TAU Complete message to the MME.

When the "Active flag" is not set in the TAU Request message and the Tracking Area Update was not initiated in ECM-CONNECTED state, the new MME releases the signalling connection with UE, according to clause 5.3.5. For a UE using Control Plane CIoT EPS Optimisation, when the "Signalling active flag" is set, the new MME shall not release the NAS signalling connection with the UE immediately after the TAU procedure is completed.

NOTE 9: The new MME may initiate E‑RAB establishment (see TS 36.413 [36]) after execution of the security functions, or wait until completion of the TA update procedure. For the UE, E‑RAB establishment may occur any time 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 should not construct an MM context for the UE. In the case of receiving the subscriber data from HSS, the new MME may construct an MM context and store the subscriber data for the UE to optimise signalling between the MME and the HSS. 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 in the Context Response message and then store the new Maximum APN restriction value.

The bearer contexts shall be prioritized by the new MME. If the new MME is unable to support the same number of active bearer contexts as received from old MME/SGSN, the prioritisation is used to decide 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 bearer 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.

The new MME shall not deactivate emergency service related EPS bearers, i.e. EPS bearers with ARP value reserved for emergency services.

NOTE 10: If 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.

If the new MME identifies that the RAT type has changed, the MME checks the subscription information to identify for each APN whether to maintain the PDN connection, disconnect the PDN connection with a reactivation request, or, disconnect the PDN connection without reactivation request. If the MME decides to deactivate a PDN connection it performs MME-initiated PDN Connection Deactivation procedure after the tracking area update procedure is completed but before the S1/RRC interface connection is released. Existing ESM cause values as specified in TS 24.301 [46] (e.g. #39, "reactivation requested"; #66 "Requested APN not supported in current RAT and PLMN combination"; and for a dedicated bearer, possibly #37 "EPS QoS not accepted") are used to cause predictable UE behaviour. If all the PDN connections are disconnected and the UE does not support "attach without PDN connectivity", the MME shall request the UE to detach and reattach.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Next Changes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#### 5.3.4.1 UE triggered Service Request



Figure 5.3.4.1-1: UE triggered Service Request procedure

The Service Request procedure in this clause is triggered by the UE in:

a) ECM-IDLE state to establish user plane radio bearers for the UE;

b) ECM-IDLE state to establish user plane radio bearers even if the UE applies Control Plane CIoT EPS Optimisation, when the UE and MME supports S1-U data transfer or User Plane EPS Optimisation in addition to Control Plane CIoT EPS Optimisation;

c) ECM-CONNECTED state to request, if the UE is a Multi-USIM UE and wants to release of the UE connection, stop of any data transmission, discard of any pending data and, optionally, Paging Restriction Information; or

d) ECM-IDLE state to request, if the UE is a Multi-USIM UE wants to remove the Paging Restriction Information.

e) ECM-IDLE state, if the UE is a Multi-USIM UE and wants to respond to paging with a Reject Paging Indication that indicates that S1 connection shall be released and no user plane radio bearers shall be established, unless it is unable to do so, e.g. due to UE implementation constraints. The UE optionally provides the Paging Restriction Information.

NOTE 1: It is not expected that a Multi-USIM UE will execute UE triggered service request procedure with Release Request indication if regulatory prioritized services (e.g. emergency service, emergency callback waiting) are ongoing.

NOTE 2: 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 towards the MME encapsulated in an RRC message to the eNodeB. The RRC message(s) that can be used to carry the S-TMSI and this NAS message are described in TS 36.300 [5].

The Multi-USIM UE in ECM-CONNECTED state may include the Release Request indication and optionally Paging Restriction Information in the Service Request message, if the UE intends to return to ECM-IDLE state.

2. The eNodeB forwards NAS message to MME. NAS message is encapsulated in either an S1-AP: Initial UE Message (NAS message, TAI+ECGI of the serving cell, S-TMSI, CSG ID, CSG access Mode, RRC establishment cause), or another S1-AP message (e.g. Uplink NAS Transport Message) used for the UE in ECM-CONNECTED. Details of this step are described in TS 36.300 [5]. If the MME can't handle the Service Request it will reject it. CSG ID is provided if the UE sends the Service Request message via a CSG cell or a hybrid cell. CSG access mode is provided if the UE sends the Service Request message via a hybrid cell. If the CSG access mode is not provided but the CSG ID is provided, the MME shall consider the cell as a CSG cell.

If a CSG ID is indicated and CSG access mode is not provided, and there is no subscription data for this CSG ID and associated PLMN or the CSG subscription is expired, the MME rejects the Service Request with an appropriate cause. The UE shall remove the CSG ID and associated PLMN of the cell where the UE has initiated the service request procedure from the Allowed CSG list, if present.

For UEs with emergency EPS bearers, i.e. at least one EPS bearer has an ARP value reserved for emergency services, if CSG access restrictions do not allow the UE to get normal services the MME shall deactivate all non-emergency bearers and accept the Service Request.

If LIPA is active for a PDN connection and if the cell accessed by the UE does not link to the L-GW where the UE initiated the LIPA PDN Connection, the MME shall not request the establishment of the bearers of the LIPA PDN connection from the eNodeB in step 4 and shall request disconnection of the LIPA PDN connection according to clause 5.10.3. If the UE has no other PDN connection then the MME shall reject the Service Request with an appropriate cause value resulting in the UE detaching, skip the following steps of the procedure and initiate the release of the core network resources with the implicit MME-initiated Detach procedure according to clause 5.3.8.3.

If there is a "Availability after DDN Failure" monitoring event or a "UE Reachability" monitoring event configured for the UE in the MME, the MME sends an event notification (see TS 23.682 [74] for further information).

To assist Location Services, the eNodeB indicates the UE's Coverage Level to the MME.

If the MME supports RACS, and the MME detects that the selected PLMN is different from the currently registered PLMN for the UE, the MME provides the UE Radio Capability ID of the newly selected PLMN in the UE context to the eNodeB as described in clause 5.11.3a.

If the Service Request message is received from a UE in ECM-IDLE state without a Release Request indication, the MME shall delete any stored Paging Restriction Information for this UE and stop restricting paging accordingly and the procedure continues form the next step 3.

If the Service Request message includes a Release Request indication or Reject Paging Indication, then:

- If the Service Request message includes Paging Restriction Information, the MME may accept or reject the Paging Restriction Information requested by the UE based on operator policy. If the MME rejects the Paging Restriction Information, the MME removes any stored Paging Restriction Information from the UE context and discards the UE requested Paging Restriction Information. If the MME accepts the Paging Restriction Information from the UE, the MME stores the received Paging Restriction Information from the UE in the UE context. The MME informs the UE about the acceptance/rejection of the requested Paging Restriction Information in the Service Accept message. If no Paging Restriction Information is provided, no paging restrictions apply;

- no S1 bearer is established (steps 4-7 are skipped);

- the MME Triggers the S1 release procedure as described in clause 5.3.5 and no further steps of this procedure are executed. The MME may however trigger the NAS Authentication/Security in step 3 before releasing the UE.

In the case of satellite access for Cellular IoT, the MME may verify the UE location and determine whether the PLMN is allowed to operate at the UE location, as described in clause 4.13.4. If the UE receives a Service Reject message with cause value indicating that the selected PLMN is not allowed to operate at the present UE location, the UE shall attempt to select a PLMN as specified in TS 23.122 [10].

3. NAS authentication/security procedures as defined in clause 5.3.10 on "Security function" may be performed.

If the MME is configured to support RLOS and the UE indicated Attach Type "RLOS", based on local regulation and operator policy, the MME may skip the authentication and security setup, or the MME may perform authentication if security information is available or obtainable from a HSS, and continue the Service Request procedure regardless of the authentication result.

In the case of satellite access for NB-IoT, if the UE indicated support for reporting its Coarse Location Information, the MME may request the UE to report its Coarse Location Information by setting the Coarse Location Information Request in the Security Mode Command message and the UE then reports its Coarse Location Information in the Security Mode Complete message to the MME. To perform UE location verification as described in clause 4.13.4, the MME provides the reported Coarse Location Information to the E-SMLC as described in clause 9.1.17 of TS 23.271 [57].

4. If there is a Service Gap timer running in the MME MM Context for the UE and the MME is not waiting for a MT paging response from the UE, the MME rejects the Service Request with an appropriate cause. In addition, MME may also provide a UE with a Mobility Management Back-off timer set to the remaining value of the Service Gap timer.

The MME deletes S11-U related information in UE context if there is any, including TEID(DL) for the S11-U for Control Plane CIoT EPS Optimisation if data buffering is in the MME, ROHC context for Control Plane CIoT EPS Optimisation, etc, but not the Header Compression Configuration. The MME sends S1-AP Initial Context Setup Request (Serving GW address, S1-TEID(s) (UL), EPS Bearer QoS(s), Security Context, MME Signalling Connection Id, Handover Restriction List, CSG Membership Indication) message to the eNodeB. If there is a PDN connection established for Local IP Access, this message includes a Correlation ID for enabling the direct user plane path between the HeNB and the L-GW. If there is a PDN connection established for SIPTO at the Local Network with L-GW function collocated with the (H)eNB, this message includes a SIPTO Correlation ID for enabling the direct user plane path between the (H)eNB and the L‑GW. This step activates the radio and S1 bearers for all the active EPS Bearers. The eNodeB stores the Security Context, MME Signalling Connection Id, EPS Bearer QoS(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".

NOTE 3: In this release of the 3GPP specification the Correlation ID and SIPTO Correlation ID is set equal to the user plane PDN GW TEID (GTP-based S5) or GRE key (PMIP-based S5) which is specified in clause 5.3.2.1 and clause 5.10.2.

If the UE included support for restriction of use of Enhanced Coverage, the MME sends Enhanced Coverage Restricted parameter to the eNodeB in the S1-AP message.

The MME shall only request to establish Emergency EPS Bearer if the UE is not allowed to access the cell where the UE initiated the service request procedure due to CSG access restriction.

If the MME receives multiple TAIs from E-UTRAN in step 2 and determines that some, but not all, TAIs in the received list of TAIs are forbidden by subscription or by operator policy, the MME shall include the forbidden TAI(s) as in the Service Reject message.

If the Service Request is performed via a hybrid cell, CSG Membership Indication indicating whether the UE is a CSG member shall be included in the S1-AP message from the MME to the RAN. Based on this information, the RAN can perform differentiated treatment for CSG and non-CSG members.

If RACS is supported and MME has UE Radio Capability ID in UE context, valid for the PLMN the UE is currently in, it signals the UE Radio Capability ID to the eNodeB as defined in clause 5.11.3a. If the eNodeB does not have mapping between the specific UE Radio Capability ID and the UE radio capabilities, it shall use the procedure described in TS 36.413 [36] to retrieve the mapping from the Core Network.

If the UE and MME are in S&F mode, the MME may include the wait timer, the list of Satellite IDs or Uplink S&F Delivery Time as described in clause 4.13.X.

5. The eNodeB performs the radio bearer establishment procedure. The user plane security is established at this step, which is described in detail in TS 36.300 [5]. When the user plane radio bearers are setup. EPS bearer state synchronization is performed between the UE and the network, i.e. the UE shall locally remove any EPS bearer for which no radio bearers are setup and, if the radio bearer for a default EPS bearer is not established, the UE shall locally deactivate all EPS bearers associated to that default EPS bearer.

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. The Serving GW forwards the uplink data to the PDN GW.

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]. If the Correlation ID or SIPTO Correlation ID is included in step 4, the eNodeB shall use the included information to establish a direct user plane path to the L-GW and forward uplink data for Local IP Access or SIPTO at the Local Network with L-GW function collocated with the (H)eNB accordingly.

8. The MME sends a Modify Bearer Request message (eNodeB address, S1 TEID(s) (DL) for the accepted EPS bearers, Delay Downlink Packet Notification Request, RAT Type, MO Exception data counter) per PDN connection to the Serving GW. If the Serving GW supports Modify Access Bearers Request procedure and if there is no need for the Serving GW to send the signalling to the PDN GW, the MME may send Modify Access Bearers Request (eNodeB address(es) and TEIDs for downlink user plane for the accepted EPS bearers, Delay Downlink Packet Notification Request) per UE to the Serving GW to optimise the signalling. 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 the PDN GW requested UE's location and/or User CSG information and the UE's location and/or User CSG information has changed, the MME also includes the User Location Information IE and/or User CSG Information IE in this message. If ISR is activated or if the Serving Network IE has changed compared to the last reported Serving Network IE then the MME also includes the Serving Network IE in this message. If the UE Time Zone has changed compared to the last reported UE Time Zone then the MME shall include the UE Time Zone IE in this message. If the internal flag Pending Network Initiated PDN Connection Signalling is set, the MME indicates UE available for end to end signalling in the Modify Bearer Request message and reset the flag.

The MME only includes the MO Exception data counter if the RRC establishment cause is set to "MO exception data" and the UE is accessing via the NB-IoT RAT. The MME maintains the MO Exception Data Counter for Serving PLMN Rate Control purposes (see clause 4.7.7.2). The MME may immediately send the MO Exception Data Counter to the Serving GW. Alternatively, in order to reduce signalling, the MME may send the MO Exception Data Counter to the Serving GW as described in TS 29.274 [43].

The MME and the Serving GW clears the DL Data Buffer Expiration Time in their UE contexts if it was set, to remember that any DL data buffered for a UE using power saving functions has been delivered and to avoid any unnecessary user plane setup in conjunction with a later TAU.

If a default EPS bearer is not accepted by the eNodeB, all the EPS bearers associated to that default bearer shall be treated as non-accepted bearers. The MME releases the non-accepted bearers by triggering the bearer release procedure as specified in clause 5.4.4.2. If the Serving GW receives a DL packet for a non-accepted bearer, the Serving GW drops the DL packet and does not send a Downlink Data Notification to the MME.

9. If the RAT Type has changed compared to the last reported RAT Type or if the UE's Location and/or Info IEs and/or UE Time Zone and/or if ISR is not activated and Serving Network id and/or the indication UE available for end to end signalling are present in step 8, the Serving GW shall send the Modify Bearer Request message (RAT Type, MO Exception data counter) per PDN connection to the PDN GW. User Location Information IE and/or User CSG Information IE and/or Serving Network IE and/or UE Time Zone and/or the indication UE available for end to end signalling are also included if they are present in step 8.

If the Modify Bearer Request message is not sent because of above reasons and the PDN GW charging is paused, then the SGW shall send a Modify Bearer Request message with PDN Charging Pause Stop Indication to inform the PDN GW that the charging is no longer paused. Other IEs are not included in this message.

If the Modify Bearer Request message is not sent because of above reasons but the MME indicated the MO Exception data counter, then the Serving Gateway should notify the PDN GW that this RRC establishment cause has been used by the MO Exception Data Counter (see TS 29.274 [43]). The Serving GW indicates each use of this RRC establishment cause by the related counter on its CDR.

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.

The PDN GW indicates each use of the RRC establishment cause "MO Exception Data" by the related counter on its CDR.

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

12. The Serving GW shall return a Modify Bearer Response (Serving GW address and TEID for uplink traffic) to the MME as a response to a Modify Bearer Request message, or a Modify Access Bearers Response (Serving GW address and TEID for uplink traffic) as a response to a Modify Access Bearers Request message. If the Serving GW cannot serve the MME Request in the Modify Access Bearers Request message without S5/S8 signalling other than to unpause charging in the PDN GW or without corresponding Gxc signalling when PMIP is used over the S5/S8 interface, it shall respond to the MME with indicating that the modifications are not limited to S1-U bearers, and the MME shall repeat its request using a Modify Bearer Request message per PDN connection.

If SIPTO at the Local Network is active for a PDN connection with stand-alone GW deployment and the Local Home Network ID for stand-alone accessed by the UE differs from the Local Home Network ID where the UE initiated the SIPTO@LN PDN Connection, the MME shall request disconnection of the SIPTO at the local network PDN connection(s) with the "reactivation requested" cause value according to clause 5.10.3. If the UE has no other PDN connection, the MME initiated "explicit detach with reattach required" procedure according to clause 5.3.8.3.

If SIPTO at the Local Network is active for a PDN connection with collocated LGW deployment and the L-GW CN address of the cell accessed by the UE differs from the L-GW CN address of the cell where the UE initiated the SIPTO at the Local Network PDN Connection, the MME shall request disconnection of the SIPTO at the local network PDN connection(s) with the "reactivation requested" cause value according to clause 5.10.3. If the UE has no other PDN connection, the MME initiated "explicit detach with reattach required" procedure according to clause 5.3.8.3.

#### 5.3.3.2 E-UTRAN Tracking Area Update without S‑GW Change



Figure 5.3.3.2-1: E-UTRAN Tracking Area Update without S‑GW 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.

NOTE 2: In the case of Tracking Area Update without MME change the signalling in steps 4, 5, 7 and steps 9-19 are skipped. A change of UE Time Zone, User CSG information or Serving Network is signalled in the next Service Request. If TAI change need to be reported to the PDN GW, location information change reporting procedure described in clause 5.9.2 is performed.

NOTE 3: Deferred reporting of UE Time Zone, or Serving Network per NOTE 2 may fail when inter-MME/SGSN mobility occurs before a UE sends SERVICE REQUEST and the target MME/SGSN (e.g. pre-Release 10) does not support the "Change to Report" flag.

1. One of the triggers described in clause 5.3.3.0 for starting the TAU procedure occurs.

2. The UE initiates a TAU procedure by sending, to the eNodeB, a Tracking Area Update Request (UE Core Network Capability, MS Network Capability, Preferred Network behaviour, Support for restriction of use of Enhanced Coverage, active flag, signalling active flag, EPS bearer status, old GUTI, Old GUTI Type, last visited TAI, P-TMSI signature, additional GUTI, KSISGSN, KSIASME, NAS sequence number, NAS-MAC, Voice domain preference and UE's usage setting, UE has UE Radio Capability ID assigned for the selected PLMN, Requested IMSI Offset, Release Request indication, Paging Restriction Information, Unavailability Period Duration, Start of Unavailability Period) message together with RRC parameters indicating the Selected Network and the old GUMMEI. An exception is that, if the TAU was triggered for load re-balancing purposes (see clause 4.3.7.3), the old GUMMEI is not included in the RRC parameters. The UE shall set the Old GUTI Type to indicate whether the Old GUTI is a native GUTI or is mapped from a P-TMSI and RAI.

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. When the UE is in connected mode (e.g. in URA\_PCH) when it reselects to E-UTRAN, the UE shall set its TIN to "P‑TMSI".

If the UE holds a valid GUTI and the old GUTI indicates a GUTI mapped from a P-TMSI and RAI, then the UE indicates the GUTI as additional GUTI. If the old GUTI indicates a GUTI mapped from a P-TMSI and RAI, and the UE has a valid P-TMSI signature, the P-TMSI signature shall be included.

The additional GUTI in the Tracking Area Update Request message allows the new MME to find any already existing UE context stored in the new MME when the old GUTI indicates a value mapped from a P-TMSI and RAI.

Alternatively, when a UE only supports E-UTRAN, it identifies itself with the old GUTI and sets the Old GUTI Type to 'native'.

The RRC parameter "old GUMMEI" takes its value from the identifier that is signalled as the old GUTI according to the rules above. For a combined MME/SGSN the eNodeB is configured to route the MME‑code(s) of this combined node to the same combined node. This eNodeB 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 eNodeB 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. Signalling active flag is a request by UE using Control Plane CIoT EPS Optimisation to maintain the NAS signalling connection after Tracking Area Update Procedure is completed in order to transmit pending Data using the Data Transport in Control Plane CIoT EPS Optimisation or NAS signalling. The UE's ISR capability is included in the UE Core Network Capability element. The EPS bearer status indicates each EPS bearer that is active in the UE. The TAU Request message shall be integrity protected by the NAS-MAC as described in TS 33.401 [41]. KSIASME is included if the UE has valid security parameters. NAS sequence number indicates the sequential number of the NAS message.

In the RRC connection establishment signalling associated with the TAU Request, the UE indicates its support of the CIoT EPS Optimisations relevant for MME selection.

For UE using CIoT EPS Optimisation without any activated PDN connection, there is no active flag or EPS bearer status included in the TAU Request message. For a UE with a running Service Gap timer in the UE the UE shall not set the active flag or the signalling active flag in the TAU request message (see clause 4.3.17.9) except for network access for regulatory prioritized services like Emergency services or exception reporting.

If the UE has any PDN connection of PDN Type "non-IP" or "Ethernet", the UE shall send the EPS bearer status in the TAU Request message.

KSISGSN is included if the UE indicates a GUTI mapped from a P‑TMSI in the information element "old GUTI".

The UE sets the voice domain preference and UE's usage setting according to its configuration, as described in clause 4.3.5.9.

The UE includes extended idle mode DRX parameters information element if it needs to enable extended idle mode DRX, even if extended idle mode DRX parameters were already negotiated before.

If a UE includes a Preferred Network Behaviour, this defines the Network Behaviour the UE is expecting to be available in the network as defined in clause 4.3.5.10.

If the UE supports RACS as defined in clause 5.11.3a, and if the UE is provisioned with a UE Radio Capability ID for use in the selected PLMN (i.e. PLMN-assigned for the specific PLMN or manufacturer-assigned), the UE includes a flag that indicates it has an assigned UE Radio Capability ID for use in the selected PLMN but the actual UE Radio Capability is provided to MME after security context is established in step 6 (see below).

If a Multi-USIM UE wants to enter ECM-IDLE state it includes the Release Request indication and optionally provides Paging Restriction Information.

If a Multi-USIM UE needs to modify the Paging Occasions in order to avoid paging collisions, it sends a Requested IMSI Offset to the MME, in order to signal an alternative IMSI as described in clause 4.3.33.

If the UE is using a eNodeB that provides discontinuous coverage (e.g. for satellite access with discontinuous coverage), the UE may include an Unavailability Period Duration and Start of Unavailability Period, see clause 4.13.8.2.

If the UE and MME are in S&F mode, the UE and MME executes the steps in S&F mode as described in clause 5.3.3.1step 2.

3. The eNodeB derives the MME address from the RRC parameters carrying the old GUMMEI, the indicated Selected Network and the RAT (NB-IoT or WB-E-UTRAN). If that GUMMEI is not associated with the eNodeB, or the GUMMEI is not available or the UE indicates that the TAU procedure was triggered by load re-balancing, 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 CSG access mode, CSG ID, TAI+ECGI of the cell from where it received the message and with the Selected Network to the MME. CSG ID is provided by RAN if the UE sends the TAU Request message via a CSG cell or a hybrid cell. CSG access mode is provided if the UE sends the TAU Request message via a hybrid cell. If the CSG access mode is not provided but the CSG ID is provided, the MME shall consider the cell as a CSG cell. For SIPTO at the Local Network with stand-alone GW architecture the eNodeB includes the Local Home Network ID in the Initial UE Message and in Uplink NAS Transport message if the target cell is in a Local Home Network.

To assist Location Services, the eNodeB indicates the UE's Coverage Level to the MME.

If the MME supports RACS, and the MME detects that the selected PLMN is different from the currently registered PLMN for the UE, the MME provides the UE Radio Capability ID of the newly selected PLMN in the UE context to the eNodeB as described in clause 5.11.3a.

In the case of satellite access for Cellular IoT, the MME may verify the UE location and determine whether the PLMN is allowed to operate at the UE location, as described in clause 4.13.4. If the UE receives a TAU Reject message with cause value indicating that the selected PLMN is not allowed to operate at the present UE location, the UE shall attempt to select a PLMN as specified in TS 23.122 [10].

4. The new MME differentiates the type of the old node, i.e. MME or SGSN, as specified in clause 4.3.19, uses the GUTI received from the UE to derive the old MME/S4 SGSN address and sends a Context Request (old GUTI, MME Address, UE Validated, complete TAU Request message, P‑TMSI Signature, CIoT EPS Optimisation support inidication) message to the old MME/S4 SGSN to retrieve the user information. UE Validated indicates that the new MME has validated the integrity protection of the TAU message, e.g. based on native EPS security context for the UE. To validate the Context Request the old MME uses the complete TAU Request message and the old S4 SGSN uses the P-TMSI Signature and responds with an appropriate error if integrity check fails in old MME/S4 SGSN. This shall initiate the security functions in the new MME. If the security functions authenticate the UE correctly, the new MME shall send a Context Request (IMSI, complete TAU Request message, MME Address, UE Validated) message to the old MME/S4 SGSN with the UE Validated set. If the new MME indicates that it has authenticated the UE or if the old MME/old S4 SGSN authenticates the UE, the old MME/old S4 SGSN starts a timer.

If the UE with emergency bearers is not authenticated in the old MME/old S4 SGSN (in a network supporting unauthenticated UEs) the old MME/old S4 SGSN continues the procedure with sending a Context Response and starting the timer also when it cannot validate the Context Request.

If a RLOS attached UE is not successfully authenticated in the old MME and/or the Context Request cannot be validated, the old MME continues the procedure with sending a Context Response and starting the existing timer.

If the new MME supports CIoT EPS Optimisation, CIoT EPS Optimisation support indication is included in the Context Request indicating support for various CIoT EPS Optimisations (e.g. support for header compression for CP CIoT EPS Optimisation, etc.).

5. If the Context Request is sent to an old MME the old MME responds with a Context Response (IMSI, ME Identity (IMEISV), unused EPS Authentication Vectors, KSIASME, KASME, EPS Bearer Context(s), Serving GW signalling Address and TEID(s), MS Info Change Reporting Action (if available), CSG Information Reporting Action (if available), UE Time Zone, UE Core Network Capability, UE Specific DRX Parameters, Change to Report (if present), Remaining Running Service Gap timer, LTE-M UE Indication) message. If the new MME supports CIoT EPS Optimisation and the use of header compression has been negotiated between the UE and old MME, the Context Response also includes the Header Compression Configuration which includes the information necessary for the ROHC channel setup but not the RoHC context itself.

If the Context Request is sent to an old S4 SGSN the old S4 SGSN responds with a Context Response (IMSI, ME Identity (if available), unused Authentication Quintets, CK, IK, KSISGSN, EPS Bearer Context(s), Serving GW signalling Address and TEID(s), ISR Supported, MS Info Change Reporting Action (if available), CSG Information Reporting Action (if available), UE Time Zone, UE Core Network Capability, UE Specific DRX Parameters, Change to Report (if present)) message. The Authentication Quintets are maintained by the old S4 SGSN. TS 33.401 [41] gives further details on the transfer of security related information.

Change to Report flag is included by the old MME or the old S4 SGSN if reporting of change of UE Time Zone, or Serving Network, or both towards Serving GW / PDN GW was deferred by the old MME or old S4 SGSN.

If the Context Response message did not include IMEISV and the MME does not already store the IMEISV of the UE, the MME shall retrieve the ME Identity (IMEISV) from the UE.

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 and the TI(s), is part of the EPS Bearer Context. ISR Supported is indicated if the old SGSN and associated Serving GW are capable to activate ISR for the UE.

The new MME shall ignore the UE Core Network Capability contained in the Context Response only when it has previously received an UE Core Network Capability in the Tracking Area Update Request. If the UE is not known in the old MME/old S4 SGSN or if the integrity check for the TAU request message fails, the old MME/old S4 SGSN responds with an appropriate error cause.

If the DL Data Buffer Expiration Time for the UE has not expired (see High latency communication in clause 4.3.17.7), the old MME/old S4-SGSN indicates Buffered DL Data Waiting in the Context Response. When this is indicated, the new MME shall setup the user plane in conjunction to the TAU procedure for delivery of the buffered DL data.

If the UE receives emergency bearer services from the old MME/old S4 SGSN and the UE is UICCless, IMSI can not be included in the Context Response. For emergency attached UEs, if the IMSI cannot be authenticated, then the IMSI shall be marked as unauthenticated. Also, in this case, security parameters are included only if available.

For a RLOS attached UE, the old MME includes an RLOS indication to the new MME. If the RLOS attached UE in the old MME does not have a USIM, IMSI can not be included in the Context Response. If the RLOS attached UE has USIM but the IMSI cannot be successfully authenticated, then the IMSI shall be marked as unauthenticated. Also, in this case, security parameters are included only if available.

If SIPTO at the Local Network is active for a PDN connection in the architecture with stand-alone GW, the old MME/old S4 SGSN shall include the Local Home Network ID of the old cell in the EPS Bearer context corresponding to the SIPTO at the Local Network PDN connection.

For UE using CIoT EPS Optimisation without any activated PDN connection, there is no EPS Bearer Context(s) included in the Context Response message.

Based on the CIoT EPS Optimisation support indication, old MME only transfers the EPS Bearer Context(s) that the new MME supports. If the new MME does not support CIoT EPS Optimisation, EPS Bearer Context(s) of non-IP PDN connection are not transferred to the new MME. If the new MME does not support Ethernet PDN Type, EPS Bearer Context(s) of Ethernet PDN type are not transferred to the new MME. If the EPS Bearer Context(s) of a PDN connection has not been transferred, the old MME shall consider all bearers of that PDN connection as failed and release that PDN connection by triggering the MME requested PDN disconnection procedure specified in clause 5.10.3. The buffered data in the old MME is discarded after receipt of Context Acknowledgement.

If the EPS Bearer Context(s) are to be transferred to the new MME, the old MME also includes the Serving GW IP address and TEID for both S1-U and S11-U, if available.

If the Old MME is aware the UE is a LTE-M UE, it provides the LTE-M UE Indication to the new MME.

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.

If this TAU request is received for a UE which is already in ECM\_CONNECTED state and the PLMN-ID of the TAI sent by the eNodeB in Step 3 is different from that of the GUTI included in the TAU Request message, the MME shall delay authenticating the UE until after Step 21 (TAU Complete message).

NOTE 4: The MME delays the authentication such that the UE first updates its registered PLMN-ID to the new PLMN-ID selected by the RAN during handover. The new PLMN-ID is provided by the MME to the UE as part of the GUTI in the TAU accept message in Step 20. Doing this ensures that the same PLMN-ID is used in the derivation of the Kasme key by both the network and the UE.

If the new MME is configured to allow emergency bearer services for unauthenticated UE the new MME behave as follows:

- where a UE has only emergency bearer services, the MME either skip the authentication and security procedure or accepts that the authentication may fail and continues the Tracking Area Update procedure; or

- where a UE has both emergency and non-emergency bearer services and authentication fails, the MME continues the Tracking Area Update procedure and deactivates all the non-emergency PDN connections as specified in clause 5.10.3.

If the new MME is configured to support Restricted Local Operator Services, the new MME, based on local regulation and operator policy, may skip the authentication and security procedure, or may perform authentication if security parameters are available or obtainable from HSS and continues the Tracking Area Update procedure regardless of the authentication result.

If the UE indicated it has a UE Radio Capability ID assigned for use in the selected PLMN in step 2, the MME may request the UE to provide the UE Radio Capability ID in Security Mode Command, if the MME needs to get the UE Radio Capability ID from the UE e.g. at inter-PLMN mobility. If enquired by the MME the UE shall include the UE Radio Capability ID in Security Mode Command Accept for the supported UE radio capabilities.

In the case of satellite access for NB-IoT, if the UE indicated support for reporting its Coarse Location Information, the MME may request the UE to report its Coarse Location Information by setting the Coarse Location Information Request in the Security Mode Command message and the UE then reports its Coarse Location Information in the Security Mode Complete message to the MME. To perform UE location verification as described in clause 4.13.4, the MME provides the reported Coarse Location Information to the E-SMLC as described in clause 9.1.17 of TS 23.271 [57].

If the MME is in S&F mode, the MME and HSS executes the steps as described in clause 5.3.3.1 step 6.

7. If the old node is an old MME the new MME sends a Context Acknowledge message to the old MME. The old MME marks in its context that the information in the GW 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.

NOTE 5: Updating the GWs refers to modification of session(s) on the Serving GW. This will result in successful re-establishment of the S11/S4 tunnel between the MME/SGSN and the Serving GW.

If the old node is an old S4 SGSN the MME sends a Context Acknowledge (ISR Activated) message to the old SGSN. Unless ISR Activated is indicated by the MME, the old S4 SGSN marks in its context that the information in the GWs is invalid. This ensures that the old S4 SGSN updates the GWs if the UE initiates a RAU procedure back to the old S4 SGSN before completing the ongoing TAU procedure. If ISR Activated is indicated to the old S4 SGSN, this indicates that the old S4 SGSN shall maintain its UE context including authentication quintets and stop the timer started in step 4. In this case, if the Implicit Detach timer is running, the old S4 SGSN shall re-start it with a slightly larger value than the UE's GERAN/UTRAN Deactivate ISR timer. Also, in this case, if the old SGSN has maintained the Serving GW address for user plane and S4 GTP-U TEID, the old SGSN shall remove Serving GW address for user plane and S4 GTP-U TEID locally. When ISR Activated 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 S4 SGSN does not send any Delete Session Request message to the S‑GW. The MME shall not activate ISR if the associated Serving GW does not support ISR.

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/old S4 SGSN. The old MME/old S4 SGSN shall continue as if the Identification and Context Request was never received.

For UE using CIoT EPS Optimisation without any activated PDN connection, the steps 9, 10, 11, 12 and 13 are skipped.

8. Void.

9. If the MME has changed 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. 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 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 at all, the MME rejects the TAU Request. If the MME has changed the new MME sends a Modify Bearer Request (new MME address and TEID, ISR Activated, RAT type, LTE-M RAT type reporting to PGW flag) message per PDN connection to the Serving GW. If there is no need for the SGW to send the signalling to the PDN GW, the MME may send Modify Access Bearers Request (new MME address and TEID) per UE to the Serving GW to optimise the signalling. The PDN GW address is indicated in the bearer contexts. If indicated, the information ISR Activated indicates that ISR is activated. If it is a mobility from a SGSN to a MME and if the MME supports location information change reporting, the MME shall include the User Location Information (according to the supported granularity) in the Modify Bearer Request, regardless of whether location information change reporting had been requested in the previous RAT by the PDN GW. If it is an inter MME mobility and if the PDN GW requested location information change reporting, the MME includes the User Location Information IE in this message if it is different compared to the previously sent information. If the PDN GW requested User CSG information, the MME also includes the User CSG Information IE in this message. If either the UE Time Zone has changed or Context Response message indicated pending UE Time Zone change reporting (via Change to Report flag), the MME includes the UE Time Zone IE in this message. If either the Serving Network has changed or Context Response message indicated pending Serving Network change reporting (via Change to Report flag) the MME includes the new Serving Network IE in this message. In network sharing scenarios Serving Network denotes the serving core network. If the old node is an old MME at a Tracking Area Update with a MME change ISR Activated shall not be indicated.

NOTE 6: The User CSG Information IE is only sent in step 9 if the "Active flag" is set in the TAU Request message.

When the Modify Access Bearers Request or Modify Bearer Request does not indicate ISR Activated 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.

If the new MME receives the EPS bearer context with SCEF, then the new MME updates the SCEF as defined in TS 23.682 [74].

For Control Plane CIoT EPS Optimisation, if the DL data is buffered in the Serving GW, and if this is a Tracking Area Update without MME change and the DL Data Buffer Expiration Time in the MM context for the UE in the MME has not expired, or if this is a Tracking Area Update with MME change and the old MME/old S4-SGSN indicated Buffered DL Data Waiting in the Context Response in step 5, the MME shall also indicate S11-U tunnelling of NAS user data and include its own S11-U IP address and MME DL TEID for DL data forwarding by the SGW in the Modify Bearer Request. The MME may also do so without DL data buffered in the SGW.

If the UE is using the LTE-M RAT type and the PDN GW expects the LTE-M RAT type reporting as specified in clause 5.11.5, the MME also includes the LTE-M RAT type reporting to PGW flag to indicate to the Serving GW to forward the LTE-M RAT type to the PDN GW.

10. If the RAT type has changed, or the Serving GW has received the User Location Information IE or the UE Time Zone IE or User CSG Information IE and/or the Serving Network IE from the MME in step 9, the Serving GW informs the PDN GW(s) about this information that e.g. can be used for charging, by sending the message Modify Bearer Request (RAT type) per PDN connection to the PDN GW(s) concerned. User Location Information IE and/or UE Time Zone IE and/or User CSG Information IE and/or Serving Network IE are also included if they are present in step 9.

If the Modify Bearer Request message is not sent because of above reasons and the PDN GW charging is paused, then the SGW shall send Modify Bearer Request message with PDN Charging Pause Stop Indication to inform the PDN GW that the charging is no longer paused. Other IEs are not included in this message.

If LTE-M RAT type and the LTE-M RAT type reporting to PGW flag were received at step 9, the Serving GW shall include the LTE-M RAT type in the Modify Bearer Request message to the PGW. Otherwise the Serving GW includes RAT type WB-E-UTRAN.

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

NOTE 7: 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 to allow DL PDUs to be routed to the correct Serving GW. PDN GW returns a Modify Bearer Response (MSISDN) to the Serving GW. The MSISDN is included if the PDN GW has it stored in its UE context. If there has been a RAT change towards E-UTRAN and location information change reporting is required and supported in the target MME, the PDN GW shall provide MS Info Change Reporting Action in the Modify Bearer Response.

13. The Serving GW updates its bearer context. If ISR Activated is indicated in step 9 and RAT Type received in step 9 indicates E‑UTRAN, then the Serving GW only updates the MME Control Plane Address stored locally and keep the SGSN related information unchanged. Also, in this case, if the Serving GW has maintained the SGSN address for user plane and S4 GTP-U TEID, the Serving GW removes the SGSN address for user plane and S4 GTP-U TEID locally. Otherwise the Serving GW shall update all of the information stored locally for this UE with the related information received from the MME. This allows the Serving GW to route Bearer PDUs to the PDN GW when received from eNodeB. The Serving GW shall return a Modify Bearer Response (Serving GW address and TEID for uplink traffic, MS Info Change Reporting Action) message to the new MME as a response to a Modify Bearer Request message, or a Modify Access Bearers Response (Serving GW address and TEID for uplink traffic) as a response to a Modify Access Bearers Request message. If the Serving GW cannot serve the MME Request in the Modify Access Bearers Request message without S5/S8 signalling other than to unpause charging in the PDN GW or without corresponding Gxc signalling when PMIP is used over the S5/S8 interface, it shall respond to the MME with indicating that the modifications are not limited to S1-U bearers, and the MME shall repeat its request using Modify Bearer Request message per PDN connection.

When the MME receives the Modify Bearer Response or the Modify Access Bearers Response message, the MME checks if there is a "Availability after DDN Failure" monitoring event or a "UE Reachability" monitoring event configured for the UE in the MME and in such a case sends an event notification (see TS 23.682 [74] for further information).

For Control Plane CIoT EPS Optimisation, if the MME address and MME DL TEID are provided in step 9, the Serving GW includes Serving GW address and Serving GW UL TEID in the Modify Bearer Response message. The DL data is sent to the MME from the Serving GW.

The buffered DL data is sent to the UE as described in steps 12-14 of clause 5.3.4B.3.

14. 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, or for some network sharing scenario (e.g. GWCN) if the PLMN-ID of the TAI supplied by the eNodeB is different from that of the GUTI in the UE's context, then the new MME informs the HSS of the change of MME by sending an Update Location Request (MME Id, IMSI, ULR-Flags, MME Capabilities, Homogenous Support of IMS Voice over PS Sessions, UE SRVCC capability, equivalent PLMN list, ME Identity (IMEISV)) message to the HSS. ULR-Flags indicates that update location is sent from an MME and the MME registration shall be updated in HSS. The HSS does not cancel any SGSN registration. The MME capabilities indicate the MME's support for regional access restrictions functionality. The inclusion of the equivalent PLMN list indicates that the MME supports the inter-PLMN handover to a CSG cell in an equivalent PLMN using the subscription information of the target PLMN. The "Homogenous Support of IMS Voice over PS Sessions" indication (see clause 4.3.5.8A) shall not be included unless the MME has completed its evaluation of the support of "IMS Voice over PS Session" as specified in clause 4.3.5.8. The ME Identity is included if step 5 caused the MME to retrieve the IMEISV from the UE.

NOTE 8: At this step, the MME may not have all the information needed to determine the setting of the IMS voice over PS Session Supported indication for this UE (see clause 4.3.5.8). Hence the MME can send the "Homogenous Support of IMS Voice over PS Sessions" later on in this procedure.

If the UE initiates the TAU procedure in a VPLMN supporting Autonomous CSG Roaming and the HPLMN has enabled Autonomous CSG Roaming in the VPLMN (via Service Level Agreement) and the MME needs to retrieve the CSG subscription information of the UE from the CSS, the MME initiates the Update CSG Location Procedure with CSS as described in clause 5.3.12.

If the MME determines that only the UE SRVCC capability has changed, the MME sends a Notify Request to the HSS to inform about the changed UE SRVCC capability.

If all the EPS bearers of the UE have emergency ARP value, the new MME may skip the update location procedure or proceed even if the update location fails.

If the UE is RLOS attached, the new MME skips the update location procedure and the TAU procedure proceeds.

If the MME is in S&F mode, the MME and HSS executes the steps as described in clause 5.3.3.1 step 12.

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

16. 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 9: ISR Activated is never indicated from new to old MME.

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

17. 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 after the timer started in step 4 has expired.

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

19. The HSS acknowledges the Update Location Request by returning an Update Location Ack (IMSI, Subscription Data) message to the new MME after the cancelling of the old MME context is finished. If all checks are successful, the MME constructs an MM context for the UE. The Subscription Data may contain the CSG subscription data for the registered PLMN and for the equivalent PLMN list requested by MME in step 14.

The subscription data may contain Enhanced Coverage Restricted parameter. If received from the HSS, MME stores this Enhanced Coverage Restricted parameter in the MME MM context.

The subscription data may contain Service Gap Time. If received from the HSS, the MME stores this Service Gap Time in the MME MM context for the UE and passes it to the UE in the Tracking Area Update Accept message if the UE has indicated Service Gap Control capability.

The subscription data may contain Subscribed Paging Time Window parameter that applies to the UEs on a specific RAT, e.g. NB-IoT. If received from the HSS, MME stores this Subscribed Paging Time Window parameter in the MME MM context.

If the UE initiates the TAU procedure at a CSG cell, the new MME shall check whether the CSG ID and associated PLMN is contained in the CSG subscription and is not expired. If the CSG ID and associated PLMN is not present or expired, the MME shall send a Tracking Area Update reject message to the UE with an appropriate cause value. The UE shall remove the CSG ID and associated PLMN from its Allowed CSG list if present.

If the Update Location is rejected by the HSS, the new MME rejects the TAU Request from the UE with an appropriate cause sent in the TAU Reject message to the UE. In such cases, the new MME releases any local MME EPS Bearer contexts for this particular UE.

If the MME is in S&F mode, the MME and HSS executes the steps as described in clause 5.3.3.1 step 17.20. If due to regional subscription restrictions or access restrictions (e.g. CSG restrictions) (received in update location procedure in step 19) the UE is not allowed to access the TA:

- The MME rejects the Tracking Area Update Request with an appropriate cause to the UE.

- For UEs with emergency EPS bearers, i.e. at least one EPS bearer has an ARP value reserved for emergency services, the new MME accepts the Tracking Area Update Request and deactivates all non-emergency PDN connections as specified in clause 5.10.3. If the Tracking Area Update procedure is initiated in ECM-IDLE state, all non-emergency EPS bearers are deactivated by the Tracking Area Update procedure without bearer deactivation signalling between the UE and the MME.

If the TAU request message includes Paging Restriction Information, the MME may accept or reject the Paging Restriction Information requested by the UE based on operator policy. If the MME rejects the Paging Restriction Information, the MME removes any stored Paging Restriction Information from the UE context and discards the UE requested Paging Restriction Information. If the MME accepts the Paging Restriction Information from the UE, the MME stores the Paging Restriction Information from the UE in the UE context and then enforces it in the Network Triggered Service Request procedure as described in clause 5.3.4.3. The MME informs the UE about the acceptance/rejection of the requested Paging Restriction Information in the TAU Accept message. If the TAU Request message does not include any Paging Restriction Information, the MME shall delete any stored Paging Restriction Information for this UE and stop restricting paging accordingly.

If the TAU Request message includes a Release Request indication, the MME does not activate the user plane setup procedure in the subsequent steps and triggers the S1 release procedure as described in clause 5.3.5 after the completion of TAU procedure.

The MME responds to the UE with a Tracking Area Update Accept (GUTI, TAI-list, EPS bearer status, NAS sequence number, NAS-MAC, ISR Activated, IMS Voice over PS session supported, Emergency Service Support indicator, LCS Support Indication, Supported Network Behaviour, Service Gap Time, Enhanced Coverage Restricted, Indication of support of 15 EPS bearers per UE, PLMN-assigned UE Radio Capability ID, Accepted IMSI Offset, Paging Restriction Information acceptance/rejection, Enhanced Discontinuous Coverage Support, Return To Coverage Notification Not Required, Unavailability Period Duration, the Start of Unavailability Period, Maximum Time Offset) 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. If this is a Tracking Area Update without MME change and the DL Data Buffer Expiration Time in the MM context for the UE in the MME has not expired, or if this is a Tracking Area Update with MME change and the old MME/old S4-SGSN indicated Buffered DL Data Waiting in the Context Response in step 5, the user plane setup procedure is activated even if the MME did not receive the active flag in the TAU Request message. If the new MME receives the Downlink Data Notification message or any downlink signalling message while the UE is still connected, the user plane setup procedure may be activated even if the new MME did not receive the active flag in the TAU Request 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. If the EPS bearer status information was in the TAU Request, the MME shall indicate the EPS bearer status to the UE. If ISR Activated is indicated to the UE, this indicates that its P-TMSI and RAI shall remain registered with the network and shall remain valid in the UE. At a Tracking Area Update with an MME change ISR Activated shall not be indicated. At a Tracking Area Update without an MME change, if ISR is activated for the UE when the MME receives the Tracking Area Update Request, the MME should maintain ISR by indicating ISR Activated in the Tracking Area Update Accept message. Handover Restriction List is described in clause 4.3.5.7 "Mobility Restrictions". The MME sets the IMS Voice over PS session supported as described in clause 4.3.5.8.

For UE using CIoT EPS Optimisation without any activated PDN connection, there is no EPS bearer status included in the TAU Accept message.

The MME indicates the CIoT EPS Optimisations it supports and prefers in the Supported Network Behaviour information as defined in clause 4.3.5.10.

If there is a Service Gap timer running for the UE in the MME, the MME shall ignore the active flag and signalling active flag and not perform any of the actions related to these flags except if the TAU Request message has been received when the UE has a PDN connection for emergency bearer services established or is establishing a PDN connection for emergency bearer services or if the UE is configured to use high priority access (AC 11-15) in selected PLMN.

The MME shall include the Service Gap Time in the TAU Accept message if the UE has indicated Service Gap Control capability and either if Service Gap Time was received in step 19 from HSS in the subscription information or if the Service Gap Time in the subscription information has been updated by HSS User Profile management (i.e. the Insert Subscriber Data procedure in clause 5.3.9.2).

If the UE included support for restriction of use of Enhanced Coverage in step 1, the MME sends Enhanced Coverage Restricted parameter to the eNodeB in the S1-AP message as defined in clause 4.3.28. The MME also sends the Enhanced Coverage Restricted parameter to the UE in the TAU Accept message. UE shall store Enhanced Coverage Restricted parameter and shall use the value of Enhanced Coverage Restricted parameter to determine if enhanced coverage feature should be used or not.

If the MME successfully obtained Header Compression Configuration parameters in step 5 it indicates he continued use of previous negotiated configuration to the UE in the Header Compression Context Status for each EPS Bearer of the UE. When Header Compression Context Status indicates that the previous negotiated configuration can no longer be used for some EPS bearers, the UE shall stop performing header compression and decompression when sending or receiving data using Control Plane CIoT EPS Optimisation on these EPS bearers.

The MME checks if there is a "Availability after DDN Failure" monitoring event or a "UE Reachability" monitoring event configured for the UE in the MME for which an event notification has not yet been sent. In such a case an event notification is sent (see TS 23.682 [74] for further information).

If the MME did not receive the Voice support match indicator in the MM Context, then the MME may send a UE Radio Capability Match Request to the eNodeB as described in clause 5.3.14. If the MME hasn't received Voice support match indicator from the eNodeB then based on implementation MME may set IMS Voice over PS session supported Indication and update it at a later stage. After step 14, and in parallel to any of the preceding steps, the MME shall send a Notify Request (Homogeneous Support of IMS Voice over PS Sessions) message to the HSS:

- If the MME has evaluated the support of IMS Voice over PS Sessions, see clause 4.3.5.8, and

- If the MME determines that it needs to update the Homogeneous Support of IMS Voice over PS Sessions, see clause 4.3.5.8A.

The Emergency Service Support indicator informs the UE that Emergency bearer services are supported. LCS Support Indication indicates whether the network supports the EPC-MO-LR and/or CS-MO-LR as described in TS 23.271 [57]. Indication for support of 15 EPS bearers per UE indicates the network supports 15 EPS bearers as defined in clause 4.12.

When receiving the TAU Accept message and there is no ISR Activated indication the UE shall set its TIN to "GUTI". When ISR Activated is indicated and the UE's TIN indicates "GUTI" the UE's TIN shall not be changed. When ISR Activated is indicated and the TIN is "P‑TMSI" or "RAT‑related TMSI" the UE shall set its TIN to "RAT‑related TMSI".

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

For an emergency attached UE, emergency ISR is not activated.

If the TAU procedure is initiated by manual CSG selection and occurs via a CSG cell, the UE upon receiving TAU Accept message shall add the CSG ID and associated PLMN to its Allowed CSG list if it is not already present. Manual CSG selection is not supported if the UE has emergency bearers established.

If the UE included extended idle mode DRX parameters information element, the MME includes extended idle mode DRX parameters information element in the TAU accept if it decides to enable extended idle mode DRX with Paging Time Window length assigned considering Subscribed Paging Time Window (if available) and the local policy. Additionally, for a UE using an eNodeB that provides discontinuous coverage (e.g. for satellite access with discontinuous coverage), the MME may consider Unavailability Period Duration and/or Start of Unavailability Period as described in clause 4.13.8.2 when determining extended idle mode DRX parameters.

If the user plane setup is performed in conjunction with the TAU Accept message and the TAU is performed via a hybrid cell, then the MME shall send an indication whether the UE is a CSG member to the RAN along with the S1-MME control message. Based on this information, the RAN may perform differentiated treatment for CSG and non-CSG members.

NOTE 10: If the UE receives a TAU Accept message via a hybrid cell, the UE does not add the corresponding CSG ID and associated PLMN to its Allowed CSG list. Adding a CSG ID and associated PLMN to the UE's local Allowed CSG list for a hybrid cell is performed only by OTA or OMA DM procedures.

If the UE receives a Service Gap Time in the TAU Accept message, the UE shall store this parameter and apply Service Gap Control (see clause 4.3.17.9).

If the UE has indicated support for dual connectivity with NR in the TAU Request and the UE is not allowed to use NR as Secondary RAT, the MME indicates that to the UE in the TAU Accept message.

If the user plane setup is performed and if RACS is supported and MME has UE Radio Capability ID in UE context, valid for the PLMN the UE is currently in, it signals the UE Radio Capability ID to the eNodeB as defined in clause 5.11.3a. If the eNodeB does not have mapping between the specific UE Radio Capability ID and the UE radio capabilities, it shall use the procedure described in TS 36.413 [36] to retrieve the mapping from the Core Network.

When the UE supports RACS, and the MME needs to configure the UE with a UE Radio Capability ID, and the MME already has the UE radio capabilities for the UE, the MME may provide the UE with the UE Radio Capability ID for the UE radio capabilities the UCMF returns to the MME for this UE.

If the UE had included a UE Specific DRX parameter for NB-IoT in the Tracking Area Update Request, the MME includes the Accepted NB-IoT DRX parameter.

If the UE provided a Requested IMSI Offset in step 2, but the network prefers a different value, the MME provides the UE with an Accepted IMSI Offset different from the one provided in step 2. Otherwise the value of the Accepted IMSI Offset the MME sends is the value of the Requested IMSI Offset sent by the UE in step 2. The MME stores the value of the alternative IMSI derived (see clause 4.3.33) from the Accepted IMSI Offset provided to the UE in the UE context.

If a Multi-USIM UE does not provide a Requested IMSI Offset in step 1, the MME erases any alternative IMSI value in the UE context.

NOTE 11: The MME does not remove IMSI Offset value if the Tracking Area Update Request is for periodic Tracking Area Update.

If the Multi-USIM UE has indicated one or more Multi-USIM specific Capabilities are supported in the UE Core Network Capability in step 2, the MME shall indicate whether the corresponding one or more Multi-USIM specific features described in clause 4.3.33 are supported based on network capability and preference by the network (based on local network policy) by providing one or more of the Connection Release Supported, Paging Cause Indication for Voice Service Supported, Reject Paging Request Supported, Paging Restriction Supported and Paging Timing Collision Control Supported indications. The MME shall only indicate Paging Restriction Supported together with either Connection Release Supported or Reject Paging Request Supported. The UE shall only use Multi-USIM specific features that the MME indicated as being supported. In case of Emergency attached UE, the MME shall not indicate support for any Multi-USIM feature to the UE.

If both UE and network support discontinuous coverage, the MME provides the Enhanced Discontinuous Coverage Support indication as described in clause 4.13.8.1.

For a UE using a eNodeB that provides discontinuous coverage (e.g. for satellite access with discontinuous coverage), the MME may provide Return To Coverage Notification Not Required, which requests the UE in ECM\_IDLE state to not perform the TAU procedure when it returns to coverage, and/or provide the UE with an Unavailability Period Duration and/or Start of Unavailability Period if available, as described in clause 4.13.8.2. The MME may also provide a Maximum Time Offset as described in clause 4.13.8.6.

21. If the GUTI was changed, or the MME indicates an Accepted IMSI Offset to the UE in step 20, the UE acknowledges the new GUTI or the Accepted IMSI Offset value by returning a Tracking Area Update Complete message to the MME.

When the "Active flag" is not set in the TAU Request message and the Tracking Area Update was not initiated in ECM-CONNECTED state, the MME releases the signalling connection with UE, according to clause 5.3.5. For a UE using Control Plane CIoT EPS Optimisation, when the "Signalling active flag" is set, the new MME shall not release the NAS signalling connection with the UE immediately after the TAU procedure is completed.

NOTE 12: The new MME may initiate E‑RAB establishment (see TS 36.413 [36]) after execution of the security functions, or wait until completion of the TA update procedure. For the UE, E‑RAB establishment may occur any time 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 should not construct an MM context for the UE. In the case of receiving the subscriber data from HSS, the new MME may construct an MM context and store the subscriber data for the UE to optimise signalling between the MME and the HSS. 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 clause "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 in the Context Response message and then store the new Maximum APN restriction value.

The bearer contexts shall be prioritized by the new MME. If the new MME is unable to support the same number of active bearer contexts as received from old MME/SGSN, the prioritisation is used to decide 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 clause "MME Initiated Dedicated Bearer Deactivation Procedure". This shall not cause the MME to reject the tracking area update.

The new MME shall not deactivate emergency service related EPS bearers, i.e. EPS bearers with ARP value reserved for emergency services.

NOTE 13: If MS (UE) was in PMM-CONNECTED state the bearer contexts are sent already in the Forward Relocation Request message as described in 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.

If the new MME identifies that the RAT type has changed, the MME checks the subscription information to identify for each APN whether to maintain the PDN connection, disconnect the PDN connection with a reactivation request, or, disconnect the PDN connection without reactivation request. If the MME decides to deactivate a PDN connection it performs MME-initiated PDN Connection Deactivation procedure after the tracking area update procedure is completed but before the S1/RRC interface connection is released. Existing ESM cause values as specified in TS 24.301 [46] (e.g. #39, "reactivation requested"; #66 "Requested APN not supported in current RAT and PLMN combination"; and for a dedicated bearer, possibly #37 "EPS QoS not accepted") are used to cause predictable UE behaviour. If all the PDN connections are disconnected and the UE does not support "attach without PDN connectivity", the MME shall request the UE to detach and reattach.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Next Changes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

#### 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.

This procedure may be also used as part of the SIPTO function when the MME determines that GW relocation is desirable for all PDN connection(s) serving SIPTO-allowed APNs. The MME initiates the "explicit detach with reattach required" procedure and the UE should then re-establish those PDN connections for the same APN(s).



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: Procedure steps (B) are used by the procedure steps (E) in clause 5.3.2.1.

1. The MME initiated detach procedure is either explicit (e.g. by O&M intervention) 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 for implicit detach. The implicit detach is local to the MME, i.e. an SGSN registration will not be detached. If the UE is in ECM-CONNNECTED state 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. If the UE is in ECM-IDLE state the MME pages the UE.

For emergency attached UEs, MME initiated implicit detach procedures are based on an inactivity timeout specific to emergency.

If this Detach procedure is due to the UE's Detach Request via a CSG cell which the UE is not allowed to access, i.e. the CSG subscription for this CSG ID and associated PLMN is absent or expired, the MME shall send a Detach Request to UE with an appropriate cause indicating the UE is not allowed to access this CSG.

In the case of satellite access for Cellular IoT, the MME initiates detach procedure if it detects that the UE's registered PLMN is not allowed to operate in the present UE location (see clause 4.13.4). In this case, the MME shall include in the Detach Request message a suitable cause value.

If the MME is in S&F mode, the MME may include the wait timer and list of satellite IDs as described in clause 4.13.X.

2. If the UE has no activated PDN connection, then steps 2 to 10 are not executed. If the PLMN has configured secondary RAT usage reporting, the MME shall wait for step 11, if applicable, and perform step 12 before step 2 onwards. For any PDN connections to the SCEF, the MME indicates to the SCEF that the PDN connection for the UE is no longer available according to TS 23.682 [74] and steps 2 to 10 are not executed. For PDN connections to the P-GW, any EPS Bearer Context information in the Serving GW regarding this particular UE and related to the MME are deactivated by the MME sending Delete Session Request (LBI, User Location Information (ECGI), NAS Release Cause if available, Secondary RAT usage data, PSCell ID) message per PDN connection to the Serving GW. If the UE Time Zone has changed, the MME includes the UE Time Zone IE in this message. NAS Release Cause is only sent by the MME to the PDN GW if this is permitted according to MME operator's policy. If Secondary RAT usage data report was received from the RAN, the MME includes this in the Delete Session Request message. If MME has received PSCell ID from eNodeB, the MME includes it in Delete Session Request.

3. When the S‑GW receives the first Delete Session Request message from the MME or SGSN in ISR activated state, the Serving GW deactivates ISR, releases the related EPS Bearer context information and responds with Delete Session Response (Cause).

When the S‑GW receives the Delete Session Request message from the MME or SGSN in ISR deactivated state, the Serving GW releases the related EPS Bearer context information and jumps to step 6 by sending a Delete Session Request (LBI) message to the PDN GW. After step 7 the Serving GW responds back to the MME/SGSN with the Delete Session Response (Cause and, optionally, APN Rate Control Status according to clause 4.7.7.3) message.

4. If ISR is activated, MME sends Detach Notification (Cause) message to the associated SGSN. The cause indicates whether it is a local or complete detach.

5. If cause indicates complete detach then the SGSN sends a Delete Session Request (LBI, CGI/SAI) message per PDN connection to the Serving GW. If Cause indicates local detach then SGSN deactivates ISR and steps 5 to 9 shall be skipped. If the UE Time Zone has changed, the SGSN includes the UE Time Zone IE in this message.

6. If ISR is activated, Serving GW deactivates ISR.

If ISR is not activated and the Serving GW received one or several Delete Bearer Request message(s) from SGSN in step 2, the Serving GW sends a Delete Session Request (LBI, User Location Information (ECGI or CGI/SAI), NAS Release Cause if available, Secondary RAT usage data) message for each associated PDN connection to the PDN GW. NAS Release Cause is the one received in the Delete Session Request from the MME. This message indicates that all bearers belonging to that PDN connection shall be released.

If the MME and/or SGSN send(s) UE's Location Information, and/or UE Time Zone and/or Secondary RAT usage data in step 2 and/or step 5, the S‑GW includes the User Location Information, and/or UE Time Zone Information with the least age in this message and/or Secondary RAT usage data.

7. The PDN GW acknowledges with Delete Session Response (Cause and, optionally, APN Rate Control Status according to clause 4.7.7.3) message.

8. 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. If requested by the PCRF the PDN GW indicates User Location Information and/or UE Time Zone Information and NAS Release Cause (if available) to the PCRF as defined in TS 23.203 [6].

9. The Serving GW acknowledges with Delete Session Response (Cause, APN Rate Control Status) message.

10. The SGSN sends Detach Acknowledge message to the MME (APN Rate Control Status). The MME stores the APN Rate Control Status in the MM context.

11. 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. The eNodeB forwards this NAS message to the MME along with the TAI+ECGI of the cell which the UE is using.

If Dual Connectivity is active for the UE, the PSCell ID shall be included in the Uplink NAS Transport that carries the Detach Accept message.

If the UE receives Detach Request from the MME via a CSG cell with the cause indicating the UE is not allowed to access this CSG, the UE shall remove this CSG ID and associated PLMN from its Allowed CSG list, if present.

12. After receiving the Detach Accept message, Delete Session Response and, if appropriate, Detach Acknowledge message, the MME releases the S1-MME signalling connection for the UE by sending an S1 Release Command (Cause) message to the eNodeB. The details of this step are covered in the "S1 Release Procedure", as described in clause 5.3.5 by step 4 to step 6. If the Detach Type requests the UE to make a new attach, the UE reattaches after the RRC Connection Release is completed.

NOTE 3: In the "S1 Release Procedure", if Dual Connectivity was active at the time of the release, the eNodeB includes the PSCell ID.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Next Changes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

### 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 stand-alone operation only.

Table 5.7.1-1: HSS data

| Field | Description |
| --- | --- |
| 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 |
| External Identifier List | External Identifier(s) used in the external network(s) to refer to the subscription. See TS 23.682 [74] for more information. |
| MME Identity | The Identity of the MME currently serving this UE. |
| MME Capabilities | Indicates the capabilities of the MME with respect to core functionality e.g. regional access restrictions. |
| 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. It may include different values for HPLMN and roaming case. It includes separate settings for WB-E-UTRAN and NB-IoT. It includes restriction information on the use of NR as a secondary RAT for user plane connectivity, the use of Unlicensed Spectrum (in the form of LAA, or LWA/LWIP, or NR-U). |
| EPS Subscribed Charging Characteristics | The charging characteristics for the UE, e.g. normal, prepaid, flat-rate, and/or hot billing subscription. |
| Trace Reference | Identifies a record or a collection of records for a particular trace. |
| Trace Type | Indicates the type of trace, e.g. HSS trace, and/or MME/ Serving GW / PDN GW trace. |
| OMC Identity | Identifies the OMC that shall receive the trace record(s). |
| Subscribed-UE-AMBR | The Maximum Aggregated uplink and downlink MBRs to be shared 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. See TS 23.003 [9] clause 9.1.2 for more information on the format of domain names that are allowed in this field. |
| RFSP Index | An index to specific RRM configuration in the E-UTRAN |
| Additional RRM Policy Index | An index to additional RRM configuration in the E-UTRAN |
| URRP-MME | UE Reachability Request Parameter indicating that UE activity notification from MME has been requested by the HSS. |
| CSG Subscription Data | The CSG Subscription Data is a list of CSG IDs per PLMN and for each CSG ID optionally an associated expiration date which indicates the point in time when the subscription to the CSG ID expires; an absent expiration date indicates unlimited subscription.  For a CSG ID that can be used to access specific PDNs via Local IP Access, the CSG ID entry includes the corresponding APN(s). |
| VPLMN LIPA Allowed | Specifies per PLMN whether the UE is allowed to use LIPA. |
| IAB-Operation Allowed | Indicates that the subscriber is allowed for IAB-operation |
| EPLMN list | Indicates the Equivalent PLMN list for the UE's registered PLMN. |
| Subscribed Periodic RAU/TAU Timer | Indicates a subscribed Periodic RAU/TAU Timer value |
| Extended idle mode DRX cycle length | Indicates a subscribed extended idle mode DRX cycle length value. |
| RAT specific Subscribed Paging Time Window | Indicates a Subscribed Paging Time Window value for the associated RAT, NB-IoT, WB-E-UTRAN or both. |
| MPS CS priority | Indicates that the UE is subscribed to the eMLPP or 1x RTT priority service in the CS domain. |
| UE-SRVCC- Capability | Indicates whether the UE is UTRAN/GERAN SRVCC capable or not. |
| MPS EPS priority | Indicates that the UE is subscribed to MPS in the EPS domain. |
| UE Usage Type | Indicates the usage characteristics of the UE for use with Dedicated Core Networks (see clause 4.3.25). |
| Group ID-list | List of the subscribed group(s) that the UE belongs to |
| Communication Patterns | Indicates per UE the Communication Patterns and their corresponding validity times as specified in TS 23.682 [74].The Communication Patterns are not provided to the SGSN. |
| Monitoring Event Information Data | Describes the monitoring event configuration information. See TS 23.682 [74] for more information. |
| PDN Connection Restriction | Indicates whether the establishment of the PDN connection is restricted for the UE. |
| Enhanced Coverage Restricted | Specify PLMN(s) with Enhanced Coverage restrictions. |
| Acknowledgements of downlink NAS data PDUs | Indicates whether acknowledgement of downlink NAS data PDUs for Control Plane CIoT EPS Optimisation is disabled for this UE (enabled by default). |
| Service Gap Time | Used to set the Service Gap timer for Service Gap Control (see clause 4.3.17.9). |
| Each subscription profile contains one or more PDN subscription contexts: | |
| Context Identifier | Index of the PDN subscription context (Note 8). |
| PDN Address | Indicates subscribed IP address(es). |
| PDN Type | Indicates the subscribed PDN Type (IPv4, IPv6, IPv4v6, Non-IP, Ethernet) |
| APN-OI Replacement | APN level APN-OI Replacement which has same role as UE level APN-OI Replacement but with higher priority than UE level APN-OI Replacement. This is an optional parameter. When available, it shall be used to construct the PDN GW FQDN instead of UE level APN-OI Replacement. |
| Access Point Name (APN) | A label according to DNS naming conventions describing the access point to the packet data network (or a wildcard) (NOTE 6). |
| Invoke SCEF Selection | Indicates whether this APN is used for establishing PDN connection to the SCEF |
| SCEF ID | Indicates the FQDN or IP address of the SCEF which is to be selected for this APN. It is required if "Invoke SCEF Selection" indicator is set. |
| SIPTO permissions | Indicates whether the traffic associated with this APN is prohibited for SIPTO, allowed for SIPTO excluding SIPTO at the local network, allowed for SIPTO including SIPTO at the local network or allowed for SIPTO at the local network only (NOTE 7). |
| LIPA permissions | Indicates whether the PDN can be accessed via Local IP Access. Possible values are: LIPA-prohibited, LIPA-only and LIPA-conditional. |
| WLAN offloadability | Indicates whether the traffic associated with this APN is allowed to be offloaded to WLAN using the WLAN/3GPP Radio Interworking feature or if it shall be kept on 3GPP access (see clause 4.3.23). The indication may contain separate values per RAT (E-UTRA and UTRA). |
| EPS subscribed QoS profile | The bearer level QoS parameter values for that APN's default bearer (QCI and ARP) (see clause 4.7.3). |
| Subscribed-APN-AMBR | The maximum aggregated uplink and downlink MBRs to be shared across all Non-GBR bearers, which are established for this APN. |
| EPS PDN Subscribed Charging Characteristics | The charging characteristics of this PDN Subscribed context for the UE, e.g. normal, prepaid, flat-rate, and/or hot billing subscription. The charging characteristics is associated with this APN. |
| VPLMN Address Allowed | Specifies per VPLMN 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 either an FQDN or an IP address. 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. |
| PDN continuity at inter RAT mobility | Provides for this APN how to handle a PDN connection when UE the moves between "broadband" (WB-E-UTRAN and UTRAN) and "narrowband" (NB-IoT, GPRS, EC-GSM-IoT). Possible values are: maintain the PDN connection; disconnect the PDN connection with a reactivation request; disconnect PDN connection without reactivation request; or to leave it to local VPLMN policy. |
| PLMN of PDN GW | Identifies the PLMN in which the dynamically selected PDN GW is located. |
| Homogenous Support of IMS Voice over PS Sessions for MME | Indicates per UE and MME if "IMS Voice over PS Sessions" is homogeneously supported in all TAs in the serving MME or homogeneously not supported, or, support is non-homogeneous/unknown, see clause 4.3.5.8A. |
| List of APN ‑ PDN GW ID relations (for PDN subscription context with wildcard APN): | |
| APN - P‑GW relation #n | The APN and the identity of the dynamically allocated PDN GW of a PDN connection that is authorised by the PDN subscription context with the wildcard APN. The PDN GW identity may be either an FQDN or an IP address. The PDN GW identity refers to a specific PDN GW. |
| Receive Time | The time stamp indicating latest interaction of the UE with MME function onboard the satellite. This is used when MME is in the S&F mode(see clause 4.13.X). |

NOTE 1: IMEI and SVN are stored in HSS when the Automatic Device Detection feature is supported, see clause 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: Void.

NOTE 4: How to indicate which of the PDN subscription contexts stored in the HSS is the default one for the UE is defined in stage 3.

NOTE 5: To help with the selection of a co-located or topologically appropriate PDN GW and Serving GW, the PDN GW identity shall be in the form of an FQDN.

NOTE 6: The "Access Point Name (APN)" field in the table above contains the APN-NI part of the APN.

NOTE 7: In this specification, the values "prohibited for SIPTO" and " allowed for SIPTO excluding SIPTO at the local network" correspond to the pre Rel‑12 values "prohibited for SIPTO" and "allowed for SIPTO". Actual coding of these values belongs to Stage 3 domain.

NOTE 8: There may be at most three default APNs for a given user. One default APN can belong to either of the three PDN types of "IPv4", "IPv6", or "IPv4v6", one default APN can belong to PDN type of "Non-IP" and another default APN can belong to PDN type of "Ethernet".

An expired CSG subscription should not be removed from the HSS subscription data before it is removed from the UE's Allowed CSG list or Operator CSG list. When a CSG subscription is cancelled it should be handled as an expired subscription in HSS subscription data to allow for removing it from UE's Allowed CSG list or Operator CSG list first.

One (and only one) of the PDN subscription contexts stored in the HSS may contain a wild card APN (see TS 23.003 [9]) in the Access Point Name field.

The PDN subscription context marked as the default one shall not contain a wild card APN.

The PDN subscription context with a wildcard APN shall not contain a statically allocated PDN GW.

If the LIPA permission and SIPTO permission flags are both included for a particular APN, they shall be set in a consistent manner, e.g. if the LIPA permission is set to LIPA-only or LIPA-conditional, the SIPTO permission shall be set to SIPTO-prohibited. Conversely, if the SIPTO permission indicates the APN is a SIPTO-allowed APN, the LIPA permission shall be set to LIPA-prohibited. A SIPTO-allowed APN is an APN for which the SIPTO permission is set to allowed for SIPTO excluding SIPTO at the local network, allowed for SIPTO including SIPTO at the local network or allowed for SIPTO at the local network only.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Next Changes \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

### 5.11.3 UE Core Network Capability

The UE Core Network Capability is split into the UE Network Capability IE (mostly for E-UTRAN access related core network parameters) and the MS Network Capability IE (mostly for UTRAN/GERAN access related core network parameters) and contains capabilities, e.g. for CIoT, NAS/AS security algorithms (that also indicate support for EPS-UPIP), etc. Both the UE Network Capability and the MS Network Capability are 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 Attach and the Tracking Area Update signalling. The MME shall remove the stored MS Network Capability, if MS Network Capability is not included in Attach or non-periodic Tracking Area Update signalling e.g. UE is only capable of E-UTRAN.

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 activated)), the UE shall perform a Tracking Area Update ('type' different to 'periodic') when it next returns to E‑UTRAN coverage - see clause 5.3.3.0.

If the UE supports multiple user plane radio bearers on the NB-IoT RAT (see TS 36.306 [82], TS 36.331 [37]), then the UE shall indicate this in the UE Network Capability IE.

If the UE supports, the RACS feature defined in clause 5.11.3a, and in this specification for the impact on the EPS procedures, then the UE shall indicate this in the UE Network Capability IE.

If the UE supports dual connectivity with NR (see clause 4.3.2a), then the UE shall indicate its support in a NAS indicator.

If the UE supports Service Gap Control (see clause 4.3.17.9), then the UE shall indicate this in the UE Network Capability IE.

If a UE operating two or more USIMs, supports and intends to use one or more Multi-USIM features (see clause 4.3.33) in a PLMN, it shall indicate in the UE Core Network Capability for this USIM in this PLMN that it supports these one or more Multi-USIM features, i.e. by means of one or more of the Connection Release Supported, Paging Cause Indication for Voice Service Supported, Reject Paging Request Supported, Paging Timing Collision Control Supported, and Paging Restriction Supported. Otherwise, the UE with the capabilities of Multi-USIM features shall indicate these one or more Multi-USIM features are not supported.

A UE not operating two or more USIMs shall indicate the Multi-USIM features are not supported.

NOTE: It is not necessary for a UE operating two or more USIMs to use Multi-USIM features with all USIMs.

If the UE supports Enhanced support of discontinuous network coverage for satellite access (see clause 4.3.18.1), then the UE shall indicate this in the UE Network Capability IE.

In the case of satellite access for NB-IoT, if the UE supports reporting its Coarse Location Information via NAS, then the UE shall indicate this in the UE Network Capability IE.

To allow for the addition of future features, the MME shall store the UE Network Capability and the MS Network Capability even if either or both is larger than specified in TS 24.008 [47]/TS 24.301 [46], up to a maximum size of 32 octets for each IE.

If the UE supports S&F mode (see clause 4.13.x), then the UE shall indicate this in the UE Network Capability IE.

Annex X (informative):   
Store and Forward operation

# X.1 Introduction

The S&F operation with satellite access is intended to provide some level of communication service for UEs under satellite coverage with intermittent/temporary satellite connectivity (e.g. when the satellite is not connected via a feeder link or via ISL to the ground network) for delay-tolerant communication service. The support of S&F operation is especially suited for the delivery of delay-tolerant/non-real-time IoT satellite services with NGSO satellites.

An example of "S&F operation" is illustrated in Figure X.1-1, in contrast to what could be considered the assumption for the "normal/default Satellite operation" with satellite access.

As shown in Figure X.1-1:

- Under "normal/default Satellite operation" mode, signalling and data traffic exchange between a UE with satellite access and the remote ground network requires the service and feeder links to be active simultaneously, so that, at the time that the UE interacts over the service link with the satellite, there is a continuous end-to-end connectivity path between the UE, the satellite and the ground network.

- In contrast, under "S&F operation", the end-to-end exchange of signalling/data traffic is now handled as a combination of two steps not concurrent in time (step A and B in Figure X.1-1). In step A, signalling/data exchange between the UE and the satellite takes place, without the satellite being simultaneously connected to the ground network (i.e. the satellite is able to operate the service link without an active feeder link connection). In step B, connectivity between the satellite and the ground network is established so that communication between the satellite and the ground network can take place. So, the satellite moves from being connected to the UE in step A to being connected to the ground network in step B.

|  |  |
| --- | --- |
| **"Normal/default Satellite operation" mode** |  |
| **"S&F operation"** |  |

Figure X.1-1: Illustration of "normal/default operation" and "S&F Satellite operation" modes with satellite access

## X.2 Example S&F Operation Architectures

### X.2.1 Split MME architecture

In this architecture option:

1) eNB is onboard the satellite

1) MME is split into two functions:

a) MME-onboard: the MME part which is onboard the satellite. MME-onboard is in charge of (1) handling the S1 interface with the onboard eNB and (2) terminating the NAS protocol signalling from/to UEs via the onboard eNB.

b) MME-ground: the MME part which is on the ground network. MME-ground is in charge of handling the rest of interfaces towards other CN functions (S6a towards HSS, SGd towards SMS-GMSC/IWMSC /SMS Router, T6a towards SCEF, T6ai towards IWF-SCEF, S11 towards SGW). One MME-ground instance can be connected to one or multiple MME-onboard instances via a Ssf reference point (see Figure X.2.1). The Ssf reference point is outside the scope of 3GPP.

2) Rest of the core network elements (HSS, SGW, PGW, SCEF/IWF-SCEF, SMS-GMSC/IWMSC/SMS Router) are on the ground to support SMS and CP CIoT services. For supporting S1-UP and UP CIoT services, part of the SGW function should be deployed on board the satellite. For SMS service, to support immediate delivery of delivery report(i.e. RP-ACK) to the UE, SMSC function is deployed on board the satellite.



Figure X.2.1-1: “Split-MME” architecture for supporting S&F satellite operation for SMS and CP CIoT services

The split-MME architecture have below principles:

1) The Ssf reference point is outside the scope of 3GPP in this release of specification.

2) The MME-ground is an anchor node situated in ground network which has the UE context. MME-ground is responsible to synchronize the UE context with all the MME-onboard(s).

3) The eNB and MME-onboard are onboard the satellite. Thus they can provide basic connection management procedures. The MME-onboard executes all the procedures with the UE which does not need interaction with other core network nodes on the ground when the service link is available.

4) Whenever a procedure needs an interaction with a core network node in the ground then MME-onboard (stores it as feeder link is not available) and synchronizes with the MME-ground when feeder link is available, the MME-ground executes the procedure with the ground network nodes and syncs back the UE context with the MME-onboard or sends back the response message to the MME-onboard.

5) The MO data is stored in the MME-onboard when the service link is available and the feeder link is unavailable, and transferred to the ground when the feeder link becomes available. The MT data is stored in the MME-ground or in S-GW when the feeder link is unavailable and transferred to the MME-onboard when the feeder link becomes available. The MT data is stored in the MME-onboard when the feeder link is available and service link is unavailable, and transferred to the UE when service link becomes available. All types of data traffic (e.g. IP etc) can be supported and transferred using the existing user plane and control plane procedures defined in EPS.

6) For MO SMS, upon reception of the MO SMS the MME-onboard stores the MO-SMS and may immediately send the delivery report(i.e. RP-ACK) to the UE i.e. as if the MO-SMS has already been successfully delivered to the Service Centre (SC). For this, some or full SMSC function is expected to be collocated with MME function onboard the satellite.

7) The MME-onboard store the timestamp of interaction with the UE (called as Request Time). This is provided to the MME-ground when feeder link is available. The MME-ground may indicate to HSS the "Request Time", allowing the HSS to check that no other (e.g., terrestrial) MME has sent an Update Location Request after the "Request Time". Further interactions between MME-ground and HSS are described in clause 4.13.X.

8) The Mobile Reachable Timer (MRT) is run at the MME-ground, each time UE gets in connected mode with any of the MME-onboard, the MME-onboard informs the MME-ground, then MME-ground restart the MRT timer. The mobile reachable timer value has to be sufficiently large at network so that it takes into account delay in receiving information from the MME-onboard after UE has come to connected mode( including case of PTAU procedure).

### X.2.2 Full CN onboard



Figure X.2.2-1: Full CN on Satellite Implementation Example S&F Architecture

The full CN on satellite implementation example has the following characteristics:

- The full CN includes eNodeB, MME, SGW, PGW, HSS, E-SMLC, SMSC etc.

- Proxies, which can also act as SCS/AS, can be deployed on the satellite and the ground for application traffic. The implementation of the proxies and the interface between them is out of 3GPP scope.

- The UE attaches, transfers data (e.g. SMS, MO and MT data, etc.) and detaches from each satellite. The MME may reject a UEs access attempts if cannot be completed, see clause 4.13.x.

- The HSS(s) on the satellite(s) may be populated with subscription data either for only the UEs that may access the specific satellite it is on or all UEs that may access the satellite. The UE may have a USIM enhanced for IOPS, or a USIM dedicated to the satellite network.