**3GPP TSG-SA2 Meeting #165 *S2-2410657***

**Hyderabad, India, 14th Oct 2024 – 18th Oct 2024 *(was S2-2410234)***

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
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|  | **23.401** | **CR** | **3801** | **rev** | **9** | **Current version:** | **19.0.0** |  |
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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:***  |  |
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| ***Source to WG:*** | Nokia, [Novamint, NEC, Tencent, CATT, Intel, Vivo], Sateliot, Qualcomm, LGE |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | 5GSAT\_Ph3\_ARC |  | ***Date:*** | 2024-10-14 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-19 |
|  | *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 canbe 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-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
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| ***Reason for change:*** | The approved 5GSAT\_ARCH\_Ph3 work item (SP-240986) is set to specify the architecture enhancements, functionalities and procedures to support Store and Forward operation mode based on conclusions of TR 23.700-29 (clause 8.2).This paper adds the general description of the Store and Forward feature and corresponding architecture enhancements in TS 23.401. |
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| ***Summary of change:*** | 1. Introduction of Store and Forward Architectural options.2. Generic principles of Store and Forward Satellite operation. |
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| ***Consequences if not approved:*** | Missing support of Store and Forward feature in 5GSAT\_ARCH\_Ph3 in Rel-19. |
|  |  |
| ***Clauses affected:*** | 3.1, 3.2, (new) 4.13.X, (new) 4.13.X.1 |
|  |  |
|  | **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 ...  |
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| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

FIRST CHANGE

# 3 Definitions and abbreviations

## 3.1 Definitions

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

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

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

**PDN Connection:** The association between a 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 Satellite operation:** An operation mode that provides to the UE a communication service when the serving satellite has a discontinuous connection to the ground network and such connection is not available when the satellite is interacting with the UE.

**S&F Mode:** The mode in which the UE, RAN and core network entities perform Store and Forward Satellite operation.

SECOND CHANGE

## 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&F Store and Forward

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

THIRD CHANGE

## 4.13 Introduction of satellite support for Cellular IoT

### 4.13.x Support of Store and Forward Satellite Operation

#### 4.13.x.1 General

The Store and Forward Satellite Operation applies in E-UTRAN with satellite access and provides communication service for UEs when a satellite serving a UE does not have a simultaneous service link connection to the UE and feeder link connection to the ground network via an NTN gateway. The Store and Forward Satellite operation is suitable for delay-tolerant communication services (e.g. CIoT/MTC, SMS, etc). If the satellite does not support Store and Forward operation and there is no feeder link connection to the ground network, then the satellite cannot provide any service to any UEs. When both the service link and feeder link are available, all services can be provided. To support Store and Forward Satellite operation, some network functionality needs to be deployed on the satellite payload.

Example deployments are described in Annex X.



Figure 4.13.x.1-1: Store and Forward (S&F) Satellite operation

In Store and Forward Satellite operation, the end-to-end exchange of signalling/data traffic is handled as a combination of two or more steps that are not concurrent in time, as depicted in Fig. 4.13.x.1.1. From the UE’s point of view, in the first step, signalling/data exchange between the UE and a satellite occurs without the satellite needing to be simultaneously connected to the ground network via a feeder link. The satellite moves from being connected to the UE in the first step (e.g., location L1 in Fig. 4.13.x.1.1) to being connected to the ground network in the second step (e.g., location L2 in Fig. 4.13.x.1.1). In the second step, the connectivity between the satellite and the ground network is established so that communication between the satellite and the ground network can take place and the end-to-end exchange can be completed. Downlink data can be stored onto the same or a different satellite and provided to the UE later using the first step, and the process is repeated.

When a satellite supports Store and Forward operation and is operating in S&F Mode, the onboard eNodeB broadcasts an indication of operating in S&F Mode as described in TS 36.300 [5] which the UE uses to determine the current operation mode of the satellite. If a satellite is operating in S&F Mode, and if a UE supporting Store and Forward operation and intends to use it, then the UE include the S&F capability during Attach and Tracking Area Update.

NOTE 1: Some deployments cannot support all system features, for example cannot support user plane establishment and user plane data transfer, when operating in S&F Mode in the split MME case.

If the network does not support S&F Satellite operation and the feeder link is not available then RAN switches off and does not broadcast any signal

The MME may adapt periodic update timer and Implicit Detach timer to the fact that the Ue is served in S&F mode

When an MME is operating in S&F Mode:

* If the MME cannot complete a NAS procedure with the information currently available on the satellite e.g. when the MME does not have UE security context or, if the MME needs to retrieve UE-specific authentication vectors or subscription information from the ground network, it shall reject the NAS procedure. In this case, if the UE supports Store and Forward operation, the MME shall include a S&F reject cause.
* If a UE supports Store and Forward operation, the MME may also provide to the UE a S&F Wait Timer, or a S&F Monitoring List, or both, when accepting or rejected a NAS procedure. The S&F Monitoring List is a list of satellites for the same PLMN with which the UE can attempt to retry the NAS procedure, in the future.

The S&F Monitoring List sent to UE during a NAS procedure can be updated by an MME when the UE performs a NAS procedure in the future.

NOTE 3: How the MME determines the S&F Monitoring List and S&F Wait Timer is up to MME implementation, e.g. based on feeder link (un)availability period, service link (un)availability period, UE power saving requirements, , Communication Pattern parameters, UE location, UE mobility etc.

When the S&F Wait Timer expires, the UE may perform a NAS procedure, which can be a subsequent NAS procedure or a reattempt of a NAS procedure rejected with a S&F reject cause.

If the S&F Monitoring List was provided:

* the UE may reattempt a NAS procedure rejected with a S&F reject cause preferably towards any of the satellites in the S&F Monitoring List if it was provided during rejection;
* the UE may perform any subsequent NAS procedure with any of the satellites in the S&F Monitoring List if it was provided during a previous NAS procedure;

If the UE did not include the S&F capability in NAS signalling, even if the MME supports S&F Mode, the MME shall not indicate a S&F reject cause, or provide a S&F Monitoring List or S&F Wait Timer to the UE.

When the MME in S&F Mode performs authentication request towards an HSS, it may indicate a timestamp and S&F flag to the HSS. The timestamp is when the on-board of satellite MME part received the initial NAS request. When the HSS receives the timestamp, if the timestamp information is older than the current location record for the UE, then the HSS shall reject the authentication request. If the HSS does not support the timestamp, the HSS shall reject the authentication request. If the timestamp information is newer than the current location record, the HSS shall provide the authentication response. The MME may trigger an Update location procedure with the HSS along with the authentication procedure to fetch subscription information from the HSS. The MME may indicate the timestamp information to HSS during the Location update procedure. This timestamp information shall be used by the HSS to ensure that newer location for that UE are not cancelled. If MME makes an Update Location Request before the completion of the authentication procedure, it shall include an indication that this Location Update is provisional, i.e. the HSS shall not consider the UE as registered until it receives the final Update Location Request (without indication that the Location Update is provisional). The timestamp information is the time when the on-board of satellite MME part has received the NAS procedure from the UE.The HSS shall reject the Location Update, if the timestamp is older than the current Location update for the UE.

NOTE 7: The timestamp information is used by the HSS to ensure that interactions with MMEs for a UE are handled in the correct order.

EPS may expose whether a UE is in S&F Mode, and provide to the SCS/AS related timing information to guide the SCS/AS decision when to try to contact the UE. This is further described in clause 5.6.3.x of TS 23.682 [74].

End of CHANGEs