**3GPP TSG-SA2 Meeting #164 *S2-2409403***

**Maastricht, Netherlands, 19th Aug 2024 - 23rd Aug 2024 *(was S2-2409108)***

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
|  |
|  | **23.401** | **CR** | **3801** | **rev** | **3** | **Current version:** | **18.6.0** |  |
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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:***  | Introduction of Store and Forward feature in EPC |
|  |  |
| ***Source to WG:*** | Nokia, Novamint, NEC, Tencent, Sateliot, CATT, Intel, Vivo |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | 5GSAT\_Ph3\_ARCH |  | ***Date:*** | 2024-08-09 |
|  |  |  |  |  |
| ***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)* |
|  |  |
| ***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 ...  |
|  |  |
| ***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 providing communication service to a UE in periods of time and/or geographical areas in which a serving satellite is not simultaneously connected to the ground network.

**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

The Store and Forward Satellite operation in an E-UTRAN system with satellite access provides communication service for UEs in periods of time and/or geographical areas in which the satellite serving a UEdoes not have a simultaneous service link connection and feeder link connection. The Store and Forward Satellite operation is suitable for delay-tolerant communication services (e.g. CIoT/MTC, SMS, etc).

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. In the first step, signalling/data exchange between the UE and the satellite occurs without the satellite being simultaneously connected to the UE via the service link and ground network via the feeder link. The satellite moves from being connected to the UE in the first step to being connected to the ground network in the second step. 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.

When the service link of a satellite is operated in S&F mode, the onboard eNB broadcasts an indication of operating in S&F mode as described in TS 36.300 [5]. A UE determines when an eNodeB is operating in S&F mode of operation, as described in TS 36.300 [5]. The UE supporting S&F mode shall include the S&F capability during initial network access to the network.

NOTE 1: From system perspective 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 UE needs to register in S&F mode to access S&F-based services from E-UTRAN satellite access running in S&F mode. This network attachment and access to S&F-based services may use one or more satellites, depending on the deployment and implementation options.

Editor’s Note: Whether operating in S&F mode should be handled as a “registration mode” or as an operational condition of a UE is FFS.

In the S&F mode, the MME shall reject the NAS procedure defined in TS 24.301[46], if this cannot be completed with the information currently available in the satellite e.g. the MME does not have UE security context or, if integrity check fails, and/or if the MME fails to retrieve UE-specific authentication vectors or subscription information. In the related NAS procedure as defined in TS 24.301[46], MME supporting S&F shall include a S&F reject cause code. The MME may also include a S&F wait timer and a list of satellites (i.e. S&F Monitoring list) from the same (UE selected) PLMN with which UE can attempt to retry the related NAS procedure as defined in TS 24.301[46], in the future.

NOTE 2: The UE can select a different PLMN to get services after getting rejection cause code due to S&F.

NOTE 3: How the MME determines the S&F Monitoring List and S&F wait timer is up to MME implementation and how the UE treats the MME provided the S&F Monitoring List and S&F wait timer is up to UE implementation.

Editor’s Note: It is FFS whether the S&F wait timer can be the same as the Unavailability Period Duration.

Upon or after expiry of the S&F wait timer, the UE may reattempt the related NAS procedure as defined in TS 24.301[46], towards any of the satellites among the list of satellites in the S&F Monitoring List provided during rejection. If during the reattempt of related NAS procedure as defined in TS 24.301[46], the MME has the UE context, authentication vectors and subscription data, the MME accepts the request and may indicate the estimated UL delivery time to UE. Additionally, the MME may include: a S&F wait timer, to indicate to the UE the time. UE shall wait before triggering any subsequent NAS procedure with one of the satellite of the same PLMN within S&F Monitoring list from the same (UE selected) PLMN, to indicate to the UE which are the satellites for triggering subsequent NAS procedures.

Editor’s Note: It is FFS whether the S&F monitoring list and S&F wait timer is needed to be sent to UE during Attach, TAU or service accept.

NOTE 4: How the MME determines the estimated UL delivery time is up to MME implementation.

NOTE 5: How UE uses estimated UL delivery time information is left for UE implementation.

If the UE does not include the S&F capability, the MME shall not include in the response message, the S&F rejection cause, any S&F Monitoring List or S&F wait timer to the UE. This rejection cause code can be an existing cause code other than S&F reject cause code.

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 records for that UE are not cancelled.. The MME may trigger an Update location with the HSS along with an authentication procedure to fetch subscription information. 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. The timestamp information is the time when the MME has received the NAS procedure from the UE.

Editor’s Note: It is FFS whether the Authentication request can be used to inform the above timestamp information to HSS.

NOTE 6: 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.

Some example deployments are described in Annex X.

End of CHANGEs