**SA WG2 Meeting #164S2-2408801**

**Maastricht, Netherlands, August 19 – 23, 2024 *(was S2-2408679)***

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
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|  | **23.401** | **CR** | **3815** | **rev** | **1** | **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 | **X** | ME | **X** | Radio Access Network | **X** | Core Network | **X** |

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| ***Title:***  | Support of Store and Forward Satellite Operation |
|  |  |
| ***Source to WG:*** | Qualcomm Incorporated |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | 5GSAT\_Ph3\_ARCH |  | ***Date:*** | 2024-08-19 |
|  |  |  |  |  |
| ***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-12 (Release 12)Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
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| ***Reason for change:*** | There was a study in SA2 on integration of satellite components in the 5G architecture Phase 3 which included a KI (KI#2) on support of store and forward satellite operation. The conclusions for this KI in clause 8.2 of TR 23.700-29 support use of a split MME architecture with HSS on the ground and a full CN (EPC) onboard a satellite. A WI on integration of satellite components in the 5G architecture Phase III was agreed at SA#104 in SP-240628 “to produce normative specifications fulfilling the results of the feasibility study as documented in the conclusions section of TR 23.700-29 v 1.0.0 for each of the three key issues investigated”. |
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| ***Summary of change:*** | Add support for the conclusions of TR 23.700-29 and objectives of the WI in SP-240628 related to store and forward satellite operation. Add an informative description in an Annex of the solution using a full CN (EPC) onboard a satellite. |
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| ***Consequences if not approved:*** | Store and forward satellite operation would not be supported according to the conclusions of TR 23.700-29 and objectives of the WI in SP-240628. |
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| ***Clauses affected:*** | Annex Y (new) |
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|  | **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 \* \* \* \*

Annex Y (informative):
Example Models of Store and Forward Satellite operation

Y.1 Model A

Y.2 Model B: Full EPC in each satellite

This clause describes an example of Model B for support of Store and Forward Satellite operation as defined in clause 4.13.x.

Y.2.1 Architecture and Principles of Operation

An example architecture of Model B is shown in Figure Y.2.1-1. Each satellite contains the functionally of an eNB plus a full EPC that can include an MME, SGW, PGW, HSS, E-SMLC, SMSC etc. Each satellite further includes an endpoint proxy function that emulates the behaviour of a real endpoint (e.g. an AF) from the perspective of a UE. There is also store and forward functionality on the ground that may be part of, or connected to, an NTN Gateway and that contains the proxy functionality that emulates the behaviour of a real UE from the perspective of remote endpoints and any ground based serving PLMN.



Figure Y.2.1-1: Example Architecture of Model B

For Model B, the signalling and procedures used between a UE and satellite to support UE access and UE services in S&F operation are the same as used between a UE and serving PLMN for normal satellite access except for the differences described in clause 4.13.x.4. A UE thus sees the onboard eNB and EPC as being equivalent to a serving PLMN for normal operation. Some PLMN services may not be available for S&F operation due to subscription restriction for a UE or lack of support by the onboard eNB and/or EPC.

A UE accesses and attaches to a satellite for Model B as described in clause 4.13.x.4. The onboard EPC may obtain the UE location and verify that the UE is allowed to access the PLMN that was selected by the UE. The UE can then, if supported by the onboard EPC, establish PDN connections to the onboard EPC and utilise them for the services that are supported in S&F operation.

Depending on what is supported by the onboard eNB and EPC, the UE can perform mobile originated (MO) transactions such as sending SMS, and sending data (e.g. using IP or non-IP protocols) using User Plane or Control Plane CIoT EPS optimisation . Each MO transaction is transferred by the onboard EPC to the onboard endpoint proxy which stores transaction data and signalling (e.g. SMS, data,) and associated protocol and remote endpoint data. The onboard endpoint proxy also returns responses to the UE at a transport and application level that are necessary to allow correct transport and application protocol operation, avoid timeouts and enable a user (if participating) to be aware of the one way communication status.

Shortly before satellite coverage will be lost, the onboard EPC can detach the UE. If there is a radio link failure before this, the satellite and UE both perform a local detach following existing procedures. If the UE can access a new satellite before coverage is lost, a satellite could transfer UE status including data for ongoing transactions to the new satellite using ISL and the UE may then perform a handover.

After the UE loses coverage and when the satellite obtains a feeder link to a ground based portion of the serving PLMN selected by the UE for the Attach, the satellite (or the onboard endpoint proxy) transfers data for the UE (e.g. the IMSI and last known UE location) and all of the stored data and signalling for the UE MO transactions to an S&F function for the serving PLMN. The S&F function contains a proxy that stores the data and signalling for the UE MO transactions and then forwards the data and signalling for each MO transaction to the associated remote endpoint. The proxy can also receive and store data and signalling for mobile terminated (MT) transactions that may be returned by the remote endpoints to the UE.

The S&F function and proxy simulate continuous reachability of the real UE and may remain permanently in a CM Connected state. The MT transaction data and signalling received and stored by the proxy are transferred to one or more satellites that are expected to, and allowed to (e.g. according to an S&F monitoring list sent earlier to the real UE), later provide coverage to the UE. When the UE accesses such a satellite, the endpoint proxy in the satellite can retrieve address information for the corresponding UE (e.g. PDN address/UE IP address, TLTRI) if the S&F function or second PLMN connects to remote endpoints via N6/SGi or N33/T8 interface and transfer the MT transaction data to the UE along with supporting any new MO transactions from the UE based on the received address information.

Y.2.2 Support of MO and MT Transactions

An MO or MT transaction for Model B can correspond to:

- Transfer of an SMS message (e.g. using NAS or IMS).

- Transfer of data to or from a remote endpoint using Control Plane CIoT EPS optimisation or User Plane.

Y.2.3 Transition between S&F and Normal Operation

When a satellite supporting normal operation loses access to a feeder link, the satellite would cease support for normal operation and may switch to S&F operation.

When a satellite supporting S&F operation obtains a feeder link, the satellite may cease support for S&F operation and switch back to normal operation. UEs in S&F operation can be detached prior to cessation of S&F operation as described in clause Y.2.1.

A UE that switches between S&F and normal operation may experience problems in interacting with remote endpoints as data and voice sent in normal operation could arrive (at the UE or at a remote endpoint) before data and voice sent earlier for S&F operation. MT data sent to a UE that was previously attached for normal operation will also be buffered in a serving PLMN, while the UE is in a coverage gap for normal operation, which could lead to an opposite effect where MT data sent later to the UE when in S&F operation arrives first. In addition, a new Attach by a UE in normal operation would normally pre-empt and release a pre-existing Attach by the UE for S&F operation or the reverse. This is not a problem when a UE transitions from normal operation to S&F operation as the Attach for normal operation is then no longer needed. But for a transition from S&F operation back to normal operation, the Attach for normal operation could be released if the S&F function instigates an Attach for S&F operation after the Attach for normal operation has occurred. Alternatively, the Attach for S&F operation could be released if the Attach for S&F operation occurs before the Attach for normal operation has occurred, which might prevent ongoing MO and MT transactions for S&F operation from being completed.

To overcome this limitation to only certain times of sending and receiving and assist with UE power saving the UE keeps the S&F monitoring list that is provided as defined in clause 4.13.x.

\* \* \* \* End of changes \* \* \* \*