**3GPP TSG-SA3 Meeting #115 *S3-240990***

**Athens, Greece, 26th February - 1st March 2024**

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| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
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|  | **33.501** | **CR** | **1970** | **rev** | **-** | **Current version:** | **18.4.0** |  |
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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 |  |

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| ***Title:***  | SCPAC: Updates to Security for Selective SCG Activation |
|  |  |
| ***Source to WG:*** | Samsung, Ericsson, Huawei, HiSilicon, Apple, Nokia, Nokia Shanghai Bell, Intel |
| ***Source to TSG:*** | S3 |
|  |  |
| ***Work item code:*** | TEI18 |  | ***Date:*** | 2024-02-19 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *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-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
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| ***Reason for change:*** | Based on the LS from RAN2 (c.f., R2-2213337), SA3 identified the key stream re-use issue if the same SN Counter is used for Subsequent Conditional PSCell Addition or Change. This CR details the security precedure, to prevent the key-stream reuse when the UE switches back and forth to the same PSCell or SN.  |
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| ***Summary of change:*** | Detailed the security mechanism and procedures for subsequent CPAC (SCPAC), where the MN assigns a sequence of distinct SN Counter values per candidate SN during the SCPAC procedure, to prevent the key-stream reuse. |
|  |  |
| ***Consequences if not approved:*** | No support for the subsequent CPAC (SCPAC) security procedure |
|  |  |
| ***Clauses affected:*** | 3.2, 6.10.2.X(new), 6.10.2.X.1(new), 6.10.2.X.2 (new), 6.10.X.3 (new), 6.10.2.X.4 (new), Annex A.16 |
|  |  |
|  | **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 \* \* \* \*

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

5GC 5G Core Network

5G-AN 5G Access Network

5G-RG 5G Residential Gateway

NG-RAN 5G Radio Access Network

5G AV 5G Authentication Vector

5G HE AV 5G Home Environment Authentication Vector

5G NSWO 5G Non-Seamless WLAN Offload

5G SE AV 5G Serving Environment Authentication Vector

ABBAAnti-Bidding down Between Architectures

AEAD Authenticated Encryption with Associated Data

AES Advanced Encryption Standard

AKA Authentication and Key Agreement

AMF Access and Mobility Management Function

AMF Authentication Management Field

NOTE: If necessary, the full word is spelled out to disambiguate the abbreviation.

ARPF Authentication credential Repository and Processing Function

AUN3 Authenticable Non-3GPP devices

AUSF Authentication Server Function

AUTN AUthentication TokeN

AV Authentication Vector

AV' transformed Authentication Vector

BAP Backhaul Adaptation Protocol

BH Backhaul

CCA Client Credentials Assertion

Cell-ID Cell Identity as used in TS 38.331 [22]

CH Credentials Holder

CHO Conditional Handover

CIoT Cellular Internet of Things

cIPX consumer's IPX

CKSRVCC Cipher Key for Single Radio Voice Continuity

cNRF consumer's NRF

CP Control Plane

CPAC Conditional PSCell Addition or Change

cPLMN consumer's PLMN

cSEPP consumer's SEPP

CTR Counter (mode)

CU Central Unit

DCS Default Credentials Server

DN Data Network

DNN Data Network Name

DU Distributed Unit

EAP Extensible Authentication Protocol

EDT Early Data Transmission

EMSK Extended Master Session Key

EN-DC E-UTRA-NR Dual Connectivity

ENSI External Network Slice Information

EPS Evolved Packet System

FN-RG Fixed Network RG

gNB NR Node B

GUTI Globally Unique Temporary UE Identity

HRES Hash RESponse

HXRES Hash eXpected RESponse

IAB Integrated Access and Backhaul

IKE Internet Key Exchange

IKSRVCC Integrity Key for Single Radio Voice Continuity

IPUPS Inter-PLMN UP Security

IPX IP exchange service

KSI Key Set Identifier

KSISRVCC Key Set Identifier for Single Radio Voice Continuity

LI Lawful Intercept

MBSF Multicast/Broadcast Service Function

MBSSF Multicast/Broadcast Service Security Function

MBSTF Multicast/Broadcast Service Transport Function

MeNB Master eNB

MN Master Node

MO-EDT Mobile Originated Early Data Transmission

MT-EDT Mobile Terminated Early Data Transmission

MR-DC Multi-Radio Dual Connectivity

MSK Master Session Key

N3IWF Non-3GPP access InterWorking Function

NAI Network Access Identifier

NAS Non Access Stratum

NDS Network Domain Security

NEA Encryption Algorithm for 5G

NF Network Function

NG Next Generation

ng-eNB Next Generation Evolved Node-B

ngKSI Key Set Identifier in 5G

N5CW Non-5G-Capable over WLAN

N5GC Non-5G-Capable

NIA Integrity Algorithm for 5G

NR New Radio

NR-DC NR-NR Dual Connectivity

NSSAI Network Slice Selection Assistance Information

NSSAA Network Slice Specific Authentication and Authorization

NSWO Non-Seamless WLAN Offload

NSWOF Non-Seamless WLAN Offload Function

PDN Packet Data Network

PEI Permanent Equipment Identifier

pIPX producer's IPX

pNRF producer's NRF

pPLMN producer's PLMN

PRINS PRotocol for N32 INterconnect Security

pSEPP producer's SEPP

PUR Preconfigured Uplink Resource

QoS Quality of Service

RES RESponse

SCG Secondary Cell Group

SEAF SEcurity Anchor Function

SCP Service Communication Proxy

NOTE: Void. Security Gateway

SEPP Security Edge Protection Proxy

SCPAC Subsequent Conditional PSCell Addition or Change

SgNB Secondary gNB

SIDF Subscription Identifier De-concealing Function

SMC Security Mode Command

SMF Session Management Function

SN Secondary Node

SN Id Serving Network Identifier

SUCI Subscription Concealed Identifier

SUPI Subscription Permanent Identifier

TLS Transport Layer Security

TNAN Trusted Non-3GPP Access Network

TNAP Trusted Non-3GPP Access Point

TNGF Trusted Non-3GPP Gateway Function

TWAP Trusted WLAN Access Point

TWIF Trusted WLAN Interworking Function

TSC Time Sensitive Communication

UE User Equipment

UEA UMTS Encryption Algorithm

UDM Unified Data Management

UDR Unified Data Repository

UIA UMTS Integrity Algorithm

ULR Update Location Request

UP User Plane

UPF User Plane Function

URLLC Ultra Reliable Low Latency Communication

USIM Universal Subscriber Identity Module

XRES eXpected RESponse

\* \* \* \* Next change \* \* \* \*

### 6.10.2.X Security mechanism and procedures for SCPAC

### 6.10.2.X.1 General

In subsequent CPAC (SCPAC), the MN may provide one or several candidate SCG configuration(s) for one or multiple candidate SN(s) to the UE. The UE may select and execute precisely one of these conditional reconfigurations to change PSCell based on the measurement results on candidate target PSCells. The conditional reconfiguration for the selected PScell remains valid after the UE selects the target and executes the target cell access procedure. Thus, the UE can connect to the same SN several times without any further reconfiguration by the network.

### 6.10.2.X.2 Security context initialization for selective SCPAC

To prevent key-stream reuse when the UE switches back and forth to the same PSCell or SN, the MN shall assign a sequence of distinct SN Counter values (maintained for dual connectivity detailed in clause 6.10.3.1 of this document) per candidate SN during the SCPAC procedure. The same SN Counter as used for DC shall be used to generate the values also for SCPAC and the MN shall ensure that no generated SN Counter value will accidentally be used to derive a KSN more than once. Each SN Counter value is unique, and the sequences (i.e. sequences of SN Counter values of candidate SNs) are non-overlapping. These sequences shall be provided to the UE by the MN. The UE shall store these sequences.

The MN shall derive the KSN keys corresponding to the SN Counter values from the KNG-RAN of the UE as described in Annex A.16. The MN shall send the KSN keys associated with the SN together with their corresponding SN Counter values to that SN in the SN Addition Request. The SN shall store the received KSN keys and the SN Counter values of the UE. The MN shall maintain the largest assigned SN Counter value and monotonically increment it either for the next KSN calculation for DC as described in clause 6.10.3.1 of this document or for further assignment for the SCPAC detailed in this clause.

When a new AS root key, KNG-RAN, in the associated 5G AS security context of the UE is established, and the SN Counter is set to '0' as specified in clause 6.10.3.1, the MN derives a new sequence of distinct SN Counter values per candidate SN and sends these to the UE in the same RRC Reconfiguration as the one that activates the new KNG-RAN. The UE shall delete the stored SN Counter value sequences and store the received new SN Counter values. Further, the MN derives the corresponding KSN for each target SN, and the derived KSN keys and the corresponding SN Counter values are sent to the SN from the MN. Each SN shall delete the stored KSNs and corresponding SN Counter values and store the received new KSNs and the corresponding SN Counter values.

### 6.10.2.X.3 Security mechanism for UE to access target PSCell or SN

A UE can access a SN, disconnect to it and then access it again. Regardless of whether the UE has accessed the SN earlier, the UE shall select the first unused SN Counter value in the sequence of SN Counter values (i.e. sequence per SN) associated with the SN. Because all counter values are distinct, selecting the first unused one ensures that it is not previously used with the current KgNB. The UE shall then derive the corresponding KSN using the SN Counter value as described in Annex A.16 of this document and shall initiate the access procedure.

In parallel, UE shall inform the SN Counter value utilized for KSN derivation in the RRC Connection Reconfiguration Complete to the MN. The MN, in turn, shall relay the corresponding SN Counter value to the SN in the SN Reconfiguration Complete message.

The protected UP messages may reach the SN before the SN has received the SN counter value in the SN Reconfiguration Complete message. In this scenario, the SN chooses the first unused KSN key of the UE to establish the security association with the UE.

The UE and the SN shall derive the user plane encryption key and user plane integrity protection key, when configured, from the KSN for protecting their communications. The SN, upon receiving the SN counter value from the UE via the MN, shall check whether the corresponding SN Counter value of the chosen KSN is the same as the received SN Counter value to determine the KSN mismatch. In case of KSN mismatch, after receiving the SN counter in the SN Reconfiguration Complete message, the SN, having stored the KSN keys and the corresponding SN counter values, selects the appropriate KSN based on the received SN Counter values for subsequent data access under the same reconfiguration.

6.10.2.X.4 Security procedure for UE to access target PSCell or SN

The SCPAC procedure in dual connectivity procedure with activation of encryption/decryption and/or integrity protection follows the steps outlined in Figure 6.10.2.X.x-1.



 **Figure 6.10.2.X.4-1: Security procedures for SCPAC**

1. The UE and the MN establishes the RRC connection.

2a-b. The MN sends SN Addition/Modification Request to each candidate target SN over the Xn-C to negotiate the available resources, configuration, and algorithms at each candidate target SN. The MN assigns a sequence of distinct SN Counter values per candidate target SN during the SCPAC procedure. The MN derives the KSN keys corresponding to the sequence of SN Counter values from the KNG-RAN of the UE. The MN delivers the sequence of SN Counter values and corresponding KSN keys of the UE to the respective candidate target SN. The UE security capabilities (see clause 6.10.2.1) and the UP security policy received from the SMF shall also be sent to SN. In case of PDU split, UP integrity protection and/or ciphering activation decision from MN may be also included as described in clause 6.10.2.1.

3. The candidate target SNs store the received sequence of SN Counter values and corresponding KSN keys of the UE and allocates the necessary resources and chooses the ciphering algorithm and integrity algorithm which has the highest priority from its configured list and is also present in the UE security capability as described in clause 6.10.2.1.

4. The respective target SN sends SN Addition/Modification Acknowledge to the MN indicating availability of requested resources and the identifiers for the selected algorithm(s) for the requested DRBs for the UE. The UP integrity protection and encryption indications shall be send to the MN.

5. The MN sends the RRC Reconfiguration Request to the UE, instructing it to configure the new DRBs for the selected target SNs.

The MN also includes all candidate SCG configuration(s) for one or multiple candidate SN(s) in the same RRC Reconfiguration Request message as the one that activates the new KNG-RAN to the UE.

NOTE x: Since the RRC Reconfiguration Request message is sent over the RRC connection between the MN and the UE, it is integrity-protected. Hence, the candidate SCG configuration(s) for one or multiple candidate SN(s) cannot be tampered with.

6. The UE accepts the RRC Reconfiguration Request after validating its integrity using the KRRCint of the MN.

7. When the UE selects a target SN, the UE shall choose the first unused SN Counter value in the SN Counter values sequence in the SCG configuration for the selected candidate target SN and compute the KSN. The UE shall also compute the needed UP keys and activate the UP protection per the indications received for the associated DRBs.

8. The UE sends the RRC Reconfiguration Complete to the MN, including the SN Counter value used in the derivation of the KSN.

9. The MN shall send the SN Reconfiguration Complete, including the SN Counter value received in step 8, to the target SN over the Xn-C to inform the target SN of the configuration result.

10. The SN shall activate encryption/decryption and integrity protection/verification with the UE upon receiving the SN Reconfiguration Complete message or the Random Access request from the UE.

If the SN activates the UP protection upon receiving the SN Reconfiguration Complete message, then the SN chooses the KSN key of the UE corresponding to the SN Counter value received in SN Reconfiguration Complete message and activates the UP protection after computing the needed UP keys.

11. In case the SN activates the UP protection upon receiving the Random Access request from the UE, then the target SN shall select the first unused KSN key of the UE in the sequence and computing the needed UP keys. Further, upon receiving the SN Reconfiguration Complete message, the SN shall determine the KSN mismatch as described in the clause 6.10.2.X.3. In case of KSN mismatch, the target SN chooses the KSN key of the UE corresponding to the SN Counter value received in SN Reconfiguration Complete message and activates the UP protection after computing the needed UP keys. The SN shall delete the configured KSN and corresponding SN counter value only after determining that there is no KSN key mismatch. The SN shall terminate the connection with the UE if the SN does not receive the SN Reconfiguration Complete message.

\* \* \* \* Next change \* \* \* \*

# A.16 Derivation of KSN

This input string is used when the MN and UE derive KSN. The following input parameters shall be used:

- FC =0x79,

- P0 = Value of the SN Counter as a non-negative integer,

- L0 = length of the SN Counter value (i.e. 0x00 0x02).

The input key KEY shall be KeNB when the MN is an ng-eNB and KgNB when the MN is a gNB.

NOTE: The same input string is used for both DC and SCPAC. Therefore, it is crucial that the SN Counter value input is never reused within or across DC and SCPAC.

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