**3GPP TSG-SA3 Meeting #104-e *S3-212506-r1***

**e-meeting, 16 - 27 August 2021**

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| **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 |  | Radio Access Network |  | Core Network | **X** |

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| ***Title:***  | Rel16 Align KAUSF handling for 5G AKA and EAP-AKA'  |
|  |  |
| ***Source to WG:*** | Ericsson |
| ***Source to TSG:*** | S3 |
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| ***Work item code:*** | TEI16 |  | ***Date:*** | 2021-08-09 |
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| ***Category:*** | **F** |  | ***Release:*** | Rel-16 |
|  | *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:*** | Step 10 in Clause 6.1.3.2, which described the authentication procedure for 5G AKA, includes a mandatory storage statement for KAUSF. However there is no corresponding statement in clause 6.1.3.1, which describes the authentication procedure for EAP-AKA'. Moreover in clause 6.1.1.1 which describes the handling of the keys on the AUSF, there is the following statement...*The anchor key KSEAF is derived from an intermediate key called the KAUSF. The KAUSF is established between the UE**and HN resulting from the primary authentication procedure. The KAUSF may be securely stored in the AUSF based on the home operator's policy on using such key e.g. if the control plane solution for Steering of Roaming (see clause 6.14) or UE Parameter Update procedures (see clause 6.15) or AKMA are supported by the HPLMN.*As a result the statements in 6.1.3.2 and 6.1.1.1 are contradictory, the statement in 6.1.3.2 states a mandatory storage requirement while the statement in 6.1.1.1 an optional storage requirement based on the support other features.An alignment is needed for these statements to refer to clause 6.1.1.1 which clearly specify the KAUSF storage behaviour.  |
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| ***Summary of change:*** | In the EAP-AKA' clause 6.1.3.1 a non-normative statement is added to refer to clause 6.1.1.1.In the 5G AKA clause 6.1.3.2, the normative mandatory statement is replaced with a non-normative statement to refer to clause 6.1.1.1. |
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| ***Consequences if not approved:*** | Unclear specification |
|  |  |
| ***Clauses affected:*** | 6.1.3.1, 6.1.3.2.0 |
|  |  |
|  | **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:*** |  |

\*\*\* 1st CHANGE \*\*\*

#### 6.1.3.1 Authentication procedure for EAP-AKA'

EAP-AKA' is specified in RFC 5448 [12]. The 3GPP 5G profile for EAP-AKA' is specified in the normative Annex F.

The selection of using EAP-AKA' is described in sub-clause 6.1.2 of the present document.



Figure 6.1.3.1-1: Authentication procedure for EAP-AKA'

The authentication procedure for EAP-AKA' works as follows, cf. also Figure 6.1.3.1-1:

1. The UDM/ARPF shall first generate an authentication vector with Authentication Management Field (AMF) separation bit = 1 as defined in TS 33.102 [9]. The UDM/ARPF shall then compute CK' and IK' as per the normative Annex A and replace CK and IK by CK' and IK'.

2. The UDM shall subsequently send this transformed authentication vector AV' (RAND, AUTN, XRES, CK', IK') to the AUSF from which it received the Nudm\_UEAuthentication\_Get Request together with an indication that the AV' is to be used for EAP-AKA' using a Nudm\_UEAuthentication\_Get Response message.

NOTE: The exchange of a Nudm\_UEAuthentication\_Get Request message and an Nudm\_UEAuthentication\_Get Response message between the AUSF and the UDM/ARPF described in the preceding paragraph is the same as for trusted access using EAP-AKA' described in TS 33.402 [11], sub-clause 6.2, step 10, except for the input parameter to the key derivation, which is the value of <network name>. The "network name" is a concept from RFC 5448 [12]; it is carried in the AT\_KDF\_INPUT attribute in EAP-AKA'. The value of <network name> parameter is not defined in RFC 5448 [12], but rather in 3GPP specifications. For EPS, it is defined as " access network identity " in TS 24.302 [71], and for 5G, it is defined as "serving network name" in sub-clause 6.1.1.4 of the present document.

In case SUCI was included in the Nudm\_UEAuthentication\_Get Request, UDM will include the SUPI in the Nudm\_UEAuthentication\_Get Response.

The AUSF and the UE shall then proceed as described in RFC 5448 [12] until the AUSF is ready to send the EAP-Success.

3. The AUSF shall send the EAP-Request/AKA'-Challenge message to the SEAF in a Nausf\_UEAuthentication\_Authenticate Response message.

4. The SEAF shall transparently forward the EAP-Request/AKA'-Challenge message to the UE in a NAS message Authentication Request message. The ME shall forward the RAND and AUTN received in EAP-Request/AKA'-Challenge message to the USIM. This message shall include the ngKSI and ABBA parameter. In fact, SEAF shall include the ngKSI and ABBA parameter in all EAP-Authentication request message. ngKSI will be used by the UE and AMF to identify the partial native security context that is created if the authentication is successful. The SEAF shall set the ABBA parameter as defined in Annex A.7.1. During an EAP authentication, the value of the ngKSI and the ABBA parameter sent by the SEAF to the UE shall not be changed.

NOTE 1: The SEAF needs to understand that the authentication method used is an EAP method by evaluating the type of authentication method based on the Nausf\_UEAuthentication\_Authenticate Response message.

5. At receipt of the RAND and AUTN, the USIM shall verify the freshness of the AV' by checking whether AUTN can be accepted as described in TS 33.102 [9]. If so, the USIM computes a response RES. The USIM shall return RES, CK, IK to the ME. If the USIM computes a Kc (i.e. GPRS Kc) from CK and IK using conversion function c3 as described in TS 33.102 [9], and sends it to the ME, then the ME shall ignore such GPRS Kc and not store the GPRS Kc on USIM or in ME. The ME shall derive CK' and IK' according to Annex A.3.

 If the verification of the AUTN fails on the USIM, then the USIM and ME shall proceed as described in sub-clause 6.1.3. 3.

6. The UE shall send the EAP-Response/AKA'-Challenge message to the SEAF in a NAS message Auth-Resp message.

7. The SEAF shall transparently forward the EAP-Response/AKA'-Challenge message to the AUSF in Nausf\_UEAuthentication\_Authenticate Request message.

8. The AUSF shall verify the message by comparing XRES and RES, and if the AUSF has successfully verified this message it shall continue as follows, otherwise it shall return an error to the SEAF. AUSF shall inform UDM about the authentication result (see sub-clause 6.1.4 of the present document for details on linking authentication confirmation).

9. The AUSF and the UE may exchange EAP-Request/AKA'-Notification and EAP-Response /AKA'-Notification messages via the SEAF. The SEAF shall transparently forward these messages.

NOTE 2: EAP Notifications as described in RFC 3748 [27] and EAP-AKA Notifications as described in RFC 4187 [21] can be used at any time in the EAP-AKA exchange. These notifications can be used e.g. for protected result indications or when the EAP server detects an error in the received EAP-AKA response.

10. The AUSF derives EMSK from CK’ and IK’ as described in RFC 5448[12] and Annex F. The AUSF uses the most significant 256 bits of EMSK as the KAUSF and then calculates KSEAF from KAUSF as described in clause A.6. The AUSF shall send an EAP Success message to the SEAF inside Nausf\_UEAuthentication\_Authenticate Response, which shall forward it transparently to the UE. Nausf\_UEAuthentication\_Authenticate Response message contains the KSEAF. If the AUSF received a SUCI from the SEAF when the authentication was initiated (see sub-clause 6.1.2 of the present document), then the AUSF shall also include the SUPI in the Nausf\_UEAuthentication\_Authenticate Response message. The AUSF optionally stores the KAUSF according to clause 6.1.1.1.

NOTE 3: For lawful interception, the AUSF sending SUPI to SEAF is necessary but not sufficient. By including the SUPI as input parameter to the key derivation of KAMF from KSEAF, additional assurance on the correctness of SUPI is achieved by the serving network from both, home network and UE side.

11. The SEAF shall send the EAP Success message to the UE in the N1 message. This message shall also include the ngKSI and the ABBA parameter. The SEAF shall set the ABBA parameter as defined in Annex A.7.1.

NOTE 4: Step 11 could be NAS Security Mode Command or Authentication Result.

NOTE 5: The ABBA parameter is included to enable the bidding down protection of security features that may be introduced later.

The key received in the Nausf\_UEAuthentication\_Authenticate Response message shall become the anchor key, KSEAF in the sense of the key hierarchy in sub-clause 6.2 of the present document. The SEAF shall then derive the KAMF from the KSEAF, the ABBA parameter and the SUPI according to Annex A.7 and send it to the AMF. On receiving the EAP-Success message, the UE derives EMSK from CK’ and IK’ as described in RFC 5448 and Annex F. The ME uses the most significant 256 bits of the EMSK as the KAUSF and then calculates KSEAF in the same way as the AUSF. The UE shall derive the KAMF from the KSEAF, the ABBA parameter and the SUPI according to Annex A.7.

NOTE 6: As an implementation option, the UE creates the temporary security context as described in step 11 after receiving the EAP message that allows EMSK to be calculated. The UE turns this temporary security context into a partial security context when it receives the EAP Success. The UE removes the temporary security context if the EAP authentication fails.

The further steps taken by the AUSF upon receiving a successfully verified EAP-Response/AKA'-Challenge message are described in sub-clause 6.1.4 of the present document.

If the EAP-Response/AKA'-Challenge message is not successfully verified, the subsequent AUSF behaviour is determined according to the home network's policy.

If AUSF and SEAF determine that the authentication was successful, then the SEAF provides the ngKSI and the KAMF to the AMF.

\*\*\* 2nd CHANGE \*\*\*

#### 6.1.3.2 Authentication procedure for 5G AKA

##### 6.1.3.2.0 5G AKA

5G AKA enhances EPS AKA [10] by providing the home network with proof of successful authentication of the UE from the visited network. The proof is sent by the visited network in an Authentication Confirmation message.

The selection of using 5G AKA is described in sub-clause 6.1.2 of the present document.

NOTE 1: 5G AKA does not support requesting multiple 5G AVs, neither the SEAF pre-fetching 5G AVs from the home network for future use.



Figure 6.1.3.2-1: Authentication procedure for 5G AKA

The authentication procedure for 5G AKA works as follows, cf. also Figure 6.1.3.2-1:

1. For each Nudm\_Authenticate\_Get Request, the UDM/ARPF shall create a 5G HE AV. The UDM/ARPF does this by generating an AV with the Authentication Management Field (AMF) separation bit set to "1" as defined in TS 33.102 [9]. The UDM/ARPF shall then derive KAUSF (as per Annex A.2) and calculate XRES\* (as per Annex A.4). Finally, the UDM/ARPF shall create a 5G HE AV from RAND, AUTN, XRES\*, and KAUSF.

2. The UDM shall then return the 5G HE AV to the AUSF together with an indication that the 5G HE AV is to be used for 5G AKA in a Nudm\_UEAuthentication\_Get Response. In case SUCI was included in the Nudm\_UEAuthentication\_Get Request, UDM will include the SUPI in the Nudm\_UEAuthentication\_Get Response after deconcealment of SUCI by SIDF.

3. The AUSF shall store the XRES\* temporarily together with the received SUCI or SUPI.

4. The AUSF shall then generate the 5G AV from the 5G HE AV received from the UDM/ARPF by computing the HXRES\* from XRES\* (according to Annex A.5) and KSEAF from KAUSF(according to Annex A.6), and replacing the XRES\* with the HXRES\* and KAUSF with KSEAF in the 5G HE AV.

5. The AUSF shall then remove the KSEAF and return the 5G SE AV (RAND, AUTN, HXRES\*) to the SEAF in a Nausf\_UEAuthentication\_Authenticate Response.

6. The SEAF shall send RAND, AUTN to the UE in a NAS message Authentication Request. This message shall also include the ngKSI that will be used by the UE and AMF to identify the KAMF and the partial native security context that is created if the authentication is successful. This message shall also include the ABBA parameter. The SEAF shall set the ABBA parameter as defined in Annex A.7.1. The ME shall forward the RAND and AUTN received in NAS message Authentication Request to the USIM.

NOTE 2: The ABBA parameter is included to enable the bidding down protection of security features.

7. At receipt of the RAND and AUTN, the USIM shall verify the freshness of the received values by checking whether AUTN can be accepted as described in TS 33.102[9]. If so, the USIM computes a response RES. The USIM shall return RES, CK, IK to the ME. If the USIM computes a Kc (i.e. GPRS Kc) from CK and IK using conversion function c3 as described in TS 33.102 [9], and sends it to the ME, then the ME shall ignore such GPRS Kc and not store the GPRS Kc on USIM or in ME. The ME then shall compute RES\* from RES according to Annex A.4. The ME shall calculate KAUSF from CK||IK according to clause A.2. The ME shall calculate KSEAF from KAUSF according to clause A.6. An ME accessing 5G shall check during authentication that the "separation bit" in the AMF field of AUTN is set to 1. The "separation bit" is bit 0 of the AMF field of AUTN.

NOTE 3: This separation bit in the AMF field of AUTN cannot be used anymore for operator specific purposes as described by TS 33.102 [9], Annex F.

8. The UE shall return RES\* to the SEAF in a NAS message Authentication Response.

9. The SEAF shall then compute HRES\* from RES\* according to Annex A.5, and the SEAF shall compare HRES\* and HXRES\*. If they coincide, the SEAF shall consider the authentication successful from the serving network point of view. If not, the SEAF proceed as described in sub-clause 6.1.3.2.2. If the UE is not reached, and the RES\* is never received by the SEAF, the SEAF shall consider authentication as failed, and indicate a failure to the AUSF.

10. The SEAF shall send RES\*, as received from the UE, in a Nausf\_UEAuthentication\_Authenticate Request message to the AUSF.

11. When the AUSF receives as authentication confirmation the Nausf\_UEAuthentication\_Authenticate Request message including a RES\* it may verify whether the 5G AV has expired. If the 5G AV has expired, the AUSF may consider the authentication as unsuccessful from the home network point of view. Upon successful authentication, the AUSF optionally stores the KAUSF according to clause 6.1.1.1.AUSF shall compare the received RES\* with the stored XRES\*. If the RES\* and XRES\* are equal, the AUSF shall consider the authentication as successful from the home network point of view. AUSF shall inform UDM about the authentication result (see sub-clause 6.1.4 of the present document for linking with the authentication confirmation).

NOTE 4: It is left to implementation to temporarily store the KAUSF received in step 2 in AUSF until the RES\* verification is done successfully (i.e., at step 11).

12. The AUSF shall indicate to the SEAF in the Nausf\_UEAuthentication\_Authenticate Response whether the authentication was successful or not from the home network point of view. If the authentication was successful, the KSEAF shall be sent to the SEAF in the Nausf\_UEAuthentication\_Authenticate Response. In case the AUSF received a SUCI from the SEAF in the authentication request (see sub-clause 6.1.2 of the present document), and if the authentication was successful, then the AUSF shall also include the SUPI in the Nausf\_UEAuthentication\_Authenticate Response message.

If the authentication was successful, the key KSEAF received in the Nausf\_UEAuthentication\_Authenticate Response message shall become the anchor key in the sense of the key hierarchy as specified in sub-clause 6.2 of the present document. Then the SEAF shall derive the KAMF from the KSEAF, the ABBA parameter and the SUPI according to Annex A.7. The SEAF shall provide the ngKSI and the KAMF to the AMF.

If a SUCI was used for this authentication, then the SEAF shall only provide ngKSI and KAMF to the AMF after it has received the Nausf\_UEAuthentication\_Authenticate Response message containing KSEAF and SUPI; no communication services will be provided to the UE until the SUPI is known to the serving network.

The further steps taken by the AUSF after the authentication procedure are described in sub-clause 6.1.4 of the present document.

\*\*\* END OF CHANGES \*\*\*