**3GPP TSG-SA3 Meeting #104-e ad-hoc *S3-213308-r1***

**e-meeting, 27 – 30 September 2021** Revision of S3-21xxxx

**Source: InterDigital**

**Title: TR 33.847 solution #10 evaluation**

**Document for: Approval**

**Agenda Item: 5.2**

# 1 Decision/action requested

***It is proposed to approve this pCR for inclusion in TR 33.847.***

# 2 References

# 3 Rationale

The contribution proposes to convert the following ENs in clause 6.10.2.2 (Remote UE using its 5G-GUTI in DCR) to a new NOTE5 documenting the potential additional impacts if support for option 2 (Remote UE context transfer) is considered.

Editor's note: When there is a KAMF (option 2), how to deal with desynchronization of K\_AMF is FFS.

Editor's note: How 5G-GUTI reallocation and Registration Update is performed when Remote UE is transferred to Relay’s AMF (option 2) is FFS.

The contribution also updates the evaluation accordingly.

# 4 Detailed proposal

It is proposed to approve the following changes for inclusion in TR 33.847.

 \*\*\* BEGIN OF CHANGES \*\*\*

#### 6.10.2.2 Connection with UE-to-Network relay using the 5G native security context of the Remote UE

The procedure for Authorization and security with UE-to-Network relay using the 5G native security context of the Remote UE is depicted in Figure 6.10.2.2-1.

Figure 6.10.2.2-1: Procedure for Authorization and security with UE-to-Network relay using 5G native security context of Remote UE

0. The Remote UE has registered with the network and established a 5G native security context with a source AMF. The Relay UE is registered and authorized to operate as a relay.

1. The Remote UE performs a discovery procedure with a Relay UE and decides to connect with the Relay UE using its 5G native security context.

2. If the Remote UE is aware of the PLMN ID of the Relay UE's serving PLMN, the Remote UE verifies that its 5G native security context was established with the Relay UE's serving PLMN before sending its 5G-GUTI to the Relay UE. If the PLMN ID of the Relay UE's serving PLMN and the PLMN ID part in its 5G-GUTI are different or if the current 5G-GUTI was used in a prior DCR with another Relay, the Remote UE sends its SUCI instead (as described in clause 6.10.2.1, step 1). If the Remote UE is not aware of the PLMN ID of the Relay UE's serving PLMN, the Remote UE may choose to send no identifier (i.e. neither SUCI nor 5G-GUTI). If a 5G-GUTI is sent, the Remote UE sends a DCR message to the Relay UE including Remote UE's core network identity (e.g., 5G-GUTI), ngKSI identifying the KAMF being used, the Remote UE's NAS security capabilities, and current UL NAS COUNT. These parameters may be included in a message integrity protected using Remote UE's 5G native security context.

NOTE 1: Remote UE has the option to use the knowledge of Relay PLMN ID to select a Relay (e.g., select Relay 1 with same PLMN over Relay 2 with different PLMN). This option of PLMN ID based selection of Relay is to be confirmed with SA2.

3. If the request includes a 5G-GUTI, the Relay UE checks whether the PLMN ID of its serving PLMN and in Remote UE's 5G-GUTI are equal. If they are not equal, the Relay UE sends an Identity Request message to the Remote UE including Relay UE's serving PLMN ID, to obtain the Remote UE's identifier (SUCI or 5G-GUTI). If the Remote UE provides a SUCI in the Identity Response, Relay UE proceeds with the procedure as described in clause 6.10.2.1, from step 2. Otherwise, the Relay UE sends the Remote UE's 5G-GUTI and integrity protected message from Remote UE to its serving AMF (target AMF) in a NAS request message.

4. The target AMF checks that Relay UE is authorized to act as a relay.

5. The target AMF identifies the source AMF serving the Remote UE using the provided 5G-GUTI. If the source and target AMFs are different, the target AMF sends a request message to the source AMF to obtain security parameters for the Remote UE. The target AMF includes the integrity protected message from Remote UE and Remote UE's identity received from the Relay UE. The target AMF indicates that the access type and reason for the request are for relay access. If the source and target AMFs are the same (i.e., Remote UE has registered with target AMF), the target AMF retrieves the Remote UE’s context directly from its local storage instead.

6. [option 1] The source AMF locates the Remote UE's security context using the received Remote UE's 5G-GUTI. The source AMF checks the integrity protection of the message from the Remote UE using the Remote UE's security context. If the security checks are successful, the source AMF derives a Krelay and Krelay ID from KAMF identified by the ngKSI. [option 2] Alternatively, the source AMF may generate a new 5G security context. The derivation of the new KAMF is specified in TS 33.501 [14] (Annex A.13). The source AMF sends a response message to the target AMF that includes the Remote UE SUPI. The message may include a Krelay and Krelay ID, a new 5G security context to be used for Remote UE with a KAMF change indication or current Remote UE's 5G security context, and Remote UE's context.

NOTE 2: In the first option, the Remote UE's registration remains with Remote UE's (source) AMF which provides Relay UE's (target) AMF with Krelay and Krelay ID (and SUPI). In the second option, the Remote UE context is transferred to the Relay UE's AMF, with a KAMF change (using the same mechanisms as in TS 33.501[14], clause 6.9.2.3.3). In that case, the target AMF derives Krelay and Krelay ID. Source AMF uses its local policy to determine whether to transfer the Remote UE context and perform horizontal key derivation. If the Remote UE’s 5G security context is moved from the source AMF to the target AMF, then if the Remote UE has simultaneously access to the 3GPP network then this connection with the source AMF (of Remote UE) will be dropped. Following the context transfer, source and target AMF registration update with UDM is handled according to existing AMF change mechanisms (see TS 23.502, clause 4.2.2.2.2).

NOTE 3: Whether Option 2 (with Remote UE context transfer to Relay's AMF) can be used is to be confirmed with SA2.

7. The target AMF checks from Remote UE's context (e.g., obtained from source AMF or locally) or with Remote UE's UDM (e.g., using SUPI provided by source AMF) for authorization to use the Relay UE. If not provided by the source AMF, the target AMF derives a Krelay and Krelay ID using Remote UE's security context.

8. The target AMF sends a NAS response message to the Relay UE that includes the Remote UE id (e.g., GPSI), Krelay and Krelay ID. [Option 2] The message may include a KAMF change flag and new ngKSI if a new security context was generated by source AMF in previous step.

9. The Relay UE sends a Direct Security Mode Command message to the Remote UE that includes Krelay ID and, if provided by the target AMF, KAMF change flag and new ngKSI. The message is integrity protected using security key derived based on Krelay.

10. If the KAMF change flag is set, the Remote UE derives a new KAMF from the KAMF indicated by the value of ngKSI. The Remote UE derives a Krelay and Krelay ID from the existing KAMF or the newly derived KAMF. The Remote UE verifies the DSMC message security using security derived based on Krelay. A successful security verification indicates to the Remote UE that the Relay UE is authorized to provide the relay service for Remote UE. The new KAMF is derived the same way as described for NAS SMC procedure when KAMF change flag is set as described in TS 33.501 [14] clause 6.7.2 step 2a and Annex A.13. If the verification of the DSMC message is unsuccessful, the Remote UE replies with a Direct Security Mode Reject message. In that case, Remote UE discards the new security context if it was derived, continues the use of the existing security context, and the Relay UE aborts the link establishment procedure.

Editor's note: When there is a KAMF change (option 2), how to deal with desynchronization of K\_AMF is FFS.

11. If the security verification is successful, the Remote UE sends a Direct Security Mode Complete message to the Relay UE with security protection (integrity, confidentiality) using security keys derived based on Krelay. The Relay UE verifies the Direct Security Mode Complete message security using security derived based on Krelay. A successful security verification indicates to the Relay UE that the Remote UE is authorized to use the relay service provided by Relay UE.

12. [Option 2] If a new KAMF derivation was indicated (in step 9), the Relay UE sends a NAS complete message to inform the AMF of the key establishment result. If the Relay indicates a successful KAMF derivation then AMF registers with Remote UE's UDM causing UDM to deregister source AMF and removal or Remote UE context (as per TS 23.502, clause 4.2.2.2.2). If the KAMF derivation fails (e.g., verification of DSMC fails) then the PC5 link setup is aborted and the Remote UE discards the new security context if it was derived and continues the use the existing security context.

13. The Remote UE receives a DCA message completing the successful PC5 link establishment.

NOTE 4: The purpose of 5G GUTI reallocation is to preserve the privacy of the subscription temporary identifier. In the above procedure using first option (i.e., Remote UE context remains with source AMF), the Remote UE transmits its 5G-GUTI only once (in the DCR). In that case, 5G-GUTI re-allocation by source AMF over Uu is performed as per TS 33.501 [14], clause 6.12.3. If the Remote UE has already a prior connection with the Relay it can send the Krelay ID (see 6.10.2.1 step 1) instead of 5G-GUTI. An attacker cannot track the Remote UE using the 5G-GUTI during communication with the Relay UE. Therefore, 5G-GUTI re-assignment is not necessary for this procedure for these scenarios. For 5G-GUTI reallocation when option 2 is used, the Remote UE triggering a connection via a Relay using DCR is considered to be similar to the case of "Service Request message triggered from the UE not triggered by the network" in TS 33.501 [14] clause 6.12.3. In that case, it is left to implementation (i.e., not required) to re-assign a 5G-GUTI. For Registration Update (option 2), the Remote UE is considered to be in a "connected" state and Relay UE's AMF is aware of Remote UE whereabouts as long as a PC5 link between the Remote UE and the Relay UE is up. Therefore, it is not necessary for the Remote UE to perform either mobility or periodic Registration Update procedures for the Relay UE's AMF to keep track of the Remote UE.

Editor's note: How 5G-GUTI reallocation and Registration Update is performed when Remote UE is transferred to Relay’s AMF (option 2) is FFS.

 \*\*\* NEXT CHANGE \*\*\*

### 6.10.3 Evaluation

The solution fulfils requirements of KI#3 (secure means to establish a PC5 link) using keys from the primary authentication to derive PC5 related keys. This solution can be combined with a solution using N3IWF (e.g., sol#19) to fulfil the second requirement of KI#3 (end to end security).

NOTE 1: The third requirement of KI#3 (i.e., security for path switch) is not considered within Rel-17 timeframe in line with TR 23.752 [2] conclusion ( clause 8.6).

The solution fulfils the requirements of KI#4 (authorization of Remote UE/ UE-to-Network relay) using a network-controlled authorization procedure based on primary authentication of Remote UE (building on TR 23.752 [2] sol#47 principles).The solution fulfils the requirements of KI#9 (PC5 key management for relay communication) by supporting derivation /distribution of PC5 related keys based on keys from the primary authentication, using existing 5GC entities (AMF, AUSF).

The solution fulfils the requirements of KI#12 (Security of one-to-one communication over PC5) including support of the Remote UE out of coverage scenario by reusing PC5 link communication security procedure as defined in TS 33.536 [8]. Specifically, the solution fulfils the second (link setup protection against MiTM), third (signalling protection) and fourth requirement (user plane protection).

When Remote UE uses its 5G-GUTI in DCR and considering option 1 (no Remote UE context transfer), the solution fulfils the requirements of KI#5 (privacy protection of Remote UE) by reusing existing privacy protection mechanisms for identifiers transmitted by Remote UE (e.g., SUCI, 5G-GUTI, KNRP ID).

When Remote UE uses its 5G-GUTI in DCR and considering option 2 (with Remote UE context transfer), the support for 5G-GUTI reallocation, Registration Update and handling of desynchronization of K\_AMF are not covered in the current specification.

Option 1 is the selected option for when Remote UE wishes to use its 5G-GUTI in DCR.

This solution requires a new relayed primary authentication procedure (aka "network controlled authorization" based on TR 23.752 [2] sol#47) to enable Remote UE to perform primary authentication with the AUSF of Remote UE via the AMF of Relay UE and Relay UE which both need to support a corresponding new NAS procedure.

In this solution, the UE-to-Network relay 's AMF, is responsible for PC5 link root key Krelay and its Krelay ID derivation from KAMF, as the Remote UE. The AMF stores Remote UE information (Remote UE id, PC5 link root key) in the Relay UE context. The Relay UE uses the PC5 root key and associated id to establish the security of the PC5 link with the Remote UE.

Other impact on 5GC and existing procedure is documented in TR 23.752 [2] sol#47, clause 6.47.3. In addition and as an optimization to skip primary authentication, the Remote UE may optionally provide its 5G-GUTI when connecting for relayed communication authorization.

This solution assumes that NAS confidentiality is activated for the relay. In this solution, the PC5 link root key Krelay is sent over the air interface to the Relay UE. It requires that the NAS message carrying Krelay is both integrity and confidentiality protected. Otherwise, there is the risk that the root key Krelay is exposed in clear text if confidentiality protection of the NAS signaling is not activated. Therefore, the use of NAS signaling encryption needs to be properly configured for key provisioning.

NOTE: In general, NAS confidentiality is assumed to be required for any L3 relay scenario, as sensitive information/parameters may be exposed during provisioning by PCF or PDU Session management procedures.

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