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**Source: Samsung, KPN N.V., Interdigital**

**Title: KI#1, Update Sol #2: Resolve ENs and Address QoS Handling Enhancements**

**Document for: Approval**

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**Work Item / Release: FS\_5G\_ProSe\_Ph3/Rel-19**

*Abstract of the contribution: This contribution proposes solution updates to KI#1 Sol#2 by resolving ENs and detailing QoS handling for Multi-hop U2N relays.*

# Discussion

In clause 5.1 of TR 23.700-03, the key issue description of KI#1 Support of multi-hop UE-to-Network Relays include:

*- Whether and how to support the authorization of multi-hop UE-to-Network Relay and Remote UE authorization and policy and parameter provisioning.*

*- Whether and how to support the multi-hop UE-to-Network Relay discovery.*

*- Whether and how to perform multi-hop UE-to-Network Relay (re-)selection.*

*- Whether and how to enhance the existing mechanisms for IP address/prefix allocation to support Layer-3 multi-hop UE-to-Network Relay.*

*- Whether and how to control the maximum number of hops supported when using multi-hop Layer-3 UE-to-Network relays.*

*- How to manage multi-hop PC5 links, at least including how to establish, modify and release Layer-2 link over PC5 reference point for multi-hop UE-to-Network Relays.*

*- Whether and how to support end-to-end QoS requirements between Remote UE and the network via multi-hop Layer-3 UE-to-Network Relay.*

This contribution proposes solution updates to KI#1 Sol#2 by resolving ENs and detailing QoS handling for Multi-hop U2N relays.

# Proposal

It is proposed to adopt the following changes into TR 23.700-03.

**\*\*\* Start of the change \*\*\***

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 23.752: "Study on system enhancement for Proximity based Services (ProSe) in the 5G System (5GS)".

[3] 3GPP TR 23.700‑33: "Study on system enhancement for Proximity based Services (ProSe) in the 5G System (5GS); Phase 2".

[4] 3GPP TS 23.304: "Proximity based Services (ProSe) in the 5G System (5GS)".

[5] 3GPP TS 22.278: "Service requirements for the Evolved Packet System (EPS); Stage 1".

[6] 3GPP TS 22.261: "Service requirements for next generation new services and markets; Stage 1".

[7] 3GPP TS 22.115: "Service aspects; Charging and billing; Stage 1".

[8] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[y] 3GPP TS 23.502: "Procedures for the 5G System (5GS); Stage 2".

[z] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

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

3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1], TS 23.304 [4] 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] and TS 23.304 [4].

**5G ProSe Intermediate Relay:** A 5G ProSe-enabled UE that provides functionality to support connectivity to the network for 5G ProSe Remote UE(s) by using the PC5 reference point with other 5G ProSe-enabled UEs, The 5G ProSe Intermediate Relay is located on the path between 5G ProSe Remote UE and 5G ProSe UE-to-Network Relay.

NOTE: This term is defined for use during the study phase, so whether to define this term for normative work will be decided when concluding the study. There is no restriction that such 5G ProSe Intermediate Relay entity/function must be used for solutions.

Editor's note: The definition of 5G ProSe Intermediate Relay may need to be further revised if this term is deemed necessary according to solution discussion. Whether and how to define intermediate relay for multi-hop UE-to-UE relay is FFS.

**5G ProSe Indirect Relay Discovery:** A procedure employed by a 5G ProSe-enabled UE to discover other 5G ProSe-enabled UEs in its vicinity based on in-direct radio transmissions through 5G ProSe Intermediate Relay UE(s) with NR technology.

**5G ProSe Indirect Relay Communication:** A communication between two or more UEs in proximity that are 5G ProSe-enabled, by means of user plane transmission using NR technology through 5G ProSe Intermediate Relay UE(s) via a path not traversing any network node.

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

## 6.2 Solution #2: Multi-hop 5G ProSe UE-to-Network Relay Discovery and Layer-3 Communication

### 6.2.1 Description

This solution provides a mechanism for enabling multi-hop 5G ProSe UE-to-Network Relay, where the Remote UE is connected to the UE-to-Network Relay via one or more 5G ProSe Intermediate Relay(s). It is assumed that the 5G ProSe UE-to-Network Relay, the Remote UE and the 5G ProSe Intermediate Relay(s) receive appropriate authorization and configuration to perform multi-hop 5G ProSe UE-to-Network Relay. In particular, the maximum number of hops is assumed to be a configurable parameter which can be set by the operator during the ProSe policy/parameter provisioning procedure for the 5G ProSe-enabled UEs supporting multi-hop Relay. The ProSe policy/parameter also includes an indication that multi-hop relay is supported for a RSC.

The solution addresses the following aspects:

- **5G ProSe UE-to-Network Relay Discovery:** To perform discovery, the Discovery message sent by the 5G ProSe UE-to-Network Relay in Model A or the Remote UE in Model B is propagated by the Intermediate Relays until the maximum number of hops is reached. The number of hops for each path is tracked by including a counter in the discovery message, which is updated by each 5G ProSe Intermediate Relay before forwarding. The discovery message is dropped if the maximum number of hops is reached. To avoid loops in the multi-hop paths, each 5G ProSe intermediate Relay includes its own User Info ID when relaying the discovery message. The 5G ProSe Intermediate Relay does not transmit a discovery message that already includes its own User Info ID.

 As the Remote UE may receive a response from the same UE-to-Network Relay via different intermediate relays and paths, the Remote UE should select both the UE-to-Network Relay and the path to reach it including the set of Intermediate Relays. The Remote UE may select the UE-to-Network Relay and path based on parameters such as the number of hops, the end-to-end QoS, or additional information on the 5G ProSe Intermediate Relay(s) or links. To assist the Remote UE with UE-to-Network Relay and path selection, each Intermediate Relay also includes additional information on the relay and link.

- **5G ProSe multi-hop UE-to-Network Relay discovery with Model A:**

- The UE-to-Network Relay decides the maximum number of hops for discovery based on (pre-)configuration. E.g., according to some mapping to the RSC.

- The 5G ProSe UE-to-Network Relay sends a UE-to-Network Relay Discovery Announcement message. The Announcement message contains the User Info ID of itself, maximum number of hops or TTL, RSC. The intermediate Relay may include its own User Info ID and forward an Announcement message when its own User Info ID is not included in the message.

- The 5G ProSe intermediate Relay initiates Model A discovery only when it has found a UE-to-Network Relay, which has a connection to the network.

**- 5G ProSe multi-hop UE-to-Network Relay discovery with Model B:**

- The Remote UE decides the maximum number of hops for discovery based on QoS requirement and (pre-)configuration. E.g., according to some mapping to the service or RSC.

- The Remote UE sends a 5G ProSe UE-to-Network Relay Discovery Solicitation message containing the maximum number of hops for discovery.

- The UE-to-Network Relay responds to Remote UE via Intermediate Relay(s) with a Response message, including the User Info IDs of intermediate Relays in the path and UE-to-Network Relay. The UE-to-Network Relay may choose the paths based on e.g., the PC5 signal strength of each message received, the number of hops to the Remote UE.

- **5G ProSe Communication via multi-hop Layer-3 UE-to-Network Relay with and without N3IWF support:** Once the 5G ProSe UE-to-Network Relay and the multi-hop path have been selected by the Remote UE, the Remote UE sends a multi-hop Communication Request to the 5G ProSe UE-to-Network Relay, which includes information about the selected path (i.e. an ordered list of User Info IDs of intermediate 5G ProSe Intermediate Relay(s)) and optionally a path ID that can be used to reference the path in further communications. The multi-hop Communication Accept message optionally includes the path ID. Then, the complete UE-to-Network multi-hop path is established, and 5G ProSe Direct Communication is established between the 5G ProSe-enabled UEs for each hop.

**- 5G ProSe Multi-hop Layer-3 UE-to-Network Relay Communication with N3IWF support:**

* The 5G ProSe Layer-e Remote UE connects to N3IWF over 5G ProSe Layer-3 Intermediate Relay and Layer-3 UE-to-Network Relay.
* The 5G ProSe Layer-3 Intermediate Relay neither selects N3IWF nor connects to N3IWF.

#### 6.2.1.X. Enhancements to QoS handling

The following principles apply for QoS handling for Layer-3 Multi-hop 5G ProSe UE-to-Network Relay:

* The Intermediate Relay at each hop can determine the per-hop QoS or cumulative QoS.(e.g. cumulative delay and/or hop-count), and QoS information may be attached in the multi-hop Communication Request / Link Modification Request to the next Intermediate Relay or UE-to-Network Relay at the next hop.
* The UE-to-NW Relay may consider the requested PC5 QoS info from the Remote UE and cumulative QoS info (e.g., cumulative delay) from Intermediate Relays when determine the PC5 QoS parameters for the PC5 QoS flow corresponding to the QoS flows of relaying PDU session for Remote UE.
* When receiving the multi-hop Communication Accept / Link Modification Accept message from the UE-to-Network Relay or another Intermediate Relay, each Intermediate Relay calculates the per hop QoS with the Remote UE or the Intermediate Relay at the next hop based on E2E QoS and the received calculated per-hop QoS(s) of Intermediate Relays at the earlier hops.

For a 5G ProSe Layer-3 Remote UE accessing the network via one 5G ProSe UE-to-Network Relay and one or more 5G ProSe Intermediate Relay(s), the end-to-end QoS requirements of the relay traffic between 5G ProSe Remote UE and UPF can be satisfied by the corresponding QoS control of the following legs in Figure 6.2.1.x-1:

* PC5 QoS control for the PC5 link 1 between 5G ProSe Remote UE and 5G ProSe Intermediate Relay 1;
* PC5 QoS control for the PC5 link (2,..., n): the PC5 link(s) between 5G ProSe Intermediate Relays, if applicable; and the PC5 link between a ProSe Intermediate Relay and UE-to-Network Relay;
* QoS control for PDU session established between 5G ProSe UE-to-Network Relay and UPF (e.g. Uu QoS control).



Figure 6.2.1.x-1 Example scenario of multi-hop UE-to-Network Relay

For the single-hop UE-to-Network relay scenarios, as specified in TS 23.304 [4], the PC5 QoS can be controlled by PC5 QoS rules and PC5 QoS parameters (e.g. PQI, GFBR, MFBR, PC5 LINK-AMBR), and the QoS of the PDU session established between the 5G ProSe UE-to-Network Relay and UPF (i.e. Uu QoS control) is controlled with QoS rules and 5G QoS parameters (e.g. 5QI, GFBR, MFBR) as specified in clause 5.7 of TS 23.501 [8]. For the multi-hop UE-to-Network relay scenarios as shown in Figure 6.x.1-1, the end-to-end QoS can be met only when the QoS requirements are properly translated and satisfied over the multiple legs.

To control and maintain the end-to-end QoS, the QoS mapping mechanism for single-hop relay scenarios can be still applied in the multiple-hop UE-to-Network scenarios. The QoS mapping might be pre-configured or provided to the 5G ProSe Layer-3 UE-to-Network Relay and Intermediate Relay(s) by the PCF using multi-hop Prose Policy. The QoS mapping may include the combinations of the 5QIs and PQIs mapping as entries. The PQI(s) can be have standardized values as defined in Table 5.6.1-1 of TS 23.304 [4] and in Table 5.4.4-1 of TS 23.287 [z], or new values. The 5QI are standardized values as defined in TS 23.501 [8] clause 5.7.4.

The QoS mapping may also include adjustment factor(s) for the PQI's PDB. Compared to the single-hop UE-to-Network relay, for the multi-hop UE-to-Network relay scenarios, the bigger number of PC5 hops may increase the overall end-to-end delay between the remote UE and UPF. Therefore, the PDB of a PQI might be varied with the numbers of hops, e.g. the scenario with larger number of PC5 hops may be associated with a higher PDB. The adjustment factor(s) associated to a PQI or PDB might be configured as an overall number for all of the PC5 links, e.g. ¾ of the standardised PDB value over all of the PC5 links in Figure 6.x.1-1, then the UE-to-Network Relay determines the adjustment factors of each PC5 link, e.g. based on the number of hops, the air interface quality and capability of different relays, etc.

NOTE: The Prose Policy for multi-hop UE-to-Network Relays is addressed by other solutions for KI#1.

In the current framework of UE-to-Network relay communication, the QoS flow setup and modification can be initiated either by the Remote UE and the UE-to-Network Relay. Similar mechanism with enhancements are possible to be applied to the multi-hop UE-to-Network relay scenarios.

**QoS Flows setup are initiated by network**

The SMF can base on the PCC rules or its local configuration to generate the QoS rules and QoS Flow level QoS parameters (e.g. 5QI, GFBR, MFBR) and signal them to the 5G ProSe UE-to-Network Relay using PDU Session Establishment/Modification procedure, similar to the single-hop UE-to-Network relay case.

Then the 5G ProSe UE-to-Network Relay may decide the PC5 QoS parameters for the corresponding PC5 QoS Flow by determining the PQI based the QoS mapping. In the multi-hop UE-to-Network relay scenarios, for the GBR QoS flow, the values of the GFBR and MFBR of the PC5 GBR QoS Flow over every PC5 link might be configured the same as those for the GBR QoS Flow. Then the 5G ProSe UE-to-Network Relay will indicate the determined PQI and any other QoS related parameters to the ProSe Intermediate Relay. If the ProSe Intermediate Relay accepts the PC5 QoS configuration, it will indicate to the parameters to the next ProSe Intermediate Relay. The QoS parameters will be transferred successively until the last ProSe Intermediate Relay that connects to the Remote UE is reached.

**PC5 QoS flows setup or modification is initiated by the 5G ProSe Layer-3 Remote UE**



Figure 6.X.2.3-1: QoS control for Layer 3 UE-to-Network Relay operation

If the 5G ProSe Layer-3 Remote UE initiates PC5 QoS Flows setup or modification during the Layer-2 link establishment or modification procedure,

1. The 5G ProSe Layer-3 Remote UE provides the QoS Info to the first Intermediate Relay.

2-3. The Intermediate Relay(s) decide the PC5 QoS hop by hop. i.e., the Intermediate Relay splits the QoS parameters, according to the received QoS Info, into two parts: one part is the QoS parameters of the previous hop, the other part is the QoS parameters from the Intermediate Relay to network (the rest PC5 QoS parameters). The Intermediate Relay(s) send the rest QoS parameters to the next hop.

4. The U2N Relay decides the Uu QoS and the PC5 QoS with the previous hop, and sends the accepted PC5 QoS with the previous hop in a DCA message.

5-6. For each Intermediate Relay, if the previously received “the rest PC5 QoS parameters” can be satisfied according to the accepted PC5 QoS in the received DCA message, Intermediate Relay sends the accepted PC5 QoS with the previous hop in a DCA message.

The Remote UE may initiate the PC5 QoS Flows setup or modification during the Layer-2 link establishment or modification procedure. In this case, the 5G ProSe Remote UE provides the QoS Info to the 5G ProSe UE-to-Network Relay, via the intermediate relay(s). The PC5 QoS parameters of the QoS Info (i.e. PQI and conditionally other parameters such as MFBR/GFBR, etc.) are interpreted as the end-to-end QoS requirements by the 5G ProSe Layer-3 UE-to-Network Relay for the traffic transmission between 5G ProSe Layer-3 Remote UE and UPF.

If the end-to-end QoS requirements can be supported by an entry of QoS mapping, the 5G ProSe Layer-3 UE-to-Network Relay uses the 5QI of the entry for the Uu QoS control and uses the PQI of the entry for the PC5 QoS control. Same PQI might be applied to all the PC5 links in the multi-hop UE-to-Network relay scenario. The determined PQI will be transferred from the UE-to-Network Relay successively to the remote UE via successive intermediate relay(s) to. If any of the intermediate relay cannot accept the PQI, it sends the reject message to the Layer-3 UE-to-Network Relay, e.g. via intermediate relay(s) if applicable.

If the end-to-end QoS requirements cannot be supported by any entries of QoS mapping, the 5G ProSe Layer-3 UE-to-Network Relay, based on its implementation, decides the 5QI for the Uu QoS control and PQI for the PC5 QoS control of all the PC5 hops in the multi-hop relay scenario. The 5G ProSe Layer-3 UE-to-Network Relay provides the QoS Info (including PQI value chosen by the 5G ProSe Layer-3 UE-to-Network Relay) as part of the Accept message to the Intermediate relay connects to it. If the 1st Intermediate relay accepts the QoS Info, it will provide QoS Info to the successive Intermediate relay until the QoS info reaches the Remote UE.

The 5G ProSe Layer-3 UE-to-Network Relay performs the UE requested PDU session Modification as defined in TS 23.502 [y], clause 4.3.3 for authorizing the requested QoS including the 5QI and the Packet Filters. If the PCF authorizes the requested QoS with a different 5QI value, the 5G ProSe Layer-3 UE-to-Network Relay may further update the PQI value based on the authorized 5QI value to the intermediate relay(s) and Remote UE, e.g. by performing Layer-2 link modification procedure to update the corresponding PC5 QoS Flow with the updated PQI value.

### 6.2.2 Procedures

#### 6.2.2.1 5G ProSe multi-hop UE-to-Network Relay Discovery

##### 6.2.2.1.1 5G ProSe multi-hop UE-to-Network Relay Discovery with Model A

Figure 6.2.2.1.1-1 illustrates the procedure for 5G ProSe multi-hop UE-to-Network Discovery with Model A.



Figure 6.2.2.1.1-1: 5G ProSe multi-hop UE-to-Network Relay Discovery with Model A

1. The 5G ProSe UE-to-Network Relay sends a UE-to-Network Relay Discovery Announcement message. Additional to the parameters described in clause 6.3.2.3.2 of TS 23.304 [4], the UE-to-Network Relay Discovery Announcement message includes an indication that multi-hop relay is supported for a RSC, and an initialized multi-hop counter.

 The Announcement message contains the User Info ID of itself, maximum number of hops or TTL, RSC.

 The Source Layer-2 ID is self-assigned by the UE-to-Network Relay, and the Destination Layer-2 ID is set to a Default Destination Layer-2 ID.

The UE-to-Network relay may send an additional Aggregation indication per RSC. Optionally, the Aggregation level per RSC is also included.

2. The 5G ProSe Intermediate Relays with (pre)configured RSC(s) matching the RSC in the Relay Discovery Announcement message propagate the Announcement message while updating the multi-hop counter until the maximum number of hops is reached, in which case the message is dropped. Additional information related to the intermediate relays and links of the path from which the Announcement message transits is added at each hop to facilitate path selection by the Remote UE and avoid loops, for example, per-hop QoS information or cumulative QoS information (e.g., cumulative delay between Remote UE up to the Intermediate Relay) may be added. The information can also be used to limit the number of propagated Announcement messages based on criteria such as the end-to-end QoS. When one 5G ProSe Intermediate Relay receives multiple Announcement messages that include same RSC and same Announcer Info of 5G ProSe UE-to-Network Relay, one 5G ProSe Intermediate Relay determines to keep the Announcement message with minimum value fo the multi-hop counter, and drop any other Announcement messages or the Intermediate Relay may decide not to forward the Announcement message if the received multi-hop counter is larger than the previous received smallest one..

 The Source Layer-2 ID is self-assigned by the Intermediate Relay, and the Destination Layer-2 ID is set to a Default Destination Layer-2 ID.

The 5G ProSe Remote UEs monitor the announcement messages corresponding to the desired services, and select the 5G ProSe UE-to-Network Relay and multi-hop path based on the information received.

##### 6.2.2.1.2 5G ProSe multi-hop UE-to-Network Relay Discovery with Model B

Figure 6.2.2.1.2-1 illustrates the procedure for 5G ProSe multi-hop UE-to-Network Discovery with Model B.



Figure 6.2.2.1.2-1: 5G ProSe multi-hop UE-to-Network Relay Discovery with Model B

1. The 5G ProSe Remote UE sends a 5G ProSe UE-to-Network Relay Discovery Solicitation message which includes, additional to the parameters described in clause 6.3.2.3.3 of TS 23.304 [4], an indication that multi-hop relay is supported for a RSC, and an initialized multi-hop number counter (e.g. determined according to QoS requirement or (pre-)configuration).

 The Source Layer-2 ID is self-assigned by the Remote UE, and the Destination Layer-2 ID is set to a Default Destination Layer-2 ID.

2. The Solicitation message is propagated by the 5G ProSe Intermediate Relay(s) with (pre)configured RSC(s) matching the RSC in the message while updating the multi-hop counter until the maximum number of hops is reached, in which case the message is dropped. To avoid loops and allow the routing of the Discovery Response, each Intermediate Relay includes its User Info ID in the message.

 The 5G ProSe UE-to-Network Discovery Solicitation message contains the Type of Discovery Message, Discoverer Info, the maximum number of hops or TTL and optionally Target Info. The Target Info may contain the User Info of UE-to-Network Relay and Intermediate Relay(s). The maximum number of hops can be a constant value or a variable similar to TTL which will be decreased by 1 per hop.

 The Source Layer-2 ID is self-assigned by the Intermediate Relay, and the Destination Layer-2 ID is set to a Default Destination Layer-2 ID.

3. If the information contained in the Solicitation message matches the 5G ProSe UE-to-Network Relay configuration, the 5G ProSe UE-to-Network Relay(s) that receives the Solicitation message send a Response which is relayed back to the Remote UE by the Intermediate Relays. Additional information related to the Intermediate Relays and links of the path from which the Response message transits is added at each hop to facilitate path selection by the Remote UE, for example, per-hop QoS information or cumulative QoS information (e.g., cumulative delay between Remote UE up to the Intermediate Relay). The information can also be used to limit the number of propagated Response messages based on criteria such as the end-to-end QoS.

The Source Layer-2 ID is self-assigned by the UE-to-Network Relay, and the Destination Layer-2 ID is set to the unicast Source Layer-2 ID of the received Relay Discovery Solicitation message from the Intermediate Relay.

If the number of User Info IDs of intermediate Relays included in the message has reached the maximum number of hops (or the TTL is 0), the Relay should drop the message. If the Target Info included in the received Solicitation does not contain the User Info ID of itself, the Relay may drop the message.

A 5G ProSe intermediate Relay sends a Solicitation message, it additionally includes its own User Info ID in the message. i.e., the message contains the User Info IDs of all intermediate Relays in the path.

The UE-to-Network send Discovery response with additional Aggregation indication per RSC. Optionally, the Aggregation level per RSC is also included.

4. If one or more discovery responses are received, the 5G ProSe Remote UE selects the 5G ProSe UE-to-Network Relay and multi-hop path to reach it based on the information received. For example, the UE-to-Network Relay may choose the path based on e.g., the PC5 signal strength of each message received, hops to the Remote UE, the User Info IDs of intermediate Relays in the path, etc.

 The Response message additionally contains the User Info IDs of intermediate Relays in the path.

 The Source Layer-2 ID is self-assigned by the Intermediate Relay, and the Destination Layer-2 ID is set to the unicast Source Layer-2 ID of the received Relay Discovery Solicitation message from the Remote UE.

#### 6.2.2.2 5G ProSe Communication via multi-hop Layer-3 UE-to-Network Relay

##### 6.2.2.2.1 5G ProSe Communication via multi-hop Layer-3 UE-to-Network Relay without N3IWF support

Figure 6.2.2.2.1-1 depicts the procedure for 5G ProSe Communication via multi-hop Layer-3 UE-to-Network Relay without N3IWF support.



Figure 6.2.2.2.1-1: 5G ProSe Communication via multi-hop 5G ProSe Layer-3 UE-to-Network Relay without N3IWF

1. Service authorization and parameter provisioning are performed for the 5G ProSe Layer-3 UE-to-Network Relay (step 1a), the 5G ProSe Intermediate Relay(s) (step 1b), and the 5G ProSe Layer-3 Remote UE (step 1c).

2. Similar to step 2 in clause 6.5.1.1 from TS 23.304 [4], the 5G ProSe Layer-3 UE-to-Network Relay may establish a PDU Session for relaying.

3. The 5G ProSe Layer-3 Remote UE performs the (re-)discovery of a 5G ProSe Layer-3 UE-to-Network Relay and multi-hop path as described in clause 6.2.2.1. As part of the discovery procedure the Layer-3 Remote UE learns about the connectivity service the Layer-3 UE-to-Network Relay provides. The Layer-3 Remote UE obtains the User Info ID of Layer-3 UE-to-Network Relay and an ordered list of User Info IDs of Intermediate Relays during the discovery procedure. If no multi-hop path is discovered, the 5G ProSe Communication cannot be established, and the other steps are skipped.

4. Once the 5G ProSe UE-to-Network Relay and the multi-hop path have been selected by the Remote UE, the Remote UE sends a multi-hop Communication Request to the 5G ProSe UE-to-Network Relay, which includes information about the selected path (i.e. ordered list of User Info IDs of 5G ProSe Intermediate Relay(s)), a optionally path ID, and (optional) the requested PC5 QoS information. The path ID may refer to the list of User Info IDs of Intermediate Relay in the DCR message.

Each Intermediate Relay forwards the received multi-hop Communication Request to the next Intermediate Relay or the UE-to-Network Relay based on the selected path information. The Communication Request from the Intermediate Relay may include per-hop QoS information or cumulative QoS information (e.g., cumulative delay between Remote UE up to the Intermediate Relay).

The 5G ProSe UE-to-Network Relay responds with a multi-hop Communication Accept message which includes the optional path ID. The path ID is generated and managed by the Remote UE, and is associated with the UE-to-Network Relay and/or referred to the reversed list of User Info IDs of Intermediate Relay in the DCA message...

It is assumed an Intermediate Relay sends the DCR message to the next Intermediate Relay only if the security association is established with the previous Intermediate Relay.

5. For IP PDU Session Type and IP traffic over PC5 reference point, IPv6 prefix or IPv4 address (including NAT case) may be allocated for the 5G ProSe Layer-3 Remote UE by the UE-to-Network Relay to Intermediate Relay.

- Option1: the UE-to-Network Relay assigns IP address for Remote UE and all the intermediate Relays in the path, e.g. based on the User Info ID list included in the DCR message, assign for each node.

- Option2: the UE-to-Network Relay and Intermediate Relay assigns IP address to the next hop

6. The complete UE-to-Network multi-hop path is established, and 5G ProSe Direct Communication is established between the 5G ProSe-enabled UEs for each hop. If there is no PDU Session associated with the Relay Service Code or a new PDU Session for relaying is needed, the 5G ProSe Layer-3 UE-to-Network Relay may establish a new PDU Session for relaying.

7. Steps 5 to 7 as described in clause 6.5.1.1 of TS 23.304 [4] with the following update:

 - When the UE-to-Network Relay determines the QoS parameters for PC5 QoS flows, it considers the requested PC5 QoS info from the Remote UE and the cumulative delay between UE-to-Network relay and Remote UE via the Intermediate Relays.

 - Each Intermediate Relay determines per hop QoS depending on its position in the path. .

 - After successful connection setup between the Remote UE and the UE-to-Network Relay via Intermediate Relays, the UE-to-Network Relay sends a Remote UE Report including User info of Remote UE and User Info of Intermediate Relays between the Remote UE and the UE-to-Network Relay in the selected path.

The IP address of Remote UE is allocated by the UE-to-Network Relay, and the mechanism defined in clause 5.5.1.3 of TS 23.304 [4] is used and the IPv4 DHCP messages/IPv6 Router messages are routed via the Intermediate Relays.

If the PDU Session for relaying is released by the UE-to-Network Relay or the network as described in clause 4.3.4 of TS 23.502, the UE-to-Network Relay and 5G ProSe Intermediate Relay(s) should initiate the release of the layer-2 links associated with the released PDU Session using the procedure defined in clause 6.4.3.3 of TS 23.304 [4].

The PDU Session(s) used for relaying should be released as described in clause 4.3.4 of TS 23.502 [12] (e.g. by 5G ProSe Layer-3 UE-to-Network Relay), if the service authorization for acting as a 5G ProSe Layer-3 UE-to-Network Relay in the serving PLMN is revoked.

The 5G ProSe Layer-3 UE-to-Network Relay may send the Remote UE Report message when the 5G ProSe Layer-3 Remote UE or any 5G ProSe Intermediate Relay disconnects from the multi-hop 5G ProSe Layer-3 UE-to-Network Relay chain, to inform the SMF that the 5G ProSe Layer-3 Remote UE(s) have left.

When the Remote UE needs to switch to a new Intermediate Relay (e.g. due to link failure), the Remote UE re-selects a new path terminated at the same UE-to-Network Relay, and allocates a new path ID. The new path ID is sent to the UE-to-Network Relay, and the older path is released.

NOTE: The security aspects of multi-hop UE-to-Network path establishment will be addressed by SA WG3.

After 5G ProSe Indirect Relay Discovery, when a 5G ProSe Layer-3 Remote UE is using discovered 5G ProSe Intermediate Relay UE(s) and 5G ProSe Layer-3 UE-to-Network Relay without involving N3IWF, the PCF based provisioning and update of 5G ProSe Policy/parameters to the 5G ProSe Layer-3 Remote UE are not supported

##### 6.2.2.2.2 5G ProSe Communication via multi-hop Layer-3 UE-to-Network Relay with N3IWF support

Intermediate Relay UE can connect to N3IWF according to clause 6.5.1.2 of TS 23.304 [4] and provides the relay function to Remote UE.



Figure 6.2.2.2.2-1: Reference architecture for 5G ProSe Layer-3 UE-to-Network Relay with N3IWF through Intermediate Relay(s)



Figure 6.2.2.2.2-2: Control plane protocol stacks between 5G ProSe Layer-3 Remote UE and N3IWF over 5G ProSe Layer-3 Intermediate Relay and Layer-3 UE-to-Network Relay after the signalling IPSec SA is established



**Figure 6.2.2.2.2-3 User plane protocol stacks between 5G ProSe Layer-3 Remote UE and N3IWF over 5G ProSe Layer-3 Intermediate Relay and Layer-3 UE-to-Network Relay after the signalling IPSec SA is established**

Figure 6.2.2.2.2-4 shows the Connection (re-)establishment over 5G ProSe Layer-3 Intermediate Relay and UE-to-Network Relay with N3IWF support:



Figure 6.2.2.2.2-4: 5G ProSe Communication via multi-hop 5G ProSe Layer-3 UE-to-Network Relay with N3IWF support

1. The 5G ProSe Layer-3 UE-to-Network Relay, the Remote UE and the 5G ProSe Layer-3 Intermediate Relay UE perform service authorization and parameter provisioning.

 Supporting of the RSC configured for making the 5G ProSe Layer-3 Remote UE access to 5GC via N3IWF is preconfigured or provisioned to the Intermediate Relay by the ProSe Policy.

2. The 5G ProSe Layer-3 Remote UE performs the (re-)discovery of a 5G ProSe Layer-3 UE-to-Network Relay and multi-hop path as described in clause 6.2.2.1 using the RSC configured for making the 5G ProSe Layer-3 Remote UE access to 5GC via N3IWF.

3. A 5G ProSe Layer-3 UE-to-Network Relay and 5G ProSe Layer-3 Remote UE follow the procedures described in steps 4-5 in clause 6.2.2.2.1 for communication establishment using the RSC configured for making the 5G ProSe Layer-3 Remote UE access to 5GC via N3IWF.

4. IP address and prefix allocation.

5. The 5G ProSe Layer-3 Remote UE that connects to a 5G ProSe Layer-3 UE-to-Network Relay with N3IWF support selects an N3IWF and determines the N3IWF IP address.

6. The 5G ProSe Layer-3 Remote UE establishes a signalling IPsec tunnel using IKE procedures with a N3IWF via Intermediate Relays and UE-to-Network Relay performs NAS Registration.

7. Based on Additional QoS Information received from the N3IWF, the 5G ProSe Layer-3 Remote UE determines whether it is necessary to request for QoS session modification for the dedicated QoS Flows toward the 5G ProSe Layer-3 UE-to-Network Relay, taking the number of hops into account.

After the procedure, both 5G ProSe Indirect Relay Communication and 5G ProSe Direction Communication between remote UE, Intermediate Relay UE(s) and UE to Network Relay UE are enabled. UE(s) can communicate each other directly or indirectly for the purpose of maintenance like heartbeat, etc.

For N3IWF of 5G ProSe Layer-3 Remote UE case, IKE keep alive(s) between the 5G ProSe Layer-3 Remote UE and the N3IWF are used for detecting possible path failure. The 5G ProSe Layer-3 Remote UE may change 5G ProSe Intermediate Relay UE(s) and 5G ProSe Layer-3 UE-to-Network Relay(s) while maintain the session with the N3IWF when the 5G ProSe Layer-3 Remote UE and the N3IWF support MOBIKE. This is negotiated between the 5G ProSe Layer-3 Remote UE and the N3IWF as specified in TS 23.502 [5], clause 4.12.2.2).

When IKE keep alive(s) are used:

1. 5G ProSe Layer-3 Remote UE needs to keep the PC5 connection with 5G ProSe Intermediate Relay UE(s)
2. 5G ProSe Intermediate Relay UE(s) keep the intermediate PC5 connections between 5G ProSe Layer-3 Remote UE and 5G ProSe Layer-3 UE-to-Network Relay
3. 5G ProSe Layer-3 UE-to-Network Relay keeps the PDU Session.

QoS differentiation can be provided on per-IPsec Child Security Association basis. When accessing 5GS via 5G ProSe Intermediate Relay UE(s) and 5G ProSe Layer-3 UE-to-Network Relay with N3IWF, the 5G ProSe Layer-3 Remote UE can request for PDU Session establishment or handover an existing PDU session to the N3IWF using UE requested PDU Session Establishment procedure defined in TS 23.502 [5] clause 4.12.5.



Figure 6.2.2.2.2-5: End-to-End QoS support via Layer-3 UE-to-Network Relay with N3IWF

Based on Additional QoS Information received from the N3IWF, the 5G ProSe Layer-3 Remote UE and 5G ProSe Intermediate Relay UE(s) can determine whether it is necessary to request for QoS session modification for the dedicated QoS Flows toward the 5G ProSe Layer-3 UE-to-Network Relay.

### 6.2.3 Impacts on services, entities and interfaces

The solution has impacts on the following entities:

- UE:

- Needs to support 5G ProSe Intermediate Relay functionality, as well as the discovery and communication establishment procedures for multi-hop 5G ProSe UE-to-Network Relay for the 5G ProSe Remote UE, 5G ProSe Layer-3 UE-to-Network Relay, and 5G ProSe Intermediate Relay.

**\*\*\* End of the change \*\*\***