**3GPP SA WG2 Meeting #162 *S2-24xxxxx***

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**Source: China Telecom**

**Title: New Solution for Key Issue #2**

**Document for: Approval**

**Agenda Item: 19.7**

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

*Abstract: Providing a solution to address discovery, connection communication and QoS handling for multi-hop UE-to-UE Relay.*

# Introduction/Discussion

This contribution is the revision of unhandled S2-2401923 in SA2#161.

For multi-hop Relay discovery, the multi-hop Relay discovery with Model A may need Relays to periodically broadcast an announcement message containing information about the Remote/End UEs and discovered multi-hop Relays to negotiate a global route, which may lead to more energy consumption for multi-hop Relays and introduce more signaling overhead. In the meantime, unlike a static network, the network consisted of multi-hop ProSe Relays is dynamic and rapidly changing. A route based on periodic signals like Model A may not be suitable for such a network because the route has probably changed when the End/Remote UE initiates the connection establishment. By comparison, multi-hop Relay discovery with Model B can be triggered when a connection needs to be established, which means better real-time of the route. This solution prefers Model B to be adopted for multi-hop Relay discovery.

Based on the multi-hop Relay discovery, the Layer-2 link establishment via 5G ProSe Layer-3 UE-to-UE Relay as described in TS 23.304 should be enhanced to support multi-hop extension. Similarly, in the case of QoS handling for 5G ProSe Layer-3 UE-to-UE Relay in TS 23.304 should be improved when extended to multiple Realy UEs.

# 2. Text Proposal

**It is proposed to update TR 23.700-03 on FS\_5G\_ProSe \_Ph3 as follows.**

\* \* \* \* First change \* \* \* \*

## 6.0 Mapping of Solutions to Key Issues

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |
| --- | --- |
|  | Key Issues |
| Solutions | 1 | 2 |
| 1 | X |  |
| 2 | X |  |
| 3 |  | X |
| 4 | X | X |
| 5 |  | X |
| 6 |  | X |
| x |  | x |

\* \* \* \* Second change(All text is new) \* \* \* \*

## 6.X Solution#X for Key Issue #2

### 6.X.1 Description

The solution applies for multi-hop UE-to-UE Relay discovery, communication and QoS handling.

The idea of this solution is shortest path discovery. Among the possible paths consisted of multiple Relay UEs between the discoverer End UE and discoveree End UE, the one firstly completing delivery of the Discovery message is selected. The route to discoverer End UE is determined during the delivery of Discovery Solicitation message, and the route to discoveree End UE is determined during the delivery of Discovery Response message. This idea has the scalability of applying to one hop and multi-hops.

Similar mechanism of this solution can also apply for the discovery of multi-hop UE-to-Network Relay.

Based on the multi-hop Realy discovery, the Layer-2 link establishment via 5G ProSe Layer-3 UE-to-UE Relay as described in TS 23.304 should be enhanced to support multi-hop extension.

Similarly, in the case of QoS handling for 5G ProSe Layer-3 UE-to-UE Relay in TS 23.304, it should be improved when extended to multiple Realy UEs. Figure 6.X.1 illustrates an issue of QoS handling when extended to multi hops using existing mechanism, the QoS parameters of QoS Info (e.g. Packet Delay Budget (PDB)) refer to the QoS parameters from current terminal to the target UE, while the accepted QoS parameters in the Layer-2 link establishment/ modification procedure as described in clause 5.6.3.1 in TS 23.304 are QoS parameters between two adjacent terminals. Therefore, the following situation may occur: the relay 2 can not judge whether the accumulated QoS parameters which is the sum of the accepted QoS parameters in step 8 and 9 is consistent with the QoS parameters decided in step 4, because the accepted QoS parameters in step 9 is only the accepted QoS parameters from Realy2 to Realy3. Therefore, we propose to add accumulated QoS parameters with the accepted QoS parameters to ensure end-to-end QoS. The accumulated QoS parameter is interpreted as the sum of several accepted QoS parameters from the receiver to the target UE.



Figure 6.X.1: Issue of QoS handling for extending to multi hops using existing mechanism

### 6.X.2 Procedures

#### 6.X.2.1 Multi-hop UE-to-UE Relay discovery with Model B



Figure 6.x.2.1-1: Multi-hop UE-to-UE Relay Discovery with Model B

1. The discoverer 5G ProSe End UE (UE-1) sends a multi-hop UE-to-UE Relay Discovery Solicitation message. The multi-hop UE-to-UE Relay Discovery Solicitation message contains the Type of Discovery Message, User Info ID of itself, RSC, User Info ID of the discoveree 5G ProSe End UE (UE-2) if available. Additionally, it includes hop count (set as 0) and transaction ID of this discovery. If UE2 is not known by UE-1, e.g. If UE-1 request one specific service corresponding to RSC, User Info ID of the discoveree 5G ProSe End UE (UE-2) is not included.

The Source Layer-2 ID for multi-hop UE-to-UE Relay Discovery Solicitation message is self-selected by the discoverer 5G ProSe End UE (UE-1), and the Destination Layer-2 ID is selected based on the configuration as described in 5.1.5.1 23.304.

 Note 1: End UE and multi-hop UE-to-UE Relay should be authorized to use multi hop capability in advance, by using existing mechanism with enhancement on multi-hop.

1. When a multi-hop UE-to-UE Relay (Relay-1) receives the multi-hop UE-to-UE Relay Discovery Solicitation message from an End UE (UE-1), if the RSC contained in the solicitation message matches any of the (pre)configured RSC(s) of a multi-hop UE-to-UE Relay, the multi-hop UE-to-UE Relay (Relay-1) determines to handle this discovery and send a corresponding multi-hop UE-to-UE Relay Discovery Solicitation message, if same solicitation message has not been received and handled before, by checking the transaction ID, User Info IDs of discoverer and discoveree. Otherwise the multi-hop UE-to-UE Relay (Relay-1) ignores the solicitation message.

The multi-hop UE-to-UE Relay Discovery Solicitation message contains the Type of Discovery Message, User Info ID of the discoverer 5G ProSe End UE (UE-1), RSC, User Info ID of the discoveree 5G ProSe End UE (UE-2) if available. Additionally, it includes hop count (set as 1), transaction ID of this discovery and UE-to-UE Relay list (Relay-1). The Source Layer-2 ID for multi-hop UE-to-UE Relay Discovery Solicitation message is self-selected by the multi-hop UE-to-UE Relay (Relay-1), and the Destination Layer-2 ID is selected based on the configuration as described in 5.1.5.1 23.304.

The multi-hop UE-to-UE Relay (Relay-1) needs to store the Source Layer-2 ID(UE-1) of the received discovery solicitation message as the destination address of subsequent messages destinated to 5G ProSe End UE (UE-1), to ensure that the subsequent discovery response message destinated to User Info ID of the discoverer 5G ProSe End UE (UE-1) in step 6 is correctly sent back to the discoverer 5G ProSe End UE (UE-1).

1. When a multi-hop UE-to-UE Relay (Relay-2) receives the multi-hop UE-to-UE Relay Discovery Solicitation message from another multi-hop UE-to-UE Relay (Relay-1), if the RSC contained in the solicitation message matches any of the (pre)configured RSC(s) of the multi-hop UE-to-UE Relay (Relay-2), the multi-hop UE-to-UE Relay (Relay-2) determines to handle this discovery and send a corresponding multi-hop UE-to-UE Relay Discovery Solicitation message, if same solicitation message has not been received and handled before , by checking the transaction ID, User Info IDs of discoverer and discoveree, and User Info ID of itself is contained in the User Info ID of UE-to-UE Relay list, and checking whether the hop count reaches the maximum allowed hops. Otherwise the multi-hop UE-to-UE Relay (Relay-2) ignores the solicitation message. If the multi-hop UE-to-UE Relay (Relay-2) simultaneously receives multiple multi-hop UE-to-UE Relay Discovery Solicitation messages from different multi-hop UE-to-UE Relays with the same RSC, transaction ID and the User Info IDs of the discoverer and discoveree, it determines which multi-hop UE-to-UE Relay acts as the previous hop (e.g. based on the PC5 signal strength or the principle of minimum hop counts) and handle corresponding Discovery Solicitation message, then other Discovery Solicitation messages are ignored. ' simultaneously ' means in a short period of time configured by UE-to-UE Relay. A longer period of time leads to longer end-to-end discovery time.

The multi-hop UE-to-UE Relay Discovery Solicitation message contains the Type of Discovery Message, User Info ID of the discoverer 5G ProSe End UE (UE-1), RSC, User Info ID of the discoveree 5G ProSe End UE (UE-2) if available. Additionally, it includes hop count (set as 2 by increase one to the hop count received from the previous hop), transaction ID of this discovery and UE-to-UE Relay list (Relay-1, Relay-2). The Source Layer-2 ID for multi-hop UE-to-UE Relay Discovery Solicitation message is self-selected by the multi-hop UE-to-UE Relay (Relay-2), and the Destination Layer-2 ID is selected based on the configuration as described in 5.1.5.1 23.304.

The multi-hop UE-to-UE Relay (Relay-2) needs to store the Source Layer-2 ID(Relay-1) of the discovery solicitation message as the destination address of subsequent messages destinated to 5G ProSe End UE (UE-1), to ensure that the subsequent discovery response message destinated to User Info ID of the discoverer 5G ProSe End UE (UE-1) in step 5 is correctly sent back to the multi-hop UE-to-UE Relay (Relay-1).

Note: maximum allowed hop parameter is configed via core network to UE-to-UE Relay.

1. When a 5G ProSe End UE (UE-2) receives the multi-hop UE-to-UE Relay Discovery Solicitation message from multi-hop UE-to-UE Relay (Relay-2), if the RSC contained in the solicitation message matches any of the (pre)configured RSC(s) of the discoveree 5G ProSe End UE (UE-2), and the discoveree 5G ProSe End UE (UE-2) matches the User Info ID of the discoveree 5G ProSe End UE (UE-2) contained in the solicitation message if the User Info ID of discoveree exists in the message, then the discoveree 5G ProSe End UE (UE-2) determines to respond to the multi-hop UE-to-UE Relay (Relay-2) with a multi-hop UE-to-UE Relay Discovery Response message, if same solicitation message has not been received and handled before, by checking the transaction ID, User Info IDs of discoverer and discoveree. Otherwise the ProSe End UE (UE-2) ignores the solicitation message.

If the discoveree 5G ProSe End UE (UE-2) simultaneously receives multiple multi-hop UE-to-UE Relay Discovery Solicitation messages from different multi-hop UE-to-UE Relays with the same RSC, transaction ID and the User Info ID of the discoverer and discoveree, it determines which multi-hop UE-to-UE Relay acts as the previous hop (e.g. based on the PC5 signal strength or the principle of minimum hop counts) and handle corresponding Discovery Solicitation message, then other Discovery Solicitation messages are ignored. ' simultaneously ' means in a short period of time configured by UE-to-UE Relay. A longer period of time leads to longer end-to-end discovery time.

The multi-hop UE-to-UE Relay Discovery Response message contains the Type of Discovery Message, RSC, User Info ID of the discoverer 5G ProSe End UE (UE-1) and User Info ID of discoveree 5G ProSe End UE (UE-2). Additionally it includes hop count of the discovered path (set as 3 by increase one to the hop count received from the previous hop), transaction ID of this discovery and UE-to-UE Relay list (Relay-1, Relay-2).The Source Layer-2 ID for multi-hop UE-to-UE Relay Discovery Response message is self-selected by the discoveree 5G ProSe End UE (UE-2), and the Destination Layer-2 ID is set to the Source Layer-2 ID of the received multi-hop UE-to-UE Relay Discovery Solicitation message from the previous hop(Relay 2).

The discoveree 5G ProSe End UE (UE-2) needs to store the Source Layer-2 ID(Relay-2) of the discovery solicitation message as the destination address of subsequent messages including Discovery Response message destinated to 5G ProSe End UE (UE-1), to ensure that the these message destinated to User Info ID of the discoverer 5G ProSe End UE (UE-1) is correctly sent back to the multi-hop UE-to-UE Relay (Relay-2).

1. When multi-hop UE-to-UE Relay (Relay-2) receives Relay Discovery Response message from 5G ProSe End UE (UE-2). The multi-hop UE-to-UE Relay (Relay-2) sends a corresponding multi-hop UE-to-UE Relay Discovery Response message. The multi-hop UE-to-UE Relay Discovery Response message contains the Type of Discovery Message, RSC, User Info ID of the discoverer 5G ProSe End UE (UE-1) and User Info ID of discoveree 5G ProSe End UE (UE-2). Additionally, it includes hop count of the discovered path (set as 3), transaction ID of this discovery. The Destination Layer-2 ID is set to the Source Layer-2 ID of UE-to-UE Relay (Relay-1) as the destination address of messages destinated to 5G ProSe End UE (UE-1)stored at step 3.

The multi-hop UE-to-UE Relay (Relay-2) needs to store the Source Layer-2 ID of the received Discovery Response message as the destination address of subsequent messages destinated to 5G ProSe End UE (UE-2), to ensure that the subsequent messages destinated to ProSe End UE (UE-2) is correctly sent.

1. When multi-hop UE-to-UE Relay (Relay-1) receives Relay Discovery Response message from multi-hop UE-to-UE Relay (Relay-2).The multi-hop UE-to-UE Relay (Relay-1) sends a corresponding multi-hop UE-to-UE Relay Discovery Response message. The multi-hop UE-to-UE Relay Discovery Response message contains the Type of Discovery Message, RSC, User Info ID of the discoverer 5G ProSe End UE (UE-1) and User Info ID of discoveree 5G ProSe End UE (UE-2). Additionally it includes hop count of the discovered path (set as 3), transaction ID of this discovery. The Destination Layer-2 ID is set to the Source Layer-2 ID of 5G ProSe End UE (UE-1) as the destination address of messages destinated to 5G ProSe End UE (UE-1) stored at step 2.

The multi-hop UE-to-UE Relay (Relay-1) needs to store the Source Layer-2 ID(Relay-2) of the reveived Discovery Response message as the destination address of subsequent messages destinated to 5G ProSe End UE (UE-2), to ensure that the subsequent messages destinated to ProSe End UE (UE-2) is correctly sent to multi-hop UE-to-UE Relay (Relay-2).

After the discoverer 5G ProSe End UE (UE-1) receives Relay Discovery Response message from multi-hop UE-to-UE Relay (Relay-1). The discoverer 5G ProSe End UE (UE-1) determines the relay route/path (i.e. the next hop is Relay-1) to the discoveree 5G ProSe End UE (UE-2). The 5G ProSe End UE (UE-1) needs to store the Source Layer-2 ID(Relay-1) of the reveived Discovery Response message as the destination address of subsequent messages destinated to 5G ProSe End UE (UE-2), to ensure that the subsequent messages destinated to ProSe End UE (UE-2) is correctly sent to multi-hop UE-to-UE Relay (Relay-1).

The discoverer 5G ProSe End UE (UE-1) may receive multiple multi-hop UE-to-UE Relay Discovery Response messages from different discoveree 5G ProSe End UEs which includes different User Info ID of discoveree 5G ProSe End UE, e.g. UE2 is not known by UE-1 as described at step 1 and mutiple discoveree 5G ProSe End UEs match the requirement of the discovery during the Discovery Solicitation/Response procedures. The 5G ProSe End UE (UE-1) needs to select the destination 5G ProSe End UE , e.g. based on the PC5 signal strength or the principle of minimum hop counts, and store the Source Layer-2 ID of the reveived Discovery Response message corresponding to the selected destination 5G ProSe End UE as described above.

#### 6.X.2.2 Layer-2 link establishment communication via multi-hop UE-to-UE Relays

The general procedure is based on Layer-2 link establishment via 5G ProSe UE-to-UE Relay as described in clause 6.7.1 in 23.304, with additional treatment for communication via multi-hop UE-to-UE Relays.

Figure 6.X.2.2 describes the general procedures of the solution.



Figure 6.X.2.2: General procedures for Layer-2 link establishment communication via multi-hop UE-to-UE Relays

1. Service authorization and provisioning are performed for source 5G ProSe End UE, target 5G ProSe End UE and 5G ProSe UE-to-UE Relays as described in clause 6.2 23.304.
2. The source 5G ProSe End UE performs discovery via multi-hop 5G ProSe UE-to-UE Relays as described in clause 6.X.2.1.
3. The Direct Communication Request message is to initiate the unicast Layer-2 link establishment procedure as described in clause 6.7.1 23.304.

If source 5G ProSe End UE request one specific service discovery corresponding to RSC, source 5G ProSe End UE may receive several multi-hop UE-to-UE Relay Discovery Response messages transferred from different 5G ProSe End UEs during Multi-hop UE-to-UE Relay Discovery as described step 1 and step 6 of clause 6.X.2.1. The source 5G ProSe End UE may determine one target 5G ProSe End UE to establish the communication via multi-hop UE-to-UE Relays (e.g. based on principle of minimum hop counts) as described in step 6 of clause 6.X.2.1. Then source 5G ProSe End UE sends the Direct Communication Request message which includes User Info ID of the selected target 5G ProSe End UE, the corresponding User info ID of the next hop, User Info ID of source 5G ProSe End UE and RSC using the Destination Layer-2 ID stored in step 6 of clause 6.X.2.1.

1. Once receiving the Direct Communication Request message, 5G ProSe UE-to-UE Relay-1(Relay-1) forwards the Direct Communication Request message to the 5G ProSe UE-to-UE Relay-2(Relay-2) using the Destination Layer-2 ID stored in step 5 of clause 6.X.2.1.
2. After receiving the Direct Communication Request message, 5G ProSe UE-to-UE Relay-2(Relay-2) forwards the Direct Communication Request message to the target 5G ProSe End UE using the Destination Layer-2 ID stored in step 4 of clause 6.X.2.1.
3. The target 5G ProSe End UE sends a Direct Communication Accept message to the 5G ProSe UE-to-UE Relay-N that has successfully established security with as described in 6.7.1.1 23.304. The Direct Communication Accept message contains User Info ID of target 5G ProSe End UE.
4. After receiving the Direct Communication Accept message from the target 5G ProSe End UE, the 5G ProSe UE-to-UE Relay-2 sends a Direct Communication Accept message to the 5G ProSe Layer-3 UE-to-UE Relay-1 that has successfully established security with. The Direct Communication Accept message contains User Info ID of target 5G ProSe End UE and the User Info ID of 5G ProSe UE-to-UE Relay-2.
5. The 5G ProSe UE-to-UE Relay-1 sends a Direct Communication Accept message to the source 5G ProSe End UE that has successfully established security with. The Direct Communication Accept message contains User Info ID of target 5G ProSe End UE and the User Info ID of 5G ProSe UE-to-UE Relay-1.
6. The source 5G ProSe End UE communicates with the target 5G ProSe End UE via multi-hop UE-to-UE Relays.

If source 5G ProSe End UE request one specific service discovery corresponding to RSC, and there exist other paths of multi-hop UE-to-UE Relay matched by other different discoveree ProSe End UEs during Multi-hop UE-to-UE Relay Discovery as described step 1 and step 6 of clause 6.X.2.1. , since these paths are not selected by source 5G ProSe End UE as described in step 3, the involved UE-to-UE Relays and discoveree 5G ProSe End UEs shall not receive Direct Communication Request message or Direct Communication Accept message. They should delete the stored route information related to destination of discoverer and discoveree 5G ProSe End UEs after the timer expires.

Note 2: IP address/prefix allocation mechanism is based on R18. For multi-hop UE-to-UE Relay extension, 5G ProSe UE-to-UE Relay may forward DNS query to other 5G ProSe UE-to-UE Relay to retrieve IP address of target UE, based on stored route information related to target UE.

Editor's note: How to perform the Security Establishment is FFS and is assumed to be handled by SA WG3.

#### 6.X.2.3 QoS handling for multi-hop UE-to-UE Relays

Figure 6.X.2.3 describes the general procedure for QoS handling.



Figure 6.X.2.3: QoS handling for multi-hop UE-to-UE Relays

1. UE-to-UE Relay is provisioned with policy parameters from the network as described in 5.1.5 23.304 and UE-to-UE Relay discovery has been completed as described in clause 6.X.2.1. Source UE may decide the E2E QoS parameters (e.g. PDB) between source UE and target UE based on the application layer requirements.
2. The source 5G ProSe Layer-3 End UE (Source UE) sends the E2E QoS parameters to UE-to-UE Relay-1(Relay-1) through Layer-2 link establishment/modification procedure as described in 6.X.2.2. The E2E QoS parameters include the QoS parameters between the Source UE and target 5G ProSe Layer-3 End UE (Target UE).
3. The UE-to-UE Relay-1, based on its implementation and the received information from the Source UE, splits the E2E QoS parameters into two parts: one part is for the PC5 interface between source UE and UE-to-UE Relay-1, the other part is the QoS parameters between UE-to-UE Relay-1 and the target UE.
4. The Relay-1 sends the acquired QoS parameters to UE-to-UE Relay-2(Relay-2) through Layer-2 link establishment/modification procedure. The acquired parameters include the QoS parameters between the Relay1 and Target UE.
5. The Relay-2 splits the QoS parameters between the Relay-1 and Target UE just like step2.
6. The Relay 2 sends the acquired QoS parameters to Target UE through Layer-2 link establishment/modification procedure. The acquired parameters include the QoS parameters between the Relay2 and Target UE.
7. Target UE sends the last hop accepted QoS parameters to the UE-to-UE Relay2.
8. The Relay 2 sends the accepted QoS parameters and accumulated QoS parameters to the Relay 1. The accepted QoS parameters refer to QoS parameters between UE-to-UE Relay1 and UE-to-UE Relay2. The accumulated QoS parameters refer to the sum of the accepted QoS parameters in step6 and step7.
9. The Relay1 sends the accepted QoS parameters and accumulated QoS parameters to the Source UE. The accepted QoS parameters refer to QoS parameters between Source UE and UE-to-UE Relay1. The accumulated QoS parameters refer to the sum of the accepted QoS parameters in step6, step7 and step8.

### 6.X.3 Impacts to Services, Entities and Interfaces

The following impacts are foreseen by this solution:

UE:

- Each UE can determine the multi-hop Realy route/path to the other End UE based on rule of shortest path discovery and send subsequent message based on stored routing information

- Each Relay UE can calculate and transfer the accumulated QoS parameters (e.g. PDB).

- Each Relay UE can receive the Discovery Solicitation message/Direct Communication Request message and determine how to handle this message such as delivering or ignoring it.

- The End UE can select the destination End UE to establish the communication via multi-hop UE-to-UE Relays.

PCF:

- Authorization policy and parameters for multi-hop UE-to-UE Relay Discovery and Communication.

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