**SA WG2 Meeting #162 S2-2404590**

**Changsha, China, 15th Apr 2024 - 19th Apr 2024 rev of S2-2402954**

**Source: Xiaomi**

**Title: new solution for KI#2: support for Multi-hop UE-to-UE Relay Discovery**

**Document for: Approval**

**Agenda Item: 19.7**

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

*Abstract of the contribution:* *This paper proposes new solution for KI#2 support of multi-hop UE-to-UE Relays Discovery with Model A and Model B.*

# 1 Discussion

This solution is aiming to resolve the following key issue #2 on multi-hop UE-to-UE Relay discovery.

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| --- |
| 5.2 Key Issue #2: Support of Layer-3 multi-hop UE-to-UE Relays5.2.1 General descriptionThis key issue focuses on architecture enhancements to support ProSe multi-hop Layer-3 UE-to-UE Relay over NR PC5 reference point. This key issue intends to support multi-hop Layer-3 UE-to-UE Relays for in coverage and out of coverage operation.Multi-Hop UE-to-UE RelaysEnd UEEnd UE**Figure 5.x.1-1: Example scenario of support of Layer-3 multi-hop UE-to-UE Relay**Aspects such as support for relay discovery, selection, authorization, connection establishment and data transfer for single hop ProSe UE-to-UE Relay have been addressed in previous releases and some of those aspects may need to be enhanced to support multi-hop extension. In Release 19, at least the following aspects need to be studied in potential solutions:* Whether and how to enhance the existing mechanisms for multi-hop UE-to-UE Relay discovery.
* Whether and how to enhance the existing mechanisms for IP address/prefix allocation.
* Whether and how to control the maximum number of hops supported when using multi-hop UE-to-UE relays.
* Whether and how to support path changes or Relay (re)selections, e.g., in the case one or more UE-to-UE Relays become unavailable/suitable.
* Whether and how to support the network control 5G ProSe multi-hops UE-to-UE Relay operations, including at least, authorization, policy and parameters provisioning etc.
* 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-UE Relays.
* How to establish the connection between source UE and target UE via multiple 5G ProSe UE-to-UE Relays.
* How to satisfy end-to-end QoS requirements for the End UEs over the path via 5G ProSe multi-hop UE-to-UE Relays, if needed.
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# 2 Proposal

It is proposed to include the following changes in TR 23.700-03 V0.1.0.

**\* \* \* \* Start of Changes \* \* \* \***

## 6.0 Mapping of Solutions to Key Issues

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |
| --- | --- |
|  | Key Issues |
| Solutions | KI#1 | KI#2 |
| solution |  | X |

## 6.X Solution #X: Support for Multi-hop UE-to-UE Relay Discovery with max hop restriction

### 6.X.1 Description

Editor's note: This clause will describe the solution principles and architecture assumptions for corresponding key issue(s). (Sub-) clause(s) may be added to capture details.

This solution aims to propose Multi-hop UE-to-UE Relay Discovery with Model A to resolve the key Issue #2 Support of Layer-3 multi-hop UE-to-UE Relays. 5G ProSe UE-to-UE Relay Discovery with Model A and Model B are reused as baseline to support for multi-hop 5G ProSe UE-to-UE Relay Discovery Model A and Model B

For 5G ProSe UE-to-UE Relay Discovery with Model A, this paper introduces two new parameters in the 5G ProSe UE-to-UE Relay Discovery Announcement message (MaxAllowedHops, hopsIndex value) to indicate the maximum hops that the user info ID of target End UE can be forwarded, and indicate the hops that the End UE can be reached.

Each UE-to-UE Relay(s) supporting multi-hop 5G ProSe UE-to-UE Relay Discovery with Model A is assumed to include a target list of other End UEs as following:

* User info ID of target End UE
* **hopsIndex**, to indicate the hops that the target End UE can be reached, e.g., when the value is 1 that means that the target UE can be reached via 1 hop (i.e., via one UE-to-UE Relay needed); when the value is 0, it means that the target can be reached directly without UE-to-UE Relay involved. It is used for Source End UE to select the multi-hop UE-to-UE Relay(s).
* **Max-allowed hops indication,** to indicate the maximum hops that the user info ID of target End UE can be forwarded.
* **previous hop UE-to-UE Relay info**, e.g., User Info ID of UE-to-UE Relay, source L2 ID of UE-to-UE Relay. When the hopsIndex value is 0, it means that the target UE can be reached directly without UE-to-UE Relay involved.

For 5G ProSe UE-to-UE Relay Discovery with Model B, this paper is to propose the two parameters in the Discovery solicitation message and response message as following:

* ***AllowedHopsIndex, is used*** in the 5G ProSe UE-to-UE Relay Discovery solicitation message to indicate the maximum hops that the U2U Relay discovery message can be forwarded. This parameter is used for U2U Relay to determine whether the Discovery solicitation message can be forwarded or not, or/and in order for End UE-2 to determine the path.
* ***resposeHopsIndex, is used***in the Discovery response message to indicate the hops that the response message has been forwarded in order for source End UE-1 to determine the path or select the U2U Relay for the first hop.

### 6.X.2 Procedures

#### 6.X.2.1 Multi-hop 5G ProSe UE-to-UE Relay Discovery with Model A



Figure 6.X.2.1-1 Multi-hop 5G ProSe UE-to-UE Relay Discovery with Model A

1. Source End UE, UE-to-UE Relay-1, UE-to-UE Relay-3 and UE-to-UE Relay-2 are provisioned with service authorization/parameters from PCF to support multiple hops UE-to-UE Relay.
2. The 5G ProSe UE-to-UE Relay-3 has a target list of other End UEs and sends a UE-to-UE Relay Discovery Announcement message. The 5G ProSe UE-to-UE Relay Discovery Announcement message contains the Type of Discovery Message, User Info ID of the 5G ProSe UE-to-UE Relay-3, RSC and list of User Info ID of the 5G ProSe End UEs, for each User Info ID of the End UE, along with MaxAllowedHops, hopsIndex and corresponding previous hop UE-to-UE Relay info, and is sent using the Source Layer-2 ID and Destination Layer-2 ID as described in clause 5.8.4 TS 23.304.

If the target End UE can be directly reached, the previous hop information is empty.

1. When UE-to-UE Relay-2 receives the Announcement message that includes a target list of other End UEs, if the value of hopsIndex value plus 1 is equal or less than MaxAllowedHops for one End UE, the User Info ID of this End UE along with hopsIndex, MaxAllowedHops, previous hop UE-to-UE Relay info are added into its target list.

If hopsIndex value plus 1 is bigger than MaxAllowedHops, this End UE shall not be updated to the target list.

When receiving the same User Info ID of End UE with different hopsIndex values and previous hop UE-to-UE Relay info from different UE-to-UE Relays, the smaller value of the hopsIndex and previous hop UE-to-UE Relay info are kept.

1. Similar as step 1, UE-to-UE Realy-2 sends the UE-to-UE Relay Discovery Announcement message, with the target list updated by UE-to-UE Relay-2 in step 2.
2. Similar as step 2, UE-to-UE Relay determine to update its target list with User Info ID of target End UE along with right hopsIndex, MaxAllowedHops and previous hop UE-to-UE Relay info announced by UE-to-UE Relay-1.
3. Similar as step 1/3, UE-to-UE Realy-1 sends the UE-to-UE Relay Discovery Announcement message, with the target list updated by UE-to-UE Relay-1 in step 4.

Source UE determines to the first hop UE-to-UE Relay, based on the received target lists in the Discovery Announcement message from UE-to-UE Relay-1. Source UE may receive multiple UE-to-UE Relay Discovery Announcement messages from UE-to-UE Relay -1/-2/-3, for same target End UE, the previous hop UE-to-UE Relay with smaller hopsIndex value may be selected. Since there are less hops.

#### 6.X.2.1 Multi-hop 5G ProSe UE-to-UE Relay Discovery with Model B



Figure: 5G ProSe UE-to-UE Relay Discovery with Model B for supporting multiple-hops

0, UE1, UE2, U2U Relay-1 and U2U Relay-2 are provisioned with service authorization/parameters from PCF to support multiple hops.

1. The discoverer 5G ProSe End UE (UE-1) sends a 5G ProSe UE-to-UE Relay Discovery Solicitation message. The 5G ProSe UE-to-UE Relay Discovery Solicitation message contains the Type of Discovery Message, User Info ID of itself, RSC, allowedHopsIndex and User Info ID of the discoveree 5G ProSe End UE (UE-2), and is sent using the Source Layer-2 ID and Destination Layer-2 ID as described in clause 5.8.4.

 A 5G ProSe UE-to-UE Relays determine the Destination Layer-2 ID for signalling reception as specified in clause 5.1.

 The allowedHopsIndex is to indicate the maximum hops that the discovery solicitation message can be forwarded by U2U Relay.

2a/b. A 5G ProSe UE-to-UE Relay-1 or Relay-2 that matches the RSC sends a 5G ProSe UE-to-UE Relay Discovery Solicitation message. The 5G ProSe 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), User Info ID of UE-to-UE Relay-1 or Relay-2, RSC, [allowedHopsIndex -1], and User Info ID of the discoveree 5G ProSe End UE (UE-2) and is sent using the Source Layer-2 ID and Destination Layer-2 ID as described in clause 5.8.4.

 A 5G ProSe End UE determines the Destination Layer-2 ID for signalling reception as specified in clause 5.1.

 When U2U Relay-1 receives the Discovery Solicitation message, it calculates the value of [allowedHopsIndex value minus 1]. If the value is not zero, the U2U Relay-1 can forward the Discovery Solicitation message.

3a. A 5G ProSe UE-to-UE Relay-2 that matches the RSC sends a 5G ProSe UE-to-UE Relay Discovery Solicitation message. The 5G ProSe 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), User Info ID of UE-to-UE Relay-2, User Info ID of UE-to-UE Relay-2, RSC, allowedHopsIndex-2, and User Info ID of the discoveree 5G ProSe End UE (UE-2) and is sent using the Source Layer-2 ID and Destination Layer-2 ID as described in clause 5.8.4.

 A 5G ProSe End UE determines the Destination Layer-2 ID for signalling reception as specified in clause 5.1.

 When U2U Relay-2 receives the Discovery Solicitation message, it calculates the value of [allowedHopsIndex value minus 1]. If the value is not zero, the U2U Relay-2 can forward the Discovery Solicitation message.

4. UE-2 may perform path selection based on the received Discovery Solicitation message(s) from multiple U2U Relay(s) by comparing the value of allowedHopsIndex. For example, the smaller value is selected since there are less hops between source UE1 and target UE2.

5a, The discoveree 5G ProSe End UE (UE-2) that matches the value of RSC and the User Info ID of the discoveree 5G ProSe End UE (UE-2) responds to the 5G ProSe UE-to-UE Relay-2 with a 5G ProSe UE-to-UE Relay Discovery Response message. The 5G ProSe 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 itself, and is sent using the Source Layer-2 ID and Destination Layer-2 ID as described in clause 5.8.4.

The allowedHopsIndex value received by UE2 is included if the UE2 doesn’t determine and select the multi-hops path..

U2U Relay-2 sends the response message to UE1 including the allowedHposIndex.

5b, Similar to step 5a, UE-2 sends the response message to UE1 via U2U Relay -2 and U2U Relay -1, including the allowedHopsIndex value.

1. UE may receive multiple Discovery response message(s), UE may determine to select the path based on the responseHopsIndex. For example, the smaller value is selected since there are less hops between source UE1 and target UE2.

### 6.X.3 Impacts on services, entities and interfaces

Editor's note: It is FFS to capture impacts on existing 3GPP nodes and functional elements.

**\* \* \* \* End of Changes\* \* \* \***