**3GPP SA WG2 Meeting #164 *S2-240xxxx***

**Maastricht, NL, 19-23 August 2024 *(was S2-240xxxx)***

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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network |  | Core Network | **x** |

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|  |
| ***Title:***  | 5G ProSe Multi-hop UE-to-Network Relay Discovery Model A and connection management |
|  |  |
| ***Source to WG:*** | Qualcomm Incorporated, AT&T, FirstNet?, Ericsson?, LG Electronics |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | 5G\_ProSe\_Ph3 |  | ***Date:*** | 2024-08-19 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-19 |
|  | *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-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
|  |  |
| ***Reason for change:*** | This contribution added the support of 5G ProSe Multi-hop UE-to-Network Relay Discovery using Model A based on conclusions in TR 23.700-03.  |
|  |  |
| ***Summary of change:*** | Add the description of the Model A discovery operations for the support of multi-hop UE-to-Network Relay, and the corresponding link management.  |
|  |  |
| ***Consequences if not approved:*** | No proper support of 5G ProSe Multi-hop UE-to-Network Relay feature in Rel-19.  |
|  |  |
| ***Clauses affected:*** | (new) 5.2.x; (new) 5.4.x; 5.8.3.1; 5.8.3.2, (new) 6.3.2.x; (new) 6.4.3.x |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  |  |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

*FIRST CHANGE*

### 5.2.x 5G ProSe Multi-hop UE-to-Network Relay Discovery

For 5G ProSe Multi-hop UE-to-Network Relay discovery, both Model A and Model B discovery are supported:

- Model A uses a single discovery protocol message (Announcement).

- Model B uses two discovery protocol messages (Solicitation and Response).

The procedures for 5G ProSe Multi-hop UE-to-Network Relay discovery Model A are defined in clause 6.3.2.x.2.

The procedures for 5G ProSe Multi-hop UE-to-Network Relay discovery Model B are defined in clause 6.3.2.x.3.

For Additional parameters announcement procedure, only Model A discovery is used and is defined in clause 6.3.2.x.y.

*NEXT CHANGE*

5.4.x 5G ProSe Intermediate UE-to-Network Relay

#### 5.4.x.1 General

5G ProSe Intermediate UE-to-Network Relay is used to support multi-hop UE-to-Network Relay operations. A 5G ProSe Intermediate UE-to-Network Relay may support Layer-2 or Layer-3 nulti-hop UE-to-Network Relay operations, based on its capabilities and the configurations in clause 5.1.4.

5G ProSe Intermediate UE-to-Network Relay can operate within NG-RAN coverage or out of NG-RAN coverage. The 5G ProSe Intermediate UE-to-Network Relays, 5G ProSe Remote UE, and the 5G ProSe UE-to-Network Relay may have different HPLMNs.

The 5G ProSe Intermediate UE-to-Network Relay may also take the role of a 5G ProSe Remote UE, e.g. generate traffic to the network via the 5G ProSe UE-to-Network Relay.

The maximum number of 5G ProSe Intermediate UE-to-Network Relay on the path of 5G ProSe Remote UE is controlled by the Hop-Limit value configured on the 5G ProSe Intermediate UE-to-Network Relays, i.e. less than the value of the Hop-Limit.

In this release, for a given RSC and 5G ProSe UE-to-Network Relay, the 5G ProSe Intermediate UE-to-Network Relay only has one active connection towards the 5G ProSe UE-to-Network Relay at any point of time, except for a transient period during relay reselections.

For a 5G ProSe Remote UE accessing 5G ProSe UE-to-Network Relay via one or more 5G ProSe Intermediate UE-to-Network Relay, the considerations defined in clause 5.4.1 to 5.4.4 still apply.

#### 5.4.x.2 5G ProSe Layer-3 Intermediate UE-to-Network Relay

The 5G ProSe Layer-3 Intermediate UE-to-Network Relay can proide relay service for any IP, Ethernet or Unstructured traffic based on the corresponding RSC announced by the 5G ProSe UE-to-Network Relay. The 5G ProSe Layer-3 Intermediate UE-to-Network Relay determines the traffic type based on configuration of the mapping between PDU Session parameters and RSC, as specified in clause 5.1.4.1.

For IP type of traffic, the 5G ProSe Layer-3 Intermediate UE-to-Network Relay needs to act as an IP router, and for Ethernet type of traffic, the 5G ProSe Layer-3 Intermediate UE-to-Network Relay needs to act as an Ethernet switch.

In case of IP type of traiffc or Ethernet type of traffic, the 5G ProSe Layer-3 Intermediate UE-to-Network Relay's upstream Layer-2 Link (with the 5G ProSe UE-to-Network Relay or another 5G ProSe Layer-3 Intermediate UE-to-Network Relay) can be shared by more than one 5G ProSe Layer-3 Remote UEs or downstream 5G ProSe Layer-3 Intermediate UE-to-Network Relays. For Unstructured type of traffic, one upstream Layer-2 Links can be used to support only one 5G ProSe Layer-3 Remote UE.

#### 5.4.x.3 5G ProSe Layer-2 Intermediate UE-to-Network Relay

Operations of the 5G ProSe Layer-2 Intermediate UE-to-Network Relay is specified in TS 38.300 [12].

The 5G ProSe Layer-2 Intermediate UE-to-Network Relay may have a different serving PLMN than that of the 5G ProSe Remote UE.

When served by the 5G ProSe Layer-2 Intermediate UE-to-Network Relay, the 5G ProSe Remote UE's behavior is the same as defined in clause 5.4.2.

*NEXT CHANGE*

5.8.3.1 Common identifiers for 5G ProSe UE-to-Network Relay

The following parameters are used for the 5G ProSe UE-to-Network Relay Discovery Announcement message (Model A), where Source Layer-2 ID and Destination Layer-2 ID are used for sending and receiving the message and Announcer Info and Relay Service Code are contained in the message:

- Source Layer-2 ID: the 5G ProSe UE-to-Network Relay self-selects a Source Layer-2 ID for 5G ProSe UE-to-Network Relay Discovery.

- Destination Layer-2 ID: the Destination Layer-2 ID for 5G ProSe UE-to-Network Relay Discovery is selected based on the configuration as described in clause 5.1.4.1.

- Announcer Info: provides information (i.e. User Info ID) about the announcing user.

- Relay Service Code: parameter identifying a connectivity service the 5G ProSe UE-to-Network Relay provides to a 5G ProSe Remote UE. The Relay Service Codes are configured in a 5G ProSe UE-to-Network Relay for advertisement. Additionally, the Relay Service Code may also identifies authorized users the 5G ProSe UE-to-Network Relay would offer service to and may be used to select the related security policies or information e.g. necessary for authentication and authorization between the 5G ProSe Remote UE and the 5G ProSe UE-to-Network Relay (e.g. a Relay Service Code for relays for police members only would be different than a Relay Service Code for relays for Fire Fighters only, even though potentially they provided connectivity to same DN e.g. to support Internet Access).

The 5G ProSe UE-to-Network Relay Discovery Announcement message (Model A) is extended and modified as follows when used for 5G ProSe Multi-hop UE-to-Network Relay discovery:

- Hop-Count: This value reflects the number of PC5 hops for the 5G ProSe Remote UE to reach the network. It is set to 1 by the 5G ProSe UE-to-Network Relay and incremented by 1 every time the 5G ProSe UE-to-Network Relay Discovery Announcement message is forwarded by a 5G ProSe Intermediate UE-to-Network Relay.

A 5G ProSe Intermediate UE-to-Network Relay shall only process the 5G ProSe UE-to-Network Relay Discovery Announcement if the Hop-Count is present and the value is less than the (pre-)configured Hop-Limit value for the associated RSC.

- Source Layer-2 ID: the 5G ProSe UE-to-Network Relay or the 5G ProSe Intermediate UE-to-Network Relay self-selects a Source Layer-2 ID when sending the discovery message.

- Destination Layer-2 ID: the 5G ProSe Intermediate UE-to-Network Relay sets the Desination Layer-2 ID of the 5G ProSe UE-to-Network Relay Discovery Announcement message based on configuration described in clause 5.1.4.1.

- Announcer Info: identify information (i.e. User Info ID) of the announcing Intermediate UE-to-Network Relay.

- (optinal) Root Relay Info: this is the User Info ID contained in the 5G ProSe UE-to-Network Relay Discovery Announcement message from the 5G ProSe UE-to-Network Relay (i.e. when Hop-Count equals 1). A 5G ProSe Intermediate UE-to-Network Relay may stored it in the discovery entry and included it in the 5G ProSe UE-to-Network Relay Discovery Announcement message. This information can be used in the relay selection at the 5G ProSe Remote UE or other 5G ProSe Intermediate UE-to-Network Relays.

- (optional) Accumulated QoS for PC5 link: this reflects the QoS supported over all the PC5 links to the Root Relay, i.e. the 5G ProSe UE-to-Network Relay, for this RSC. Editor's Note: Whether the same 5G ProSe UE-to-Network Relay Discovery Announcement message is reused for multi-hop operation or a new message type is to be defined will be decided by Stage 3.

The following parameters are used for the 5G ProSe UE-to-Network Relay Discovery Solicitation message (Model B), where Source Layer-2 ID and Destination Layer-2 ID are used for sending and receiving the message and Discoverer Info and Relay Service Code are contained in the message:

- Source Layer-2 ID: the 5G ProSe Remote-UE self-selects a Source Layer-2 ID for 5G ProSe UE-to-Network Relay Discovery.

- Destination Layer-2 ID: the Destination Layer-2 ID for 5G ProSe UE-to-Network Relay Discovery is selected based on the configuration as described in clause 5.1.4.1.

- Discoverer Info: provides information (i.e. User Info ID) about the discoverer user.

- Target Info: provides information (i.e. User Info ID) about the targeted discoveree user.

- Relay Service Code: information about connectivity that the discoverer UE is interested in. The Relay Service Codes are configured in the 5G ProSe Remote UEs interested in related connectivity services.

The following parameters are used in the 5G ProSe UE-to-Network Relay Discovery Response message (Model B), where Source Layer-2 ID and Destination Layer-2 ID are used for sending and receiving the message and Discoveree Info and Relay Service Code are contained in the message:

- Source Layer-2 ID: the 5G ProSe UE-to-Network Relay self-selects a Source Layer-2 ID for 5G ProSe UE-to-Network Relay Discovery.

- Destination Layer-2 ID: set to the Source Layer-2 ID of the received 5G ProSe UE-to-Network Relay Discovery Solicitation message.

- Relay Service Code: identifies the connectivity service the 5G ProSe UE-to-Network Relay provides to 5G ProSe Remote UEs that matches the Relay Service Code from the corresponding Discovery Solicitation message.

- Discoveree Info: provides information (i.e. User Info ID) about the discoveree.

The following parameters may be used in the Relay Discovery Additional Information message (using Model A) based on the procedure defined in clause 6.5.1.3 for 5G ProSe UE-to-Network Relay and 6.3.2.x.y for 5G ProSe multi-hop UE-to-Network Relay where Source Layer-2 ID and Destination Layer-2 ID are used for sending and receiving the message and the other parameters are contained in the message:

- Source Layer-2 ID: the 5G ProSe UE-to-Network Relay or the 5G ProSe Intermediate UE-to-Network Relay self-selects a Source Layer-2 ID to send the Relay Discovery Additional Information message.

- Destination Layer-2 ID: the Destination Layer-2 ID to send the Relay Discovery Additional Information message is selected based on the configuration as described in clause 5.1.4.1.

- Relay Service Code: the Relay Service Code associated with the message. The Relay Service Code is used to identify the security parameters needed by the receiving UE to process the discovery message.

- Announcer Info: provides information about the announcing user (i.e. User Info ID of the 5G ProSe UE-to-Network Relay).

- Hop-Count: This value reflects the number of PC5 hops for the 5G ProSe Remote UE to reach the network. It is set to 1 by the 5G ProSe UE-to-Network Relay and incremented by 1 every time the Relay Discovery Additional Information message is forwarded by a 5G ProSe Intermediate UE-to-Network Relay.

A 5G ProSe Intermediate UE-to-Network Relay shall only process the Relay Discovery Additional Information message if the Hop-Count is present and the value is less than the (pre-)configured Hop-Limit value for the associated RSC.

- Announcer Info of 5G ProSe Intermediate UE-to-Network Relay: identify information (i.e. User Info ID) of the 5G ProSe Intermediate UE-to-Network Relay connected to 5G ProSe UE-to-Network Relay. This parameter is only applicable to the additional parameter announcement procedure over 5G ProSe multi-hop UE-to-Network Relay specified in clause 6.3.2.x.y.

- Additional parameters: the additional parameters for 5G ProSe Layer-3 UE-to-Network Relay (when applicable) are defined in clause 5.8.3.2.

NOTE 1: The UE implementation needs to ensure that when the UE self-selects Source Layer-2 IDs, the self-selected Source Layer-2 IDs are different between 5G ProSe Direct Discovery (including 5G ProSe UE-to-Network Relay Discovery) in clause 6.3.2 and 5G ProSe Direct Communication (including 5G ProSe UE-to-Network Relay Communication) in clause 6.4 and are different from any other provisioned Destination Layer-2 IDs as described in clause 5.1 and any other self-selected Source Layer-2 IDs used in a simultaneous 5G ProSe Direct Discovery (including 5G ProSe UE-to-Network Relay Discovery) with a different discovery model.

NOTE 2: If a 5G ProSe UE-to-Network Relay and 5G ProSe Remote UE from different PLMNs discover each other, it means that the Relay Service Code is associated with the same connectivity service, and the same Relay Service Code is provisioned based on Service Level Agreement among PLMNs.

*NEXT CHANGE*

#### 5.8.3.2 Identifiers for 5G ProSe Layer-3 UE-to-Network Relay

For 5G ProSe Layer-3 UE-to-Network relay, a Relay Service Code in the Announcement Message is associated with a set of PDU session parameters (e.g. PDU Session type, DNN, SSC Mode, S-NSSAI, Access Type Preference). The Relay Service Code may also represent if the relay UE can provide secure N3IWF connection.

For 5G ProSe Layer-3 Remote UE discovering 5G ProSe Layer-3 UE-to-Network relay, the Relay Service Code in the Solicitation Message represents the PDU session parameters that a PDU session of the relay should be able to support. The Relay Service Code may also represent if the remote UE requires secure N3IWF connection.

The following additional parameters may be used in the Relay Discovery Additional Information message (using Model A) for 5G ProSe Layer-3 UE-to-Network Relay:

- NCGI: indicates the NCGI of the serving cell of the 5G ProSe Layer-3 UE-to-Network Relay. This parameter may be requested by application running on 5G ProSe Layer-3 Remote UE.

- TAI: indicates the Tracking Area Identity of the serving cell of the 5G ProSe Layer-3 UE-to-Network Relay. This parameter may be used by 5G ProSe Layer-3 Remote UE to select a N3IWF.

- NCGI of 5G ProSe Intermediate UE-to-Network Relay: indicates the NCGI of the serving cell of the 5G ProSe Intermediate UE-to-Network Relay connected to the 5G ProSe UE-to-Network Relay. This parameter may be requested by application running on 5G ProSe Layer-3 Remote UE and is only applicable to the additional parameter announcement procedure over 5G ProSe multi-hop UE-to-Network Relay specified in clause 6.3.2.x.y.

*NEXT CHANGE*

6.3.2.x 5G ProSe Mulit-hop UE-to-Network Relay Discovery

6.3.2.x.1 General

5G ProSe Multi-hop UE-to-Network Relay Discovery is applicable to both 5G ProSe Multi-hop Layer-3 and Layer-2 UE-to-Network relay discovery for public safety use and commercial services. To perform 5G ProSe Multi-hop UE-to-Network Relay Discovery, the 5G ProSe Remote UE, the 5G ProSe Intermedidate UE-to-Network Relay and the 5G ProSe UE-to-Network Relay are (pre-)configured or provisioned with the related information as described in clause 5.1.4

The RSC is used in the 5G ProSe Multi-hop UE-to-Network Relay discovery, to indicate the connectivity service the 5G ProSe Intermedidate UE-to-Network Relay and the 5G ProSe UE-to-Network Relay provide to the 5G ProSe Remote UE. The maximum number of hops is provisioned by the network to the 5G ProSe Remote UE, 5G ProSe Intermedidate UE-to-Network Relay and the 5G ProSe UE-to-Network Relay per RSC. The 5G ProSe Multi-hop UE-to-Network Relay Discovery message may be dropped if the maximum number of hops is reached.

A 5G ProSe Multi-hop UE-to-Network Relay supporting multiple RSCs can advertise the RSCs using multiple discovery messages, with one RSC per discovery message.

Additional information not directly used for discovery can also be advertised using the PC5-D protocol stack in single or separate discovery messages of type "Relay Discovery Additional Information".

6.3.2.x.2 Procedure for 5G ProSe Multi-hop UE-to-Network Relay Discovery with Model A

Figure 6.3.2.x.2-1 provides an example operation procedures for 5G ProSe Multi-hop UE-to-Network Relay Discovery using Model A discovery.



Figure 6.3.2.x.2-1: 5G ProSe Multi-hop UE-to-Network Relay discovery procedure with Model A

0. The 5G ProSe Remote UE, the 5G ProSe Intermedidate UE-to-Network Relay and the 5G ProSe UE-to-Network Relay are (pre-)configured or provisioned with the related information to support Multi-hop UE-to-Network Relay discovery, as described in clause 5.1.4. If the 5G ProSe Remote UE, 5G ProSe Intermedidate UE-to-Network Relay and 5G ProSe UE-to-Network Relay belong to different PLMNs, their HPLMNs need to ensure consistent configuraitons are provided.

1. If a 5G ProSe UE-to-Network Relay is successfully registered and authorized by the 5GS and the above configurations to operate Multi-hop UE-to-Network Relay in the current region, it can start the discovery procedure below. Otherwise, it shall not perfrom the 5G ProSe Multi-hop UE-to-Network Relay discovery, i.e. not sending any announcement message or respond to any solicitation message.

2. The 5G ProSe UE-to-Network Relay sends a 5G ProSe UE-to-Network Relay Discovery Announcement message. To support Multi-hop UE-to-Network Relay discovery, the 5G ProSe UE-to-Network Relay sets the Hop-Count to 1, sets the Announcer Info to its own User Info ID, and sets the RSC according to the configuration as in clause 5.1.4.

3. The 5G ProSe Intermedidate UE-to-Network Relay creates a corresponding discovery entry based on the received 5G ProSe UE-to-Network Relay Discovery Announcement message, if the discovery message meets the AS layer criteria, and the Hop-Count is less than the Hop-Limit in the configuration.

 The discovery entry includes the following information: RSC, (optional) Root Relay Info, Announcer Info, Hop-Count, (optional) Accumlated QoS for PC5 link, (optional) NCGI, (optional) RRC Container.

 The Announcer Info is set to the Announcer Info of the received message. The Root Relay Info is set to the Announcer Info of the received mesasge, if the Hop-Count is set to 1 in the received message. In other cases, the Root Relay Info is set to the Root Relay Info of the reived message. The Hop-count is set to the value of the received message. The Accumlated QoS for PC5 link, if present in the received discovery message, will be updated based on the QoS of the PC5 link between the 5G ProSe Intermedidate UE-to-Network Relay and the sender of the message.

 If an discovery entry already exist, i.e. with the same RSC and (optional) Root Relay Info, the 5G ProSe Intermedidate UE-to-Network Relay updates the discovery entry accordingly, if the Hop-Count of the received message is less than the Hop-Count in the discovery entry. The Announcer Info will be set to the Annoncer Info of the newly received discovery message.

 If the RSC is for Layer-2 UE-to-Network Relay services and the NCGI is present in the message, the 5G ProSe Intermedidate UE-to-Network Relay considers an discovery entry matches a new received discovery message if the RSC, Root Relay Info, and the NCGI are the same.

NOTE 1: Based on implementation, a 5G ProSe Intermedidate UE-to-Network Relay may decide try update the discovery entry based on the Accumlated QoS for PC5 link instead of the Hop-Count, or a combination of the two information elements.

4a. 5G ProSe Intermedidate UE-to-Network Relay sends a 5G ProSe UE-to-Network Relay Discovery Announcement message, using the information from the stored discovery entry. The Hop-Count value will be incremented by 1, and the Announcer Info is set to the User Info of the 5G ProSe Intermedidate UE-to-Network Relay.

 When received by the 5G ProSe Remote UE, the information in the 5G ProSe UE-to-Network Relay Discovery Announcement message will be used for relay (re)selection, if the Hop-Count is less or equal to the Hop-Limit in the configuration. The 5G ProSe Remote UE can also take the Accomulated QoS for PC5 link into account. For relay reselection, the and the Root Relay Info may be used to prioritize a relay offering the connection to the same 5G ProSe UE-to-Network Relay.

4b. 5G ProSe Intermedidate UE-to-Network Relay sends a 5G ProSe UE-to-Network Relay Discovery Announcement message, using the information from the stored discovery entry. This message may reach another 5G ProSe Intermedidate UE-to-Network Relay.

5. The 5G ProSe Intermedidate UE-to-Network Relay drops the received message if the Hop-Count is not less than the configured Hop-Limit.

6. The 5G ProSe Intermedidate UE-to-Network Relay sets a locally configured timer for each of the discovery entry based on implementation. If the 5G ProSe Intermedidate UE-to-Network Relay does not have an active PC5 link with the relay identfied by the Announcer Info, and it does not receive any new announcement message from that relay, the 5G ProSe Intermedidate UE-to-Network Relay removes the corresponding discovery entry and stops sending related 5G ProSe UE-to-Network Relay Discovery Announcement message.

Based on configuration, the 5G ProSe Intermedidate UE-to-Network Relay may need to establish a Layer-2 link with the relay identified by the Announcer Info in the discovery entry before sending the 5G ProSe UE-to-Network Relay Discovery Announcement message containing this relay.

*NEXT CHANGE*

##### 6.3.2.x.y Additional parameters announcement procedure over 5G ProSe multi-hop UE-to-Network Relay

Additional parameters announcement procedure outlined in figure 6.3.2.x.y-1 is used by a 5G ProSe Remote UE to request a 5G ProSe UE-to-Network Relay to announce additional parameters (using Model A). The Additional parameters announcement procedure specified in clause 6.5.1.3 is used with the following differences described in the procedure below.



Figure 6.3.2.x.y-1: Procedure for additional parameters announcement for multi-hop UE-to-Network relaying

1. 5G ProSe Remote UE has discovered a 5G ProSe UE-to-Network Relay for connectivity to the network as described in clause 6.3.2.x.2, and requires additional parameters.

2. The 5G ProSe Remote UE sends to the 5G ProSe Intermediate UE-to-Network Relay an Additional Parameters Announcement Request including the following additional information to obtain additional parameters.

- Relay Service Code: information about the connectivity service provided by the 5G ProSe UE-to-Network Relay.

- Root Relay Info: identify information (i.e. User Info ID) of the 5G ProSe UE-to-Network Relay.

3-4. The Additional Parameters Announcement Request is sent up to the 5G ProSe UE-to-Network Relay.

5. The 5G ProSe UE-to-Network Relay acknowledges receipt of the request in step 4 with an Additional Parameters Announcement Response (Additional\_Parameters\_Announcement\_Request\_Refresh Timer).

6-7. The Additional Parameters Announcement Response is sent to the 5G ProSe Remote UE, relayed via the 5G ProSe Intermediate UE-to-Network Relay.

8. The 5G ProSe UE-to-Network Relay reuses the Relay Discovery Additional Information message as defined in clause 5.8.3 with the following additional information:

- Hop-Count: the value is set to 1.

The Destination Layer-2 ID to send the Relay Discovery Additional Information message is selected based on the configuration as described in clause 5.1.4.1.

9. The 5G ProSe Intermediate UE-to-Network Relay forwards the Relay Discovery Additional Information message. The 5G ProSe Intermediate UE-to-Network Relay updates the Hop-Count as below and may include additional information, Announcer Info and NCGI of 5G ProSe Intermediate UE-to-Network Relay if its NCGI is available:

- Hop-Count: the value of the received Relay Discovery Additonal Information message is incremented by 1.

- Announcer Info of 5G ProSe Intermediate UE-to-Network Relay: identity information (i.e. User Info ID) of the 5G ProSe Intermediate UE-to-Network Relay transmitting this message.

- NCGI of 5G ProSe Intermediate UE-to-Network Relay: indicates the NCGI of the serving cell of the 5G ProSe Intermediate UE-to-Network Relay.

10. The 5G ProSe Intermediate UE-to-Network Relay forwards the Relay Discovery Additional Information message, with the Hop-Count incremented. The 5G ProSe Intermediate UE-to-Network Relay shall not forward the Relay Discovery Additional Information message if the Hop-Count is bigger than the Hop-Limit.

11. The 5G ProSe UE-to-Network Relay detects new or updated additional parameters.

12-14. Same as steps 8-10.

If the 5G ProSe Intermediate UE-to-Network Relay connected to 5G ProSe UE-to-Network Relay detects new or updated additional parameters (e.g. due to change of its serving cell, moving into network coverage), it may send a Relay Discovery Additional Information message including the new or updated additional parameters. In this case, the 5G ProSe Intermediate UE-to-Network Relay acts as the 5G ProSe UE-to-Network Relay in Figure 6.3.2.x.y-1, i.e. to send Relay Discovery Additional Information message. The 5G ProSe Intermediate UE-to-Network Relay also keeps a record of the additional parameters from the 5G ProSe UE-to-Network Relay.

NOTE: The NCGI of the 5G ProSe Intermediate UE-to-Network Relay connected to 5G ProSe UE-to-Network Relay can be used as supplementary by the 5G ProSe Remote UE and not provided to the network side from the 5G ProSe Remote UE.

*NEXT CHANGE*

#### 6.4.3.x Layer-2 link management over PC5 reference point for 5G ProSe Multi-hop UE-to-Network Relay

##### 6.4.3.x.1 Layer-2 Link establishment and management

Each of the 5G ProSe Intermediate UE-to-Network Relay needs to establish a Layer-2 Link with its parent Intermediate UE-to-Network Relay or the 5G ProSe UE-to-Network Relay, before it can serve the 5G ProSe Remote UE, or a child Intermediate UE-to-Network Relay. RSC based configuration for the 5G ProSe Intermediate indicates whether it should establish the Layer-2 Link with a parent relay before it can participate in the discover operation.

Layer-2 link management procedure as defined in clause 6.4.3.6 for 5G ProSe UE-to-Network Relay operation can be re-used. When establishing the Layer-2 link with its parent relay (either a 5G ProSe UE-to-Network Relay or another 5G ProSe Intermediate UE-to-Network Relay), the 5G ProSe Intermediate UE-to-Network Relay takes the role of the 5G ProSe Remote UE and its parent relay takes the role of 5G ProSe UE-to-Network Relay. The Layer-2 link is established per RSC.

The 5G ProSe Remote UE can use the procedure defined in clause 6.4.5.6 to establish a Layer-2 Link with the selected 5G ProSe Intermediate UE-to-Network Relay. In this case, the Intermediate UE-to-Network Relay takes the role of of 5G ProSe UE-to-Network Relay.

NOTE: In the case of Layer-3 UE-to-Network Relay operation, only the root 5G ProSe UE-to-Network Relay needs to establish the PDU session with the network.

When an Intermediate UE-to-Network Relay has a child Intermediate UE-to-Network Relay or a 5G ProSe Remote UE connected, it needs to update the Layer-2 link with its parent relay, using the procedure defined in clause 6.4.3.4, with the following enhancements:

- The link modification procedure is enhanced to inform the parent relay, e.g. another 5G ProSe Intermediate UE-to-Network Relay or the 5G ProSe UE-to-Network Relay, of the User Info of the child relay or the Remote UE. The Link Modification Request message contains a list of 5G ProSe Remote UE (Remote User ID, Remote UE Info) and the corresponding PC5 QoS Flow associated with each 5G ProSe Remote UE. The Remote User ID and Remote UE Info are as defined in clasue 6.5.1.1.

This Layer-2 Link modification procedure will propagate back towards the 5G system, until it reaches a 5G ProSe UE-to-Network Relay or a 5G ProSe Intermediate UE-to-Network Relay that already has the context of these new list of Remote UEs.

The 5G ProSe UE-to-Network Relay's Remote UE reporting procedure will report all the Remote UE information.

##### 6.4.3.x.2 IP address/prefix management for 5G ProSe Layer-3 Multi-hop UE-to-Network Relay

When IP based PDU session types are used by the 5G ProSe UE-to-Network Relay, the Intermediate UE-to-Network Relay needs to act as an IP Router.

The actual IP address allocation is performed by the 5G ProSe UE-to-Network Relay, in the same way as that defined in clause 6.5.1.

To support DHCP based IP address configuration, the 5G ProSe Intermediate UE-to-Network Relay act as a DHCPv4 or DHCPv6 proxy. To support IPv6 SLAAC, the 5G ProSe Intermediate UE-to-Network Relay also relays the Router Solicitation and Router Announcement messages between the 5G ProSe Remote UE and the 5G ProSe UE-to-Network Relay.

The 5G ProSe Intermediate UE-to-Network Relay builds its local IP routing table based on the Remote UE info from the link modification procedures as described in clause 6.4.2.x.1. The local IP routing table is per RSC and used based on RSC of the link the packet is received.

##### 6.4.3.x.3 Relay reselection and mobility support

There are two types of scenarios for parent relay reselection, i.e. for a single 5G ProSe Remote UE, and for a 5G ProSe Intermediate UE-to-Network Relay with multiple child relays or 5G ProSe Remote UEs.

For a single 5G ProSe Remote UE, when it lost the connection with its old parent relay (either a 5G ProSe Intermediate UE-to-Network Relay or a 5G ProSe UE-to-Network Relay), it may select another relay offers the same service, identified by the same RSC.



Figure 6.4.3.x.3-1: Relay reselection for 5G ProSe Remote UE with 5G ProSe Multi-hop UE-to-Network Relays

Figure 6.4.3.x.3-1 illustrates an example operation for for this scenario. The 5G ProSe Remote UE has lost the connection or has an imminent connection loss/deteriorated connection with the 5G ProSe Intermediate UE-to-Network Relay-1 and the Remote UE discovered the 5G ProSe Intermediate UE-to-Network Relay -2 that offers the same RSC. In this case, the 5G ProSe Intermediate UE-to-Network Relay -2 can even offer the connection to the same 5G ProSe UE-to-Network Relay. 5G ProSe Remote UE can prioritize 5G ProSe Intermediate UE-to-Network Relay -2 if there are other discovered 5G ProSe Intermediate UE-to-Network Relay connected to different 5G ProSe UE-to-Network Relay.

5G ProSe Remote UE establishes the Layer-2 link with the 5G ProSe Intermediate UE-to-Network Relay-2 as described in clause 6.4.3.x.1. After the connection establishment, the Intermediate UE-to-Network Relay-2 uses the Layer-2 Link Modification procedure to update the 5G ProSe UE-to-Network Relay regarding the 5G ProSe Remote UE. As the 5G ProSe UE-to-Network Relay is aware of the 5G ProSe Remote UE, it can switch the connection/routing context from the Layer-2 link with the 5G Intermediate UE-to-Network Relay-1 to that of the Layer-2 link with the 5G ProSe Intermediate UE-to-Network Relay-2.

The 5G ProSe Remote UE may tear down the link with the 5G ProSe Intermediate UE-to-Network Relay-1 (or the link failure is detected), which will trigger the 5G ProSe Intermediate UE-to-Network Relay-1 to update the 5G ProSe UE-to-Network Relay to remove its association with 5G ProSe Remote UE.

If the same 5G ProSe UE-to-Network Relay is selected after the relay reselection, the 5G ProSe Remote UE can keep its IP address/prefix (in case of Layer-3 UE-to-Network relay) or its RAN anchor point (in case of Layer-2 UE-to-Network Relay).

If a new 5G ProSe UE-to-Network Relay is used after the relay reselection, the procedures as that described in clause 6.4.3.x.1 will be executed again. In this case, there will be IP address/prefix changes after the relay reselection (in case of Layer-3 UE-to-Network relay) or its end to end AS layer procedures (in case of Layer-2 UE-to-Network Relay).

If the parent relay reselection is performed by an 5G Intermediate UE-to-Network Relay (which is serving 5G ProSe Remote UEs or child 5G Intermediate UE-to-Network Relays), it is also preferrable to select a new relay that shares the same 5G ProSe UE-to-Network Relay. When estalbishing the Layer-2 link with the selected relay, the 5G ProSe Intermediate UE-to-Network Relay needs to run the Layer-2 link modification procedure after the connection establishment to update the selected relay of all the 5G Remote UEs it is serving.

*End of CHANGEs*