**h3GPP TSG-RAN WG2 Meeting #130 *R2-250xxxx***

**Wuhan, China, Apr.7th – 11th, 2025**

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| *CR-Form-v12.3* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **38.300** | **CR** | **draft** | **rev** |  | **Current version:** | **18.5.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network | **x** | Core Network |  |

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|  | | | | | | | | | | |
| ***Title:*** | Multi-hop U2N Relay in TS 38.300 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | LG Electronics (Rapporteur) | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_SL\_relay\_multihop | | | | |  | ***Date:*** | | | 2025-07-16 |
|  |  | | | |  | |  | | |  |
| ***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 can be 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:*** | | Introduction of multi-hop U2N relay | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | 1. In clause 3.2, the definition of last U2N Relay UE is introduced. It’s aligned with R2-2503088. 2. In clause 16.12.1single-hop/multi-hop is clarified. 3. In clause 16.12.2.1, multi-hop U2N relay architecture is introduced. 4. In clause 16.12.3, multi-hop U2N relay operation in terms of discovery message is introduced. 5. In clause 16.12.4, multi-hop U2N relay operation in terms of relay selection and reselection. 6. In clause 16.12.5.1, control plane procedure for multi-hop L2 U2N Relay is introduced. 7. In clause 16.12.6.1, multi-hop indirect to direct path switching is introduced. 8. In clause 16.12.6.2, direct to multi-hop indirect path switching is introduced. 9. In clause 16.12.6.3, multi/single-hop indirect to single/multi-hop indirect path switching is introduced. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | If the CR is not approved there is no support for multi-hop sidelink U2N relay operation in NR. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 3.2, 16.12.1, 16.12.2.1, 16.12.3, 16.12.4, 16.12.5.1, 16.12.6.1, 16.12.6.2, 16.12.6.3 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | TS 38.331 CR, TS 38.304 CR, TS 38.321 CR, TS 38.351 CR | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

START OF CHANGE

## 3.2 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1], in TS 36.300 [2] 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 36.300 [2].

**2Rx XR UE**: two antenna port XR UE as specified in TS 38.101-1 [18].

**A2X communication**: A communication to support A2X services leveraging PC5 reference points. A2X services are realized by various types of A2X applications, i.e. BRID or DAA.

**Aerial UE communication:** functionality enabling Aerial UE function, as defined in 16.18.

**Air to Ground network:** An NG-RAN consisting of ground-based gNBs, which provide cell towers that send signals up to an aircraft's antenna(s) of onboard ATG terminal, with typical vertical altitude of around 10,000m and take-off/landing altitudes down to 3000m.

**BH RLC channel**: an RLC channel between two nodes, which is used to transport backhaul packets**.**

**Boundary IAB-node:** as defined in TS 38.401 [4].

**Broadcast MRB**:A radio bearer configured for MBS broadcast delivery.

**CAG Cell**:a PLMN cell broadcasting at least one Closed Access Group identity.

**CAG Member Cell**:for a UE, a CAG cell broadcasting the identity of the selected PLMN, registered PLMN or equivalent PLMN, and for that PLMN, a CAG identifier belonging to the Allowed CAG list of the UE for that PLMN.

**CAG-only cell**: a CAG cell that is only available for normal service for CAG UEs.

**Cell-Defining SSB**: an SSB with an RMSI associated.

**Child node**: IAB-DU's and IAB-donor-DU's next hop neighbour node; the child node is also an IAB-node.

**Child UE:** A U2N Relay UE’s next hop in downstream direction for serving a U2N Remote UE in U2N Relay communication. Child UE can be the U2N Remote UE or a U2N Relay UE.

**Conditional Handover (CHO**): a handover procedure that is executed only when execution condition(s) are met.

**CORESET#0**: the control resource set for at least SIB1 scheduling, can be configured either via MIB or via dedicated RRC signalling.

**DAPS Handover**: a handover procedure that maintains the source gNB connection after reception of RRC message for handover and until releasing the source cell after successful random access to the target gNB.

**Data Burst:** A set of multiple PDUs generated and sent by the application in a short period of time, as defined in TS 23.501 [3].

**Direct Path**: a type of UE-to-Network transmission path, where data is transmitted between a UE and the network without sidelink relaying.

**Downstream**: direction toward child node or UE in IAB-topology or U2N Remote UE in U2N Relay communication.

**Early Data Forwarding**: data forwarding that is initiated before the UE executes the handover.

**Earth-centered, earth-fixed**: a global geodetic reference system for the Earth intended for practical applications of mapping, charting, geopositioning and navigation, as specified in NIMA TR 8350.2 [51].

**eRedCap UE**: a UE with enhanced reduced capabilities as specified in clause 4.2.22.1 in TS 38.306 [11].

**Feeder link**: wireless link between the NTN Gateway and the NTN payload.

**First U2N Relay UE**: an Intermediate U2N Relay UE having both PC5 connection to a parent UE and PC5 connection to a U2N Remote UE for serving the U2N Remote UE in case of multi-hop L2 U2N Relay communication.

**Geosynchronous Orbit**: earth-centered orbit at approximately 35786 kilometres above Earth's surface and synchronised with Earth's rotation. A geostationary orbit is a non-inclined geosynchronous orbit, i.e. in the Earth's equator plane.

**Group ID for Network Selection**: an identifier used during SNPN selection to enhance the likelihood of selecting a preferred SNPN that supports a Default Credentials Server or a Credentials Holder, as specified in TS 23.501 [3].

**gNB**: node providing NR user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**High Altitude Platform Station**: airborne vehicle embarking the NTN payload placed at an altitude between 8 and 50 km.

**IAB-donor**:gNB that provides network access to UEs via a network of backhaul and access links.

**IAB-donor-CU**: as defined in TS 38.401 [4].

**IAB-donor-DU**:as defined in TS 38.401 [4].

**IAB-DU**: gNB-DU functionality supported by the IAB-node to terminate the NR access interface to UEs and next-hop IAB-nodes, and to terminate the F1 protocol to the gNB-CU functionality, as defined in TS 38.401 [4], on the IAB-donor.

**IAB-MT**: IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise. IAB-MT function used in 38-series of 3GPP Specifications corresponds to IAB-UE function defined in TS 23.501 [3].

**IAB-node**: RAN node that supports NR access links to UEs and NR backhaul links to parent nodes and child nodes. The IAB-node does not support backhauling via LTE.

**IAB topology**: the unison of all IAB-nodes and IAB-donor-DUs whose F1 and/or RRC connections are terminated at the same IAB-donor-CU.

**Indirect Path**: a type of UE-to-Network transmission path, where data is forwarded via a U2N Relay UE between a U2N Remote UE and the network.

**Intermediate U2N Relay UE**: a U2N Relay UE having both PC5 connection to a parent UE and PC5 connection to a child UE or a U2N Remote UE for serving the U2N Remote UE in case of multi-hop L2 U2N Relay communication.

**Inter-donor partial migration:** migration of an IAB-MT to a parent node underneath a different IAB-donor-CU while the collocated IAB-DU and its descendant IAB-node(s), if any, are terminated at the initial IAB-donor-CU. The procedure renders the said IAB-node as a boundary IAB-node.

**Intra-system Handover**:handover that does not involve a CN change (EPC or 5GC).

**Inter-system Handover**:handover that involves a CN change (EPC or 5GC).

**Late Data Forwarding**: data forwarding that is initiated after the source NG-RAN node knows that the UE has successfully accessed a target NG-RAN node.

**Last U2N Relay UE**: a U2N Relay UE having both Uu connection to the network and PC5 connection to a child UE for serving a U2N Remote UE in case of L2 U2N Relay communication.

Editor’s note: FFS whether the term ‘Last U2N Relay UE’ can also cover single-hop U2N Relay UE, if needed, i.e. single-hop U2N Relay UE can be also called ‘Last U2N Relay UE’ in Rel-19 specifications.

**L1/L2 Triggered Mobility**: a cell switch procedure that the network triggers via MAC CE based on L1 or L3 measurement report.

**Mapped Cell ID**: in NTN, it corresponds to a fixed geographical area.

**MBS Radio Bearer**: A radio bearer configured for MBS delivery.

**Mobile-IAB cell**: a cell of a mobile IAB-DU.

**Mobile IAB-DU**: gNB-DU functionality supported by the mobile IAB-node to terminate the NR access interface to UEs, and to terminate the F1 protocol to the gNB-CU functionality on the IAB-donor, as defined in TS 38.401 [4].

**Mobile IAB-DU migration**: procedure for a mobile IAB-node as defined in TS 38.401 [4].

**Mobile IAB-MT**: mobile IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise.

**Mobile IAB-MT migration**: procedure for a mobile IAB-MT as defined in TS 38.401 [4].

**Mobile IAB-node**: RAN node that supports NR access links to UEs and an NR backhaul link to a parent node, and that can conduct physical mobility across the RAN area. The mobile IAB-node function used in 38-series of 3GPP Specifications corresponds to the MBSR function defined in TS 23.501 [3].

**MP Relay UE**: a UE that provides functionality to support connectivity to the network for MP Remote UE(s).

**MP Remote UE**: a UE that communicates with the network via a direct Uu link and a MP Relay UE.

**MSG1**: preamble transmission of the random access procedure for 4-step random access (RA) type.

**MSG3**: first scheduled transmission of the random access procedure.

**MSGA**:preamble and payload transmissions of the random access procedure for 2-step RA type.

**MSGB**:response to MSGA in the 2-step random access procedure. MSGB may consist of response(s) for contention resolution, fallback indication(s), and backoff indication.

**Multicast/Broadcast Service**: A point-to-multipoint service as defined in TS 23.247 [45].

**Multicast MRB**:A radio bearer configured for MBS multicast delivery.

**Multi-hop backhauling**: using a chain of NR backhaul links between an IAB-node and an IAB-donor.

**NCR-Fwd**: Network-Controlled Repeater node function, which performs amplifying-and-forwarding of UL/DL RF signals between gNB and UE. The behaviour of the NCR-Fwd is controlled according to the side control information received by the NCR-MT from a gNB.

**NCR-Fwd access link**: link used for transmissions between the NCR-Fwd and UEs.

**NCR-Fwd backhaul link**: link used for backhauling between the NCR-Fwd and gNB.

**NCR-MT**: NCR-node entity which communicates with a gNB via a control link to receive side control information. The control link is based on NR Uu interface.

**NCR-node**: RAN node comprising NCR-MT and NCR-Fwd.

**ng-eNB**: node providing E-UTRA user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**NG-C**: control plane interface between NG-RAN and 5GC.

**NG-U**: user plane interface between NG-RAN and 5GC.

**NG-RAN node**: either a gNB or an ng-eNB.

**Non-CAG Cell**: a PLMN cell which does not broadcast any Closed Access Group identity.

**Non-Cell Defining SSB**: an SSB without an RMSI associated.

**Non-Geosynchronous orbit**: earth-centered orbit with an orbital period that does not match Earth's rotation on its axis. This includes Low and Medium Earth Orbit (LEO and MEO). LEO operates at altitudes between 300 km and 1500 km and MEO at altitudes between 7000 km and 25000 km, approximately.

**Non-terrestrial network**: an NG-RAN consisting of gNBs, which provide non-terrestrial NR access to UEs by means of an NTN payload embarked on an airborne or space-borne NTN vehicle and an NTN Gateway.

**NR backhaul link**: NR link used for backhauling between an IAB-node and an IAB-donor, and between IAB-nodes in case of a multi-hop backhauling.

**NR sidelink communication**: AS functionality enabling at least V2X communication as defined in TS 23.287 [40] and/or A2X communication as defined in TS 23.256 [60] and/or the ProSe communication (including ProSe non-Relay and UE-to-Network Relay communication) as defined in TS 23.304 [48], between two or more nearby UEs, using NR technology but not traversing any network node.

**NR sidelink discovery**: AS functionality enabling ProSe non-Relay Discovery and ProSe UE-to-Network Relay discovery for Proximity based Services as defined in TS 23.304 [48] between two or more nearby UEs, using NR technology but not traversing any network node.

**NTN Gateway**: an earth station located at the surface of the earth, providing connectivity to the NTN payload using the feeder link. An NTN Gateway is a TNL node.

**NTN payload**: a network node, embarked on board a satellite or high altitude platform station, providing connectivity functions, between the service link and the feeder link. In the current version of this specification, the NTN payload is a TNL node.

**Numerology**: corresponds to one subcarrier spacing in the frequency domain. By scaling a reference subcarrier spacing by an integer *N*, different numerologies can be defined.

**Parent node**: IAB-MT's or mobile IAB-MT's next hop neighbour node; the parent node can be an IAB-node or IAB-donor-DU

**Parent UE:** A U2N Remote UE or U2N Relay UE’s next hop U2N Relay UE in upstream direction for serving the U2N Remote UE in U2N Relay communication.

**PC5 Relay RLC channel**: an RLC channel between L2 U2N Remote UE and L2 U2N Relay UE, between L2 U2N Relay UEs (in case of multi-hop L2 U2N relay communication), or between L2 U2U Remote UE and L2 U2U Relay UE, which is used to transport packets over PC5 for L2 UE-to-Network/UE-to-UE Relay**.**

**PDU Set**: one or more PDUs carrying the payload of one unit of information generated at the application level (e.g. frame(s) or video slice(s) for XR Services), as defined in TS 23.501 [3].

**PLMN Cell**: a cell of the PLMN.

**RACH-less LTM**: an LTM cell switch procedure where UE skips the random access procedure.

**RedCap UE**: a UE with reduced capabilities as specified in clause 4.2.21.1 in TS 38.306 [11].

**Relay discovery**: AS functionality enabling 5G ProSe UE-to-Network Relay Discovery as defined in TS 23.304 [48], using NR technology but not traversing any network node.

**Satellite**:a space-borne vehicle orbiting the Earth embarking the NTN payload.

**Service link**:wireless link between the NTN payload and UE.

**Sidelink Discovery RSRP:** RSRP measurements on PC5 link related to NR sidelink discovery.

**Sidelink RSRP:** RSRP measurements on PC5 link related to NR sidelink communication.

**SNPN Access Mode**: mode of operation whereby a UE only accesses SNPNs.

**SNPN-only cell**: a cell that is only available for normal service for SNPN subscribers.

**SNPN Identity**: the identity of Stand-alone NPN defined by the pair (PLMN ID, NID).

**Special Cell:** For Dual Connectivity operation the term Special Cell refers to the PCell of the MCG or the PSCell of the SCG, otherwise, in case of NR Standalone, the term Special Cell refers to the PCell.

**Transmit/Receive Point**:part of the gNB transmitting and receiving radio signals to/from UE according to physical layer properties and parameters inherent to that element.

**U2N Relay UE**: a UE that provides functionality to support connectivity to the network for U2N Remote UE(s). Up to three L2 U2N Relay UEs (i.e. one Last U2N Relay and up to two Intermediate U2N Relays including one First U2N Relay) can be configured for serving a L2 U2N Remote UE in multi-hop L2 U2N Relay communication in this release.

**U2N Remote UE**: a UE that communicates with the network via one or more U2N Relay UEs on an indirect path.

**U2U Relay UE**: a UE that provides functionality to support connectivity between two U2U Remote UEs.

**U2U Remote UE**: a UE that communicates with other UE(s) via a U2U Relay UE.

**UE-to-Network Relay communication:** A mode of communication in which a UE communicates with the network through an indirect path involving only one U2N Relay UE for single-hop L2 U2N Relay communication or multiple L2 U2N Relay UEs for multi-hop L2 U2N Relay communication.

**UE-to-Network Relay discovery:** A mode of NR sidelink discovery in which a UE disovers other UEs for U2N Relay communication.

**Upstream**: direction toward parent node in IAB-topology or gNB in U2N Relay communication.

**Uu Relay RLC channel**: an RLC channel between L2 U2N Relay UE or MP Relay UE and gNB, which is used to transport packets over Uu for L2 UE-to-Network Relay or for indirect path in case of MP.

**V2X sidelink communication**: AS functionality enabling V2X communication as defined in TS 23.285 [41], between nearby UEs, using E-UTRA technology but not traversing any network node.

**Xn**: network interface between NG-RAN nodes.

## 16.12 Sidelink Relay

### 16.12.1 General

Sidelink relay supports 5G ProSe UE-to-Network Relay (U2N Relay) function (specified in TS 23.304 [48]) to provide single/multi-hop connectivity to the network for U2N Remote UE(s). Both L2 and L3 U2N Relay architectures are supported. The L3 U2N Relay architecture is transparent to the serving NG-RAN of the U2N Relay UE, except for controlling sidelink resources. The detailed architecture and procedures for L3 U2N Relay can be found in TS 23.304 [48].

A U2N Relay UE shall be in RRC\_CONNECTED to perform relaying of unicast data.

For L2 U2N Relay operation, the following RRC state combinations are supported:

- Both L2 U2N Relay UE and L2 U2N Remote UE shall be in RRC\_CONNECTED to perform transmission/reception of relayed unicast data; and

- The L2 U2N Relay UE can be in RRC\_IDLE, RRC\_INACTIVE or RRC\_CONNECTED as long as all the L2 U2N Remote UE(s) that are connected to the L2 U2N Relay UE are either in RRC\_INACTIVE or in RRC\_IDLE.

A single unicast link is established between one L2 U2N Relay UE and one L2 U2N Remote UE and, in case of multi-hop L2 U2N relay, between L2 U2N Relay UEs. The traffic to the NG-RAN of L2 U2N Remote UE via a given L2 U2N Relay UE and the traffic of the L2 U2N Relay UE shall be separated in different Uu RLC channels.

In multi-hop U2N Relay, U2N Remote UE refers to both the actual U2N Remote UE and the intermediate U2N Relay UE that also functions as a U2N Remote UE.

For L2 U2N Relay, the L2 U2N Remote UE can only be configured to use resource allocation mode 2 (as specified in 5.7.2 and 16.9.3.1) for data to be relayed.

Sidelink relay additionally supports 5G ProSe UE-to-UE Relay (U2U Relay) function (specified in TS 23.304 [48]) to provide connectivity between U2U Remote UEs. Both L2 and L3 U2U Relay architectures are supported. The L3 U2U Relay architecture is transparent to the AS layer of the U2U Relay UE. The detailed architecture and procedures for L3 U2U Relay can be found in TS 23.304 [48].

A U2U Relay UE is used to provide coverage extension of the sidelink transmissions between two U2U Remote UEs. For the coverage extension, the U2U Remote UE can communicate with a peer U2U Remote UE(s), which are not reachable within the sidelink coverage, via the U2U Relay UE.

The U2U Relay UE and U2U Remote UE can be in any RRC state. The U2U Relay UE and the U2U Remote UEs can be in the coverage of the same or different cells or out-of-coverage. Both sidelink resource allocation modes, i.e., mode 1 and mode 2 are supported for the U2U Relay UE and U2U Remote UEs. For U2U Relay, a single PC5 unicast link is established between U2U Relay UE and each of the U2U Remote UEs. After PC5 unicast link establishment between U2U Relay UE and U2U Remote UEs, end-to-end PC5 unicast link connection establishment is performed between U2U Remote UEs. Only unicast is supported between U2U Relay UE and U2U Remote UEs.

### 16.12.2 Protocol Architecture

#### 16.12.2.1 L2 UE-to-Network Relay

The protocol stacks for the user plane and control plane of single-hop L2 U2N Relay architecture are illustrated in Figure 16.12.2.1-1 and Figure 16.12.2.1-2. The protocol stacks for the user plane and control plane of multi-hop L2 U2N Relay architecture are illustrated in Figure 16.12.2.1-3 and Figure 16.12.2.1-4. The SRAP sublayer is placed above the RLC sublayer for both CP and UP at both PC5 interface and Uu interface. The Uu SDAP, PDCP and RRC are terminated between L2 U2N Remote UE and gNB, while SRAP, RLC, MAC and PHY are terminated in each hop (i.e., the link between L2 U2N Remote UE and the L2 U2N Relay UE, the link between L2 U2N Relay UEs, and the link between L2 U2N Relay UE and the gNB).

For L2 U2N Relay, the SRAP sublayer over PC5 hop is only for the purpose of bearer mapping. The SRAP sublayer is not present over PC5 hop for relaying the L2 U2N Remote UE's message on BCCH and PCCH. For L2 U2N Remote UE's message on SRB0, the SRAP header is not present over PC5 hop between the U2N Remote UE and the directly connected U2N Relay UE, but the SRAP header is present over Uu hop or PC5 hop between U2N Relay UEs for both DL and UL.



Figure 16.12.2.1-1: User plane protocol stack for single-hop L2 UE-to-Network Relay



Figure 16.12.2.1-2: Control plane protocol stack for single-hop L2 UE-to-Network Relay



Figure 16.12.2.1-3: User plane protocol stack for multi-hop L2 UE-to-Network Relay



Figure 16.12.2.1-4: Control plane protocol stack for multi-hop L2 UE-to-Network Relay

For L2 U2N Relay, for uplink:

- The Uu/PC5 SRAP sublayer at the U2N Relay UE performs UL bearer mapping between end-to-end Uu Radio Bearers of L2 U2N remote UE (identified for the purposes of this mapping by the local Remote UE ID and an associated bearer ID) and egress Uu/PC5 Relay RLC channels over the L2 U2N Relay UE Uu/PC5 interface. For uplink relaying traffic, the different end-to-end Uu Radio Bearers (SRBs or DRBs) of the same L2 U2N Remote UE and/or different L2 U2N Remote UEs can be multiplexed over the same egress Uu/PC5 Relay RLC channel;

- The Uu/PC5 SRAP sublayer at the U2N Relay UE supports L2 U2N Remote UE identification for the UL traffic. The identity information of L2 U2N Remote UE end-to-end Uu Radio Bearer and a local Remote UE ID are included in the Uu SRAP header at UL in order for gNB to correlate the received packets for the specific PDCP entity associated with the right end-to-end Uu Radio Bearer of the L2 U2N Remote UE;

- The PC5 SRAP sublayer at the L2 U2N Remote UE supports UL bearer mapping between L2 U2N Remote UE end-to-end Uu Radio Bearers and egress PC5 Relay RLC channels.

For L2 U2N Relay, for downlink:

- The Uu SRAP sublayer performs DL bearer mapping at gNB to map end-to-end Uu Radio Bearer (SRB, DRB) of L2 U2N Remote UE (identified for the purposes of this mapping by the local Remote UE ID and an associated bearer ID) into Uu Relay RLC channel. The Uu/PC5 SRAP sublayer at the U2N Relay UE performs DL bearer mapping and data multiplexing between multiple end-to-end Radio Bearers (SRBs or DRBs) of a L2 U2N Remote UE and/or different L2 U2N Remote UEs and one Uu Relay RLC channel over the L2 U2N Relay UE Uu/PC5 interface;

- The Uu/PC5 SRAP sublayer at the U2N Relay UE supports L2 U2N Remote UE identification for DL traffic. The identity information of L2 U2N Remote UE end-to-end Uu Radio Bearer and a local Remote UE ID are included into the Uu SRAP header by the gNB at DL for the L2 U2N Relay UE to identify the corresponding end-to-end Uu Radio Bearer(s) of L2 U2N Remote UE;

- The PC5 SRAP sublayer at the L2 U2N Relay UE performs DL bearer mapping between end-to-end Uu Radio Bearers of L2 U2N remote UE and egress PC5 Relay RLC channels;

- The PC5 SRAP sublayer at the L2 U2N Remote UE correlates the received packets with the right PDCP entity associated with the given end-to-end Uu Radio Bearer of the L2 U2N Remote UE based on the identity information included in the PC5 SRAP header.

A local Remote UE ID is included in both PC5 SRAP header and Uu SRAP header. L2 U2N Relay UE is configured by the gNB with the local Remote UE ID(s) to be used in SRAP header. L2 U2N Remote UE obtains the local Remote ID from the gNB via Uu RRC messages including *RRCSetup*, *RRCReconfiguration*, *RRCResume* and *RRCReestablishment*.

The end-to-end DRB(s) or end-to-end SRB(s), except SRB0, of L2 U2N Remote UE can be multiplexed to the PC5 Relay RLC channels and Uu Relay RLC channels in both PC5 hop and Uu hop, but an end-to-end DRB and an end-to-end SRB can neither be mapped into the same PC5 Relay RLC channel nor be mapped into the same Uu Relay RLC channel.

It is the gNB responsibility to avoid collision on the usage of local Remote UE ID. The gNB can update the local Remote UE ID by sending the updated local Remote UE ID via *RRCReconfiguration* message. The serving gNB can perform local Remote UE ID update independent of the PC5 unicast link L2 ID update procedure.

#### 16.12.2.2 L2 UE-to-UE Relay

The protocol stacks for the user plane and the control plane of the L2 U2U Relay architecture are illustrated in Figure 16.12.2.2-1 and Figure 16.12.2.2-2. The SRAP sublayer is placed above the RLC sublayer for both CP and UP at both PC5 interfaces. The sidelink SDAP, PDCP and RRC are terminated between two L2 U2U Remote UEs (i.e., end-to-end), while SRAP, RLC, MAC and PHY are terminated in each hop of PC5 link.



Figure 16.12.2.2-1: User plane protocol stack for L2 UE-to-UE Relay



Figure 16.12.2.2-2: Control plane protocol stack for L2 UE-to-UE Relay

For L2 UE-to-UE Relay, the SRAP sublayer at L2 U2U Remote UE:

- The SRAP sublayer at L2 U2U Remote UE performs bearer mapping between end-to-end PC5 Radio Bearers (SL-SRBs or SL-DRBs) of the L2 U2U Remote UE and PC5 Relay RLC Channels between the L2 U2U Remote UE and the L2 U2U Relay UE.

- For the traffic transmitted from an L2 U2U Remote UE to an L2 U2U Relay UE, the different end-to-end PC5 Radio Bearers (SL-SRBs or SL-DRBs) towards the same peer L2 U2U Remote UE and/or different peer L2 U2U Remote UEs can be multiplexed to the same PC5 Relay RLC channel between the L2 U2U Remote UE(s) and the L2 U2U Relay UE. An end-to-end SL-DRB and an end-to-end SL-SRB cannot be multiplexed to the same PC5 Relay RLC channel.

- For the traffic received at L2 U2U Remote UE, the same PC5 Relay RLC channel from one L2 U2U Relay UE can be de-multiplexed to the different end-to-end PC5 Radio Bearers (SL-SRBs or SL-DRBs) of the same peer L2 U2U Remote UE and/or different peer L2 U2U Remote UEs.

- The SRAP sublayer at L2 U2U Remote UE supports identification of the peer L2 U2U Remote UE and itself. The local IDs are assigned by L2 U2U Relay UE to both L2 U2U Remote UEs for identification. For the two local IDs, one of them identifies L2 U2U Remote UE and the other identifies the peer L2 U2U Remote UE. The local ID of the peer L2 U2U Remote UE and the local ID of L2 U2U Remote UE are delivered by L2 U2U Relay UE to the L2 U2U Remote UEs along with the corresponding L2 ID of the peer L2 U2U Remote UE. The SRAP header includes the identity information of the end-to-end PC5 Radio Bearer and two local IDs. The peer L2 U2U Remote UE matches the received packets with the specific sidelink PDCP entity with the correct end-to-end PC5 Radio Bearer of the L2 U2U Remote UEs.

For L2 UE-to-UE Relay, the SRAP sublayer at L2 U2U Relay UE:

- The SRAP sublayer at L2 U2U Relay UE determines the egress PC5 Relay RLC Channel based on the mapping of the end-to-end PC5 Radio Bearer and egress PC5 Relay RLC Channel for a particular pair of L2 U2U Remote UE and the peer L2 U2U Remote UE.

- For the ingress traffic received from an/multiple L2 U2U Remote UE(s) at L2 U2U Relay UE, the different end-to-end PC5 Radio Bearers (SL-SRBs or SL-DRBs) of the same L2 U2U Remote UE and/or the same/different end-to-end PC5 Radio Bearers (SL-SRBs or SL-DRBs) of L2 U2U Remote UEs can be multiplexed to the same egress PC5 Relay RLC channel in between the L2 U2U Relay UE and the peer L2 U2U Remote UE. An end-to-end SL-DRB and an end-to-end SL-SRB cannot be multiplexed to the same PC5 Relay RLC channel.

### 16.12.3 Relay Discovery

Model A and Model B discovery models as defined in TS 23.304 [48] are supported for U2N/U2U Relay discovery. The protocol stack used for discovery is illustrated in Figure 16.12.3-1.



Figure 16.12.3-1: Protocol Stack of Discovery Message for UE-to-Network/UE-to-UE Relay

The U2N Remote UE can perform Relay discovery message (i.e., as specified in TS 23.304 [48]) transmission and may monitor the sidelink for Relay discovery message while in RRC\_IDLE, RRC\_INACTIVE or RRC\_CONNECTED. The network may broadcast or configure via dedicated RRC signalling a Uu RSRP threshold, which is used by the U2N Remote UE to determine if it can transmit Relay discovery messages to U2N Relay UE(s).

The U2N Relay UE can perform Relay discovery message (i.e., as specified in TS 23.304 [48]) transmission and may monitor the sidelink for Relay discovery message while in RRC\_IDLE, RRC\_INACTIVE or RRC\_CONNECTED. The network may broadcast or configure via dedicated RRC signalling a maximum Uu RSRP threshold, a minimum Uu RSRP threshold, or both, which are used by the U2N Relay UE to determine if it can transmit Relay discovery messages to U2N Remote UE(s).

In multi-hop U2N relay, one U2N Relay UE establishes a PC5 connection with each of its child UE(s). One intermediate U2N Relay UE or U2N Remote UE maintains a single PC5 connection with its parent UE.

The U2U Remote UE and U2U Relay UE can perform Relay discovery message transmission or DCR/DCA message with integrated discovery transmission and may monitor for Relay discovery message or DCR/DCA message with integrated discovery while in coverage (i.e. RRC\_IDLE, RRC\_INACTIVE, or RRC\_CONNECTED) or out-of-coverage.

The network may provide the Relay discovery configuration using broadcast or dedicated signalling. In addition, the U2N/U2U Remote UE, L3 U2N Relay UE and U2U Relay UE may use pre-configuration for Relay discovery. If the candidate intermediate U2N Relay UE is out of coverage without a PC5 connection to a parent UE, it can forward discovery messages based on pre-configuration. If the candidate intermediate U2N Relay UE is in coverage without a PC5 connection to a parent UE or out of coverage with a PC5 connecteion to a parent UE, it can forward discovery message based on SIB12 or dedicated configuration.

The resource pool(s) used for NR sidelink communication can be used for Relay discovery or the network may configure resource pool(s) dedicated for Relay discovery. Resource pool(s) dedicated for Relay discovery can be configured simultaneously with resource pool(s) for NR sidelink communication in system information, dedicated signalling and/or pre-configuration. Whether dedicated resource pool(s) for Relay discovery are configured is based on network implementation. If resource pool(s) dedicated for Relay discovery are configured, only those resource pool(s) dedicated for Relay discovery shall be used for Relay discovery. If only resource pool(s) for NR sidelink communication are configured, all the configured resource pool(s) can be used for Relay discovery and NR sidelink communication. Only the resource pool for NR sidelink communication is used for the DCR/DCA message with integrated discovery.

For U2N Remote UE (including both in-coverage and out of coverage cases) that has been connected to the network via single/multip-hop U2N Relay UE(s), only resource allocation mode 2 is used for Relay discovery message transmission.

For in-coverage U2N Relay UE, and for both in-coverage and out of coverage U2N Remote UEs, NR sidelink resource allocation principles are applied for Relay discovery message transmission.

For U2U Remote UE and U2U Relay UE, NR sidelink resource allocation principles, both mode 1 and mode 2, can be applied for Relay discovery message transmission.

The sidelink power control for the transmission of Relay discovery messages is same as for NR sidelink communication.

No ciphering or integrity protection in PDCP layer is applied for the Relay discovery messages.

The U2N/U2U Remote UE and U2N/U2U Relay UE can determine from SIB12 whether the gNB supports Relay discovery, or Non-Relay discovery, or both.

### 16.12.4 Relay Selection/Reselection

The U2N Remote UE performs radio measurements at PC5 interface and uses them for U2N Relay selection and reselection along with higher layer criteria, as specified in TS 23.304 [48]. When there is no unicast PC5 connection between the U2N Relay UE and the U2N Remote UE, the U2N Remote UE uses SD-RSRP measurements to evaluate whether PC5 link quality towards a candidate parent UE satisfies relay selection criterion.

For relay reselection, U2N Remote UE uses SL-RSRP measurements towards the serving U2N Relay UE for relay reselection trigger evaluation when there is data transmission from U2N Relay UE to U2N Remote UE, and it is left to UE implementation whether to use SL-RSRP or SD-RSRP for relay reselection trigger evaluation in case of no data transmission from U2N Relay UE to U2N Remote UE. A U2N Relay UE is considered suitable by a U2N Remote UE in terms of radio criteria if the PC5 link quality measured by U2N Remote UE towards the U2N Relay UE exceeds configured threshold (pre-configured or provided by gNB). The U2N Remote UE searches for suitable U2N Relay UE candidates that meet all AS layer and higher layer criteria (see TS 23.304 [48]). If there are multiple such suitable U2N Relay UEs, it is up to U2N Remote UE implementation to choose one U2N Relay UE among them. For L2 U2N Relay (re)selection, the PLMN ID and cell ID can be used as additional AS criteria.

The U2N Remote UE triggers U2N Relay selection in following cases:

- Direct Uu signal strength of current serving cell of the U2N Remote UE is below a configured signal strength threshold;

- Indicated by upper layer of the U2N Remote UE.

The U2N Remote UE may trigger U2N Relay reselection in following cases:

- PC5 signal strength of current U2N Relay UE is below a (pre)configured signal strength threshold;

- Cell reselection, handover, Uu RLF, or Uu RRC connection establishment/resume failure has been indicated by U2N Relay UE via PC5-RRC signalling;

- When U2N Remote UE receives a PC5-S link release message from U2N Relay UE;

- When U2N Remote UE detects PC5 RLF;

- Indicated by upper layer.

For L2 U2N Remote UEs in RRC\_IDLE or RRC\_INACTIVE and L3 U2N Remote UEs, the cell (re)selection procedure and relay (re)selection procedure run independently. If both suitable cells and suitable U2N Relay UEs are available, it is up to the U2N Remote UE implementation to select either a cell or a U2N Relay UE. A L3 U2N Remote UE may select a cell and a L3 U2N Relay UE simultaneously and this is up to implementation of L3 U2N Remote UE.

For both L2 and L3 U2N Relay UE in RRC\_IDLE or RRC\_INACTIVE, the PC5-RRC message(s) are used to inform their connected U2N Remote UE(s) or child UE(s) when U2N Relay UE selects a new cell. The PC5-RRC message(s) are also used to inform their connected L2 or L3 child UE(s) when L2 or L3 U2N Relay UE performs handover, detects Uu/PC5 RLF, detects its Uu RRC connection establishment/resume fails, or is released PC5 unicast link with its parent UE. Upon reception of the PC5 RRC message for notification, it is up to U2N Remote UE/intermediate U2N Relay UE implementation whether to release or keep the unicast PC5 link with its parent UE. Upon reception of the PC5 RRC message for notification, it is up to intermediate U2N Relay UE implementation whether to release or send the notification message to the child Relay UE(s). If U2N Remote UE/intermediate U2N Relay UE decides to release the unicast PC5 link, it triggers the PC5 release procedure and may perform cell or relay reselection.

For the discovery model A, the intermediate U2N Relay UE should send the discovery announcemence message after PC5 connection establishes with its parent UE. There are no additional SD/SL-RSRP threshold criteria when forwarding discovery messages.

For the discovery model B, if the intermediate U2N Relay UE already has been established a PC5 connection with its parent UE, the intermediate U2N Relay UE may send a response message without forwarding the received discovery solicitation message to the parent UE. Otherwise, the intermediate Relay UE should forward the received discovery solicitation message to the candidate parent UE only when the PC5 RSRP between the child UE and itself is above a SD-RSRP threshold. Upon receiving the discovery solicitation message, a last U2N Relay UE without having a PC5 link between itself and an intermediate U2N Relay UE, or an intermediate U2N Relay UE with already having PC5 link between itself and its parent UE sends the discovery response message only when the PC5 RSRP between itself and child UE is above the SD-RSRP threshold. Upon receiving the discovery response message, the intermediate U2N Relay UE does not check the PC5 AS condition to forward the response message towards the U2N Remote UE since it assumed that the PC5 links have already been checked when the solicitation messages were forwarded. Upon receiveing the discovery response message, the U2N Remote UE considers an intermediate Relay UE(s) as a candidate first U2N Relay UE(s) along the path to the last U2N Relay UE if the PC5 RSRP towards the first U2N Relay UE is above a SD-RSRP.

The U2U Remote UE performs radio measurements (i.e., SD-RSRP and/or SL-RSRP) at PC5 interface and uses them for U2U Relay selection and reselection along with higher layer criteria, as specified in TS 23.304 [48].

For relay selection, U2U Remote UE uses SL-RSRP measurements towards the peer U2U Remote UE for relay selection trigger evaluation when valid SL-RSRP measurements are available. For relay reselection, U2U Remote UE uses SL-RSRP measurement towards the U2U Relay UE for relay reselection trigger evaluation when there is data transmission from U2U Relay UE to U2U Remote UE. It is left to U2U Remote UE implementation whether to use SL-RSRP or SD-RSRP for relay selection or reselection trigger evaluation in case of no data transmission. The thresholds for SD-RSRP and SL-RSRP can be configured separately for the trigger evaluation of U2U relay selection or reselection. The same value(s) of the SD-RSRP and SL-RSRP thresholds, which is used for relay selection or reselection, are applied for all the discovery models including DCR with integrated discovery.

The U2U Remote UE may trigger U2U Relay selection in the following cases:

- When the SL-RSRP or SD-RSRP between U2U Remote UEs is below a (pre)configured signal strength threshold;

- When U2U Remote UE receives an indication to trigger U2U relay selection from the upper layer of the UE.

The U2U Remote UE may trigger U2U Relay reselection in the following cases:

- When the SL-RSRP or SD-RSRP of the current U2U Relay UE is below a (pre)configured signal strength threshold;

- When U2U Remote UE receives an indication from the upper layer due to detecting PC5 RLF;

- When L2 U2U Remote UE receives an indication from the upper layer due to receiving the PC5 RLF indication from the L2 U2U Relay UE;

- When U2U Remote UE receives a PC5-S link release message from U2U Relay UE;

- When U2U Remote UE receives an indication to trigger U2U relay reselection from the upper layer of the UE.

For the discovery model A, the U2U Relay UE should announce via discovery announcement message only the neighbour U2U Remote UE(s) for which the SD-RSRP/SL-RSRP between the U2U Relay and the neighbour U2U Remote UE(s) is above a configured threshold. Upon discovery message reception, U2U Remote UE considers a U2U Relay UE as a candidate U2U Relay UE if the SD-RSRP towards the U2U Relay UE is above a configured threshold and the upper layer criteria are met.

For the discovery model B, when the U2U Relay UE receives the discovery solicitation message from U2U Remote UE, the U2U Relay UE forwards the discovery solicitation message only if the SD-RSRP between the U2U Relay UE and the U2U Remote UE is above a threshold. After the peer U2U remote UE receives a discovery solicitation message from the U2U Relay UE, the peer U2U Remote UE transmits the discovery response message only if the SD-RSRP between the peer U2U Remote UE and the U2U Relay UE is above a configured threshold. Upon discovery response message reception forwarded by the U2U Relay UE, the U2U Remote UE considers a U2U Relay UE as a candidate U2U Relay UE if the SD-RSRP towards the U2U Relay UE is above a configured threshold and the upper layer criteria are met.

For the DCR message with integrated discovery, when the U2U Relay UE receives the DCR message with integrated discovery from U2U Remote UE, the U2U Relay UE forwards the DCR message with integrated discovery only if the SL-RSRP between the U2U Relay UE and the U2U Remote UE is above a configured SD-RSRP threshold (not the SL-RSRP, as broadcast is used). Upon receiving DCR message with integrated discovery from one or multiple U2U Relay UEs, the peer U2U Remote UE should consider to which received DCR message to respond amongst candidate U2U Relay UEs towards which the SL-RSRP is above a configured SD-RSRP threshold (not the SL-RSRP, as broadcast is used) and that satisfy upper-layer criteria, and select a U2U Relay UE among them.

### 16.12.5 Control plane procedures for L2 U2N Relay

#### 16.12.5.1 RRC Connection Management

The L2 U2N Remote UE needs to establish its own PDU sessions/DRBs with the network before user plane data transmission.

The NR sidelink PC5 unicast link establishment procedures can be used to setup a secure unicast link between L2 U2N Remote UE and L2 U2N Relay UE before L2 U2N Remote UE establishes a Uu RRC connection with the network via L2 U2N Relay UE.

The establishment of Uu SRB1/SRB2 and DRB of the L2 U2N Remote UE is subject to Uu configuration procedures for L2 UE-to-Network Relay.

The following high level connection establishment procedure in Figure 16.12.5.1-1 applies to a L2 U2N Relay and L2 U2N Remote UE:



Figure 16.12.5.1-1: Procedure for L2 U2N Remote UE connection establishment

1. The L2 U2N Remote and L2 U2N Relay UE perform discovery procedure, and establish a PC5-RRC connection using the NR sidelink PC5 unicast link establishment procedure.

2. The L2 U2N Remote UE sends the first RRC message (i.e., *RRCSetupRequest*) for its connection establishment with gNB via the L2 U2N Relay UE, using a specified PC5 Relay RLC channel configuration. The L2 U2N Relay UE sends the *SidelinkUEInformationNR* message to request for the dedicated configurations required to support the relay operation for the L2 U2N Remote UE. If the L2 U2N Relay UE is not in RRC\_CONNECTED, it needs to do its own Uu RRC connection establishment upon reception of a message on the specified PC5 Relay RLC channel. After L2 U2N Relay UE's RRC connection establishment procedure and sending the *SidelinkUEInformationNR* message, gNB configures SRB0 relaying Uu Relay RLC channel to the U2N Relay UE. The gNB responds with an *RRCSetup* message to L2 U2N Remote UE. The *RRCSetup* message is sent to the L2 U2N Remote UE using SRB0 relaying Uu Relay RLC channel over Uu and a specified PC5 Relay RLC channel over PC5.

NOTE 1: Void.

3. The gNB and L2 U2N Relay UE perform relaying channel setup procedure over Uu. According to the configuration from gNB, the L2 U2N Relay/Remote UE establishes a PC5 Relay RLC channel for relaying of SRB1 towards the L2 U2N Remote/Relay UE over PC5.

4. The *RRCSetupComplete* message is sent by the L2 U2N Remote UE to the gNB via the L2 U2N Relay UE using SRB1 relaying channel over PC5 and SRB1 relaying channel configured to the L2 U2N Relay UE over Uu. Then the L2 U2N Remote UE is as in RRC\_CONNECTED with the gNB.

5. The L2 U2N Remote UE and gNB establish security following the Uu security mode procedure and the security messages are forwarded through the L2 U2N Relay UE.

6. The gNB sends an *RRCReconfiguration* message to the L2 U2N Remote UE via the L2 U2N Relay UE, to setup the end-to-end SRB2/DRBs of the L2 U2N Remote UE. The L2 U2N Remote UE sends an *RRCReconfigurationComplete* message to the gNB via the L2 U2N Relay UE as a response. In addition, the gNB may configure additional Uu Relay RLC channels between the gNB and L2 U2N Relay UE, and PC5 Relay RLC channels between L2 U2N Relay UE and L2 U2N Remote UE for the relaying traffic.

The following high level connection establishment procedure in Figure 16.12.5.1-2 applies to a multi-hop L2 U2N Relay(s) and L2 U2N Remote UE:



Figure 16.12.5.1-2: Procedure for multi-hop L2 U2N Remote UE connection establishment

1. The L2 U2N Remote and the first L2 U2N Relay UE, and between L2 U2N Relay UEs, perform a discovery procedure and establish a PC5-RRC connection using the NR sidelink PC5 unicast link establishment procedure.

2. The L2 U2N Remote UE sends the first RRC message (i.e., *RRCSetupRequest*) for its connection establishment with gNB via the first L2 U2N Relay UE, using a specified PC5 Relay RLC channel configuration. The first L2 U2N Relay UE sends the *SidelinkUEInformationNR* message to request for the dedicated configurations required to support the relay operation for the L2 U2N Remote UE. If the first L2 U2N Relay UE is not in RRC\_CONNECTED, it performs its connection establishment procedure with the gNB. In this case, the first L2 U2N Relay UE acts as a L2 U2N Remote UE to establish its own relay connection. The first L2 U2N Relay UE stores the first RRC message received from the L2 U2N Remote UE and sends its own first RRC message (i.e., *RRCSetupRequest*) via the parent UE, using a specified PC5 Relay RLC channel configuration. If the parent UE is not the last L2 U2N Relay UE and not in RRC\_CONNECTED, the same connection establishment procedure as the first L2 U2N Relay UE is performed. If the parent UE is the last L2 U2N Relay UE and not in RRC\_CONNECTED, the same connection establishment procedure as the L2 U2N Relay UE in the single-hop is performed. After the first L2 U2N Relay UE’s RRC connection establishment procedure and sending the *SidelinkUEInformationNR* message, gNB configures SRB0 relaying PC5 Relay RLC channel to the first L2 U2N Relay UE. The first L2 U2N Relay UE sends the stored first RRC message of the L2 U2N Remote UE to the gNB via the parent UE. The gNB responds with an *RRCSetup* message to L2 U2N Remote UE. The *RRCSetup* message is delivered toward the L2 U2N Remote UE using SRB0 relaying Uu Relay RLC channel over Uu or PC5 Relay RLC channel over PC5 through multiple U2N Relay UEs. The *RRCSetup* message for the L2 U2N Remote UE is delivered via a specified PC5 Relay RLC channel over PC5 from the first L2 U2N Relay UE to the L2 U2N Remote UE.

3. The gNB and the last L2 U2N Relay UE perform relaying channel setup procedure over Uu. The gNB and the intermediate L2 U2N Relay UE(s) perform relaying channel setup procedure over PC5. According to the configuration from gNB, the L2 U2N Relay UEs/Remote UE establishes a PC5 Relay RLC channel for relaying of SRB1 towards the L2 U2N Remote UE/Relay UEs over PC5.

4. The *RRCSetupComplete* message is sent by the L2 U2N Remote UE to the gNB via intermediate L2 U2N Relay UE(s) using SRB1 relaying channel over PC5 and SRB1 relaying channel configured to the last L2 U2N Relay UE over Uu. Then the L2 U2N Remote UE is as in RRC\_CONNECTED with the gNB.

5. The L2 U2N Remote UE and gNB establish security following the Uu security mode procedure and the security messages are forwarded through the multiple L2 U2N Relay UEs.

6. The gNB sends an *RRCReconfiguration* message to the L2 U2N Remote UE via multiple L2 U2N Relay UEs, to setup the end-to-end SRB2/DRBs of the L2 U2N Remote UE. The L2 U2N Remote UE sends an *RRCReconfigurationComplete* message to the gNB via multiple L2 U2N Relay UEs as a response. In addition, the gNB may configure additional Uu Relay RLC channels between the gNB and the last L2 U2N Relay UE, and PC5 Relay RLC channels between L2 U2N Relay UEs, and between the first L2 U2N Relay UE and L2 U2N Remote UE for the relaying traffic.

#### 16.12.5.2 Radio Link Failure

The L2 U2N Remote UE in RRC\_CONNECTED suspends Uu RLM (as described in clause 9.2.7) when connected to the gNB via a L2 U2N Relay UE.

The L2 U2N Relay UE declares Uu/PC5 Radio Link Failure (RLF) following the same criteria as described in clause 9.2.7.

After Uu/PC5 RLF is declared, the L2 U2N Relay UE takes the following action on top of the actions described in clause 9.2.7:

- a PC5-RRC message can be used for sending an indication to its connected L2 child UE(s), which may trigger RRC connection re-establishment for L2 child UE; or

- indicating to upper layer to trigger PC5 unicast link release.

Upon detecting PC5 RLF or PC5 link release, the L2 U2N Remote UE may trigger RRC connection re-establishment.

#### 16.12.5.3 RRC Connection Re-establishment

The L2 U2N Remote UE may perform the following actions during the RRC connection re-establishment procedure:

- If only suitable cell(s) are available, the L2 U2N Remote UE initiates RRC re-establishment procedure towards a suitable cell;

- If only suitable L2 U2N Relay UE(s) are available, the L2 U2N Remote UE initiates RRC re-establishment procedure towards a suitable relay UE's serving cell via selected suitable L2 U2N Relay;

- If both a suitable cell and a suitable relay are available, the L2 U2N Remote UE can select either one to initiate RRC re-establishment procedure based on implementation.

#### 16.12.5.4 RRC Connection Resume

The RRC connection resume procedure described in clause 9.2.2 is applied to L2 U2N Remote UE.

#### 16.12.5.5 System Information

The in-coverage L2 U2N Remote UE or the intermiedate L2 U2N Relay UE(s) being in the same cell of the last L2 U2N Relay UE is allowed to acquire any necessary SIB(s) over Uu interface irrespective of its PC5 connection to L2 U2N Relay UE. The intermediate L2 U2N Relay UE acquires the SIB(s) requested from the child UE(s) or the SIB(s) of its own concerned.

The L2 U2N Remote UE can also receive the system information from the L2 U2N Relay UE after PC5 connection establishment with L2 U2N Relay UE.

The L2 U2N Remote UE in RRC\_CONNECTED can use the on-demand SIB framework as specified in TS 38.331 [12] to request the SIB(s) via L2 U2N Relay UE. The L2 U2N Remote UE in RRC\_IDLE or RRC\_INACTIVE can inform L2 parent UE of its requested SIB type(s) via PC5-RRC message. Then, the L2 U2N Relay UE in single-hop or the last L2 U2N Relay UE in multi-hop triggers on-demand SI/SIB acquisition procedure as specified in TS 38.331 [12] according to its own RRC state (if needed) and sends the acquired SI(s)/SIB(s) to L2 -child UE via PC5-RRC message.

If the RRC\_IDLE or RRC\_INACTIVE intermediate L2 U2N Relay UE receives the requested SIB type(s) from its child UE and the requested SIB type(s) has not been included in the SIB(s) request to the parent UE, the intermediate L2 U2N Relay UE can response SIB(s) request of the child UE via Uu interface or unsolicitated SIB1 forwarding. The intermediate L2 U2N Relay UE determines whether SIB(s) requests to L2 parent UE, depending on whether it has the requested SIB(s) information to provide to the child UE.Any SIB that the RRC\_IDLE or RRC\_INACTIVE L2 U2N Remote UE has a requirement to use (e.g., for relay purpose) can be requested by the L2 U2N Remote UE (from the L2 U2N Relay UE or the network). For SIBs that have been requested by the L2 U2N Remote UE from the L2 U2N Relay UE, the L2 U2N Relay UE forwards them again in case of any update for requested SIB(s). In case of RRC\_CONNECTED L2 U2N Remote UE(s), it is the responsibility of the network to send updated SIB(s) to L2 U2N Remote UE(s) when they are updated. The L2 U2N Remote UE de-configures SI request with L2 U2N Relay UE when entering into RRC\_CONNECTED state.

For SIB1 forwarding, for L2 U2N Remote UE, both request-based delivery (i.e., SIB1 request by the U2N Remote UE) and unsolicited forwarding are supported by L2 U2N Relay UE, of which the usage is left to L2 U2N Relay UE implementation. If SIB1 changes, for L2 U2N Remote UE in RRC\_IDLE or RRC\_INACTIVE, the L2 U2N Relay UE always forwards SIB1.

For the L2 U2N Remote UE in RRC\_IDLE or RRC\_INACTIVE, the short message over Uu interface is not forwarded by the L2 U2N Relay UE to the L2 U2N Remote UE. The L2 U2N Relay UE can forward PWS SIBs to its connected L2 U2N Remote UE(s).

RAN sharing is supported for L2 U2N Relay UE. In particular, the L2 U2N Relay UE may forward, via discovery message, cell access related information before the establishment of a PC5-RRC connection.

#### 16.12.5.6 Paging

When both L2 U2N Relay UE and L2 U2N Remote UE are in RRC IDLE or RRC INACTIVE, the L2 U2N Relay UE monitors paging occasions of its connected L2 U2N Remote UE(s). When a L2 U2N Relay UE needs to monitor paging for a L2 U2N Remote UE, the L2 U2N Relay UE should monitor all POs of the L2 U2N Remote UE.

When L2 U2N Relay UE is in RRC\_CONNECTED and L2 U2N Remote UE(s) is in RRC\_IDLE or RRC\_INACTIVE, there are two options for paging delivery:

- The L2 U2N Relay UE monitors POs of its connected L2 U2N Remote UE(s) if the active DL BWP of the L2 U2N Relay UE is configured with common search space including paging search space;

- The delivery of the L2 U2N Remote UE's paging can be performed through a dedicated RRC message from the gNB to the L2 U2N Relay UE. The dedicated RRC message for delivering L2 U2N Remote UE paging to the RRC\_CONNECTED L2 U2N Relay UE may contain one or more Remote UE IDs (5G-S-TMSI or I-RNTI).

It is up to network implementation to decide which of the above two options to use. The L2 U2N Relay UE in RRC\_CONNECTED, if configured with paging search space, can determine whether to monitor POs for a L2 U2N Remote UE based on the indication within the PC5-RRC signalling received from the L2 U2N Remote UE.

The L2 U2N Remote UE in RRC\_IDLE provides 5G-S-TMSI and UE specific DRX cycle (if configured by upper layer) to the L2 U2N Relay UE for requesting to perform PO monitoring. The L2 U2N Remote UE in RRC\_INACTIVE provides the minimum value of two UE specific DRX cycles (if configured respectively by upper layer and NG-RAN), 5G-S-TMSI and I-RNTI to the L2 U2N Relay UE for PO monitoring. The L2 U2N Relay UE in RRC\_CONNECTED can notify the L2 U2N Remote UE information (i.e. 5G-S-TMSI/I-RNTI) to the gNB via the *SidelinkUEInformationNR* message for paging delivery purpose. The L2 U2N Relay UE receives paging messages to check the 5G-S-TMSI/I-RNTI and sends relevant paging record to the L2 U2N Remote UE accordingly.

The L2 U2N Relay UE uses unicast signalling to send paging to the L2 U2N Remote UE via PC5.

#### 16.12.5.7 Access Control

The L2 U2N Remote UE performs unified access control as defined in TS 38.331 [12]. The L2 U2N Relay UE does not perform UAC for L2 U2N Remote UE's data.

#### 16.12.5.8 Mobility Registration Update and RAN Area Update

The L2 U2N Remote UE performs Mobility Registration Update/RNAU based on the L2 U2N Relay UE's serving cell when it is connected with the L2 U2N Relay UE. A L2 U2N Remote UE in RRC\_IDLE or RRC\_INACTIVE initiates Mobility Registration Update/RNAU procedure if the serving cell changes (due to cell change by the L2 U2N Relay UE) and the new serving cell is outside of the L2 U2N Remote UE's configured RNA/TA.

### 16.12.6 Service Continuity for L2 U2N relay

#### 16.12.6.0 General

The service continuity procedure is applicable for the mobility cases of path switch from indirect to direct path and from direct to indirect path when the L2 U2N Remote UE and L2 U2N Relay UE belong to the same gNB or different gNB. This procedure is also applicable for the mobility cases of path switch from indirect to indirect path when the two L2 U2N Relay UEs belong to the same gNB or different gNBs. For inter-gNB path switching, the source gNB decides to trigger path switching and the path switch type.

#### 16.12.6.1 Switching from single/multi-hop indirect to direct path

For service continuity of L2 U2N Relay, the following procedure is used, in case of L2 U2N Remote UE switching from indirect to direct path under the same gNB. The Figure 16.12.6.1-1a describes a single-hop indirect path to direct path switching and Figure 16.12.6.1-1b describes a multi-hop indirect path to direct path switching:



Figure 16.12.6.1-1a: Procedure for L2 U2N Remote UE intra-gNB switching from single-hop indirect to direct path



Figure 16.12.6.1-1b: Procedure for L2 U2N Remote UE intra-gNB switching from multi-hop indirect to direct path

1. The Uu measurement configuration and measurement report signalling procedures are performed to evaluate both relay link measurement and Uu link measurement. The measurement results from L2 U2N Remote UE are reported when configured measurement reporting criteria are met. The sidelink relay measurement report shall include at least L2 U2N Relay UE's source L2 ID, serving cell ID (i.e., NCGI/NCI), and sidelink measurement quantity result. The sidelink measurement quantity can be SL-RSRP of the serving L2 U2N Relay UE, and if SL-RSRP is not available, SD-RSRP is used.

2. The gNB decides to switch the L2 U2N Remote UE onto direct Uu path.

3. The gNB sends the *RRCReconfiguration* message to the L2 U2N Remote UE. The L2 U2N Remote UE stops User Plane and Control Plane transmission via the L2 U2N Relay UE(s) after reception of the *RRCReconfiguration* message with the path switch configuration.

4. The L2 U2N Remote UE synchronizes with the gNB and performs Random Access.

5. The UE (i.e., L2 U2N Remote UE in previous steps) sends the *RRCReconfigurationComplete* message to the gNB via the direct path, using the configuration provided in the *RRCReconfiguration* message. From this step, the UE (i.e., L2 U2N Remote UE in previous steps) uses the RRC connection via the direct path to the gNB.

6. The gNB sends the *RRCReconfiguration* message to the L2 U2N Relay UE(s) on the source path to reconfigure the connection between the L2 U2N Relay UE and the gNB. The *RRCReconfiguration* message to the L2 U2N Relay UE(s) on the source path can be sent any time after step 3 based on gNB implementation (e.g., to release Uu Relay RLC Channel and PC5 Relay RLC channel configuration for relaying, and bearer mapping configuration related to the L2 U2N Remote UE).

7. Either L2 U2N Relay UE or L2 U2N Remote UE's AS layer indicates upper layers to release PC5 unicast link after receiving the *RRCReconfiguration* message from the gNB. The timing to execute link release is up to UE implementation.

8. The data path is switched from indirect path to direct path between the UE (i.e., previous L2 U2N Remote UE) and the gNB. The PDCP re-establishment or PDCP data recovery in uplink is performed by the UE (i.e., previous L2 U2N Remote UE) for lossless delivery during path switch if gNB configures it.

NOTE 1: Step 8 can be executed any time after step 4. Step 8 is independent of step 6 and step 7.

For service continuity of L2 U2N Relay, the following procedure is used, in case of L2 U2N Remote UE switching from indirect to direct path under another gNB:



Figure 16.12.6.1-2: Procedure for L2 U2N Remote UE inter-gNB switching from indirect to direct path

1. The Uu measurement configuration is configured by the source gNB, and measurement report signalling procedures are performed by the L2 U2N Remote UE to evaluate both relay link measurement and Uu link measurement. The measurement results from L2 U2N Remote UE are reported when configured measurement reporting criteria are met. The sidelink relay measurement report shall include at least L2 U2N Relay UE's source L2 ID, serving cell ID (i.e., NCGI/NCI), and sidelink measurement quantity result. The sidelink measurement quantity can be SL-RSRP of the serving L2 U2N Relay UE, and if SL-RSRP is not available, SD-RSRP is used.

2. The source gNB decides to trigger path switch for the L2 U2N Remote UE, onto direct path.

3. The source gNB sends the HANDOVER REQUEST message to the target gNB with necessary information to prepare the handover at the target side.

NOTE 2: In order to support the DL lossless path switch for the L2 U2N Remote UE, the source gNB may not discard the DL data even though the delivery of the data has been acknowledged by the L2 U2N Relay UE based on the gNB implementation. Then, the source gNB forwards the buffered DL data to the target gNB during the data forwarding procedure.

4. Admission Control may be performed by the target gNB.

5. The target gNB sends the HANDOVER REQUEST ACKNOWLEDGE message to the source gNB, which contains RRC configuration for the L2 U2N Remote UE at the target side.

6. The source gNB triggers the path switch by sending an *RRCReconfiguration* message to the L2 U2N Remote UE, containing at least cell ID and the information required to access the target cell. The L2 U2N Remote UE stops User Plane and Control Plane transmission via the L2 U2N Relay UE after reception of the *RRCReconfiguration* message.

7. The source gNB sends the SN STATUS TRANSFER message to the target gNB to convey the uplink PDCP SN receiver status and the downlink PDCP SN transmitter status of the L2 U2N Remote UE's DRBs for which PDCP status preservation applies (i.e. for RLC AM).

8. The L2 U2N Remote UE synchronizes with the target gNB and performs Random Access.

9. The L2 U2N Remote UE sends *RRCReconfigurationComplete* message to target gNB via the direct path.

10. The target gNB sends the UE CONTEXT RELEASE message to inform the source gNB about the success of the path switch.

11. The source gNB sends *RRCReconfiguration* message to the L2 U2N Relay UE to reconfigure the connection between the L2 U2N Relay UE and the source gNB. The *RRCReconfiguration* message to the L2 U2N Relay UE can be sent any time after step 6 based on source gNB implementation (e.g., to release Uu Relay RLC channel and PC5 Relay RLC channel configuration for relaying, and bearer mapping configuration related to the L2 U2N Remote UE).

12. Either L2 U2N Relay UE or L2 U2N Remote UE's AS layer indicates upper layer to release PC5 unicast link after receiving the *RRCReconfiguration* message from the source gNB. The timing to execute link release is up to UE implementation.

#### 16.12.6.2 Switching from direct to indirect path

The gNB can select a L2 U2N Relay UE in any RRC state i.e., RRC\_IDLE, RRC\_INACTIVE, or RRC\_CONNECTED, as a target L2 U2N Relay UE for direct to indirect path switch.

For service continuity of L2 U2N Remote UE, the following procedure is used, in case of the L2 U2N Remote UE switching from direct to indirect path under the same gNB via a L2 U2N Relay UE in RRC\_CONNECTED:



Figure 16.12.6.2-1: Procedure for L2 U2N Remote UE intra-gNB switching from direct to single-hop indirect path via a L2 U2N Relay UE in RRC\_CONNECTED



Figure 16.12.6.2-2: Procedure for L2 U2N Remote UE intra-gNB switching from direct to multi-hop indirect path via a L2 U2N Relay UE in RRC\_CONNECTED

1. The L2 U2N Remote UE reports one or multiple candidate L2 U2N Relay UE(s) and Uu measurements, after it measures/discovers the candidate L2 U2N Relay UE(s):

- The L2 U2N Remote UE filters the appropriate L2 U2N Relay UE(s) according to relay selection criteria before reporting. The L2 U2N Remote UE shall report only the L2 U2N Relay UE candidate(s) that fulfil the higher layer criteria;

- The reporting includes at least a L2 U2N Relay UE ID, a L2 U2N Relay UE's serving cell ID, and a sidelink measurement quantity information. SD-RSRP is used as sidelink measurement quantity.

2. The gNB decides to switch the L2 U2N Remote UE to a target L2 U2N Relay UE. Then the gNB sends an *RRCReconfiguration* message to the target L2 U2N Relay UE, which includes at least the L2 U2N Remote UE's local ID and L2 ID, Uu Relay RLC channel and PC5 Relay RLC channel configuration for relaying, and bearer mapping configuration.

3. The gNB sends the *RRCReconfiguration* message to the L2 U2N Remote UE. The *RRCReconfiguration* message includes at least the L2 U2N Relay UE ID, Remote UE's local ID, PC5 Relay RLC channel configuration for relay traffic and the associated end-to-end Uu radio bearer(s). The L2 U2N Remote UE stops User Plane and Control Plane transmission over the direct path after reception of the *RRCReconfiguration* message from the gNB.

4. The L2 U2N Remote UE establishes PC5-RRC connection with target L2 U2N Relay UE.

5. The L2 U2N Remote UE completes the path switch procedure by sending the *RRCReconfigurationComplete* message to the gNB via the L2 U2N Relay UE.

6. The data path is switched from direct path to indirect path between the L2 U2N Remote UE and the gNB.

For service continuity of L2 U2N Remote UE, the following procedure is used, in case of the L2 U2N Remote UE switching from direct to indirect path via a L2 U2N Relay UE in RRC\_CONNECTED under another gNB:



Figure 16.12.6.2-2: Procedure for L2 U2N Remote UE inter-gNB switching from direct to indirect path via a L2 U2N Relay UE in RRC\_CONNECTED

1. The L2 U2N Remote UE reports one or multiple candidate L2 U2N Relay UE(s) and Uu measurements to the source gNB, after it measures/discovers the candidate L2 U2N Relay UE(s):

- The L2 U2N Remote UE filters the appropriate L2 U2N Relay UE(s) according to relay selection criteria before reporting. The L2 U2N Remote UE shall report only the L2 U2N Relay UE candidate(s) that fulfil the higher layer criteria;

- The reporting includes at least a L2 U2N Relay UE ID, a L2 U2N Relay UE's serving cell ID, and a sidelink measurement quantity information. SD-RSRP is used as sidelink measurement quantity.

2. The source gNB decides to trigger path switch for the L2 U2N Remote UE onto indirect path of the target gNB, based on *MeasurementReport* and RRM information.

3. The source gNB sends a HANDOVER REQUEST message to the target gNB to prepare the path switch at the target side. The HANDOVER REQUEST message includes Remote UE L2 ID and a list of candidate target Relay UE IDs belonging to one cell of the target gNB.

4. Admission Control may be performed by the target gNB.

5. The target gNB selects one target Relay UE from the list of candidate Relay UEs provided by the source gNB, and sends the *RRCReconfiguration* message to L2 U2N Relay UE for relaying configuration, which includes at least the L2 U2N Remote UE's local ID and L2 ID, Uu Relay RLC channel and PC5 Relay RLC channel configuration for relaying, and bearer mapping configuration. If the target gNB fails to select a target Relay UE from the list of candidate Relay UEs, the target gNB rejects the handover request from the source gNB.

6. The target gNB sends the HANDOVER REQUEST ACKNOWLEDGE message to the source gNB, which contains RRC configuration for L2 U2N Remote UE at the target side.

7. The source gNB sends the *RRCReconfiguration* message to the L2 U2N Remote UE, which includes at least the L2 U2N Relay UE ID, Remote UE's local ID, PC5 Relay RLC channel configuration for relay traffic and the associated Uu end-to-end radio bearer(s). The L2 U2N Remote UE stops User Plane and Control Plane transmission over the direct path after reception of the *RRCReconfiguration* message from the source gNB.

8. The source gNB sends the SN STATUS TRANSFER message to the target gNB to convey the uplink PDCP SN receiver status and the downlink PDCP SN transmitter status of the L2 U2N Remote UE's DRBs for which PDCP status preservation applies (i.e. for RLC AM).

9. The L2 U2N Remote UE establishes PC5 connection with L2 U2N Relay UE.

10. The L2 U2N Remote UE sends the *RRCReconfigurationComplete* message to target gNB via the L2 U2N Relay UE.

11. The data path is switched from direct path to indirect path between the L2 U2N Remote UE and the target gNB via the target L2 U2N Relay UE.

12. The target gNB sends the UE CONTEXT RELEASE message to inform the source gNB about the success of the path switch.

If the target path is multi-hop, it is assumed that all L2 U2N Relay UEs along the target path are in the RRC\_CONNECTED. However, if the target path is a single-hop, the target U2N Relay UE can be in any RRC state.

In case the selected L2 U2N Relay UE for direct to single-hop indirect path switch is in RRC\_IDLE or RRC\_INACTIVE, after receiving the path switch command, the L2 U2N Remote UE establishes a PC5 link with the L2 U2N Relay UE and sends the *RRCReconfigurationComplete* message via the L2 U2N Relay UE, which triggers the L2 U2N Relay UE to enter RRC\_CONNECTED state. The procedure for L2 U2N Remote UE switching to indirect path in Figure 16.12.6.2-1 can be also applied for the case that the selected L2 U2N Relay UE for direct to indirect path switch is in RRC\_IDLE or RRC\_INACTIVE with the exception that the *RRCReconfiguration* message is sent from the gNB to the L2 U2N Relay UE after the L2 U2N Relay UE enters RRC\_CONNECTED state, which happens during step 5 in Figure 16.12.6.2-1, and during step 10 in Figure 16.12.6.2-2.

#### 16.12.6.3 Switching from multi/single-hop indirect to multi/single-hop indirect path

The gNB can select an L2 U2N Relay UE in any RRC state i.e., RRC\_IDLE, RRC\_INACTIVE, or RRC\_CONNECTED, as a target L2 U2N Relay UE for multi/single-hop indirect to single-hop indirect path switch.

For service continuity of L2 U2N Remote UE, the following Figure 16.12.6.3-1a describes the case of the L2 U2N Remote UE switching from single-hop indirect path via L2 U2N Relay UE to single-hop indirect path via a target L2 U2N Relay UE in RRC\_CONNECTED under the same gNB. The Figure 16.12.6.3-1b describes the case of the L2 U2N Remote UE switching from multi-hop indirect path via the source first L2 U2N Relay UEs to single-hop indirect path via a target L2 U2N Relay UE in RRC\_CONNECTED under the same gNB. The Figure 16.12.6.3-1c describes the case of the L2 U2N Remote UE switching from single-hop indirect path via source L2 U2N Relay UE to multi-hop indirect path via target first L2 U2N Relay UE in RRC\_CONNECTED under the same gNB:



Figure 16.12.6.3-1a: Procedure for L2 U2N Remote UE intra-gNB switching from single-hop indirect to single-hop indirect path via a target L2 U2N Relay UE in RRC\_CONNECTEDFigure 16.12.6.3-1b: Procedure for L2 U2N Remote UE intra-gNB switching from multi-hop indirect to single-hop indirect path via a target L2 U2N Relay UE in RRC\_CONNECTED



Figure 16.12.6.3-1c: Procedure for L2 U2N Remote UE intra-gNB switching from single-hop indirect to multi-hop indirect path via a target L2 U2N Relay UE in RRC\_CONNECTED

1. The L2 U2N Remote UE reports one or multiple candidate L2 U2N Relay UE(s) and sidelink measurement between the L2 U2N Remote UE and the parent UE to the source gNB, after it measures/discovers the candidate L2 U2N Relay UE(s):

- The L2 U2N Remote UE filters the appropriate L2 U2N Relay UE(s) according to relay selection criteria before reporting. The L2 U2N Remote UE shall report only the L2 U2N Relay UE candidate(s) that fulfil the higher layer criteria;

- The reporting includes at least a L2 U2N Relay UE ID, a L2 U2N Relay UE's serving cell ID, and a sidelink measurement quantity information. SD-RSRP is used as sidelink measurement quantity.

2. The gNB decides to switch the L2 U2N Remote UE to a target L2 U2N Relay UE under the same gNB.

3. The gNB sends an *RRCReconfiguration* message to the target L2 U2N Relay UE, which includes at least the L2 U2N Remote UE's local ID and L2 ID, Uu and PC5 Relay RLC channel configuration for relaying, and bearer mapping configuration.

4. The gNB sends the *RRCReconfiguration* message to the L2 U2N Remote UE. The *RRCReconfiguration* message includes at least the target L2 U2N Relay UE ID, Remote UE's local ID, PC5 Relay RLC channel configuration for relay traffic, and the associated end-to-end radio bearer(s). The L2 U2N Remote UE stops User Plane and Control Plane transmission over the indirect path via the source L2 U2N Relay UE(s) after the reception of the *RRCReconfiguration* message from the gNB.

5. The L2 U2N Remote UE establishes PC5-RRC connection with the target L2 U2N Relay UE.

6. The L2 U2N Remote UE sends *RRCReconfigurationComplete* message to the gNB via the target L2 U2N Relay UE.

7. The gNB sends the *RRCReconfiguration* message to the L2 U2N Relay UE(s) on the source path to reconfigure the connection between the source L2 U2N Relay UE and the gNB. The *RRCReconfiguration* message to the L2 U2N Relay UE(s) on the source path can be sent any time after step 4 based on gNB implementation (e.g., to release Uu and PC5 Relay RLC channel configuration for relaying, and bearer mapping configuration related to the L2 U2N Remote UE).

8. Either source L2 U2N Relay UE's AS layer or L2 U2N Remote UE's AS layer indicates upper layers to release PC5 unicast link after receiving the *RRCReconfiguration* message from the gNB. The timing to execute link release is up to UE implementation after step 4 or step7.

9. The data path is switched from the source L2 U2N Relay UE(s) to the target L2 U2N Relay UE between the L2 U2N Remote UE and the gNB. This step can be any time after step 6.

For service continuity of L2 U2N Remote UE between gNBs, the following procedure is used, in case of the L2 U2N Remote UE, which is connected to indirect path, switching to another indirect path via a target L2 U2N Relay UE in RRC\_CONNECTED under another gNB:



Figure 16.12.6.3-2: Procedure for L2 U2N Remote UE inter-gNB switching from indirect to indirect path via a target L2 U2N Relay UE in RRC\_CONNECTED

1. The L2 U2N Remote UE reports one or multiple candidate L2 U2N Relay UE(s) and sidelink measurement between the L2 U2N Remote UE and the source L2 U2N Relay UE to the source gNB, after it measures/discovers the candidate L2 U2N Relay UE(s):

- The L2 U2N Remote UE filters the appropriate L2 U2N Relay UE(s) according to relay selection criteria before reporting. The L2 U2N Remote UE shall report only the L2 U2N Relay UE candidate(s) that fulfil the higher layer criteria;

- The reporting includes at least a L2 U2N Relay UE ID, a L2 U2N Relay UE's serving cell ID, and a sidelink measurement quantity information. SD-RSRP is used as sidelink measurement quantity.

2. The source gNB decides to trigger the L2 U2N Remote UE to switch to an indirect path of another gNB.

3. The source gNB sends a HANDOVER REQUEST message to the target gNB to prepare the path switch at the target side. The HANDOVER REQUEST message includes Remote UE L2 ID and a list of candidate target Relay UE IDs belonging to one cell of the target gNB.

NOTE: In order to support the DL lossless path switching for the L2 U2N Remote UE, the source gNB may not discard the DL data even though the delivery of the data has been acknowledged by the source L2 U2N Relay UE based on the gNB implementation. Then, the source gNB forwards the buffered DL data to the target gNB during the data forwarding procedure.

4. Admission Control may be performed by the target gNB.

5. The target gNB selects one target Relay UE from the list of candidate Relay UEs provided by the source gNB, sends the *RRCReconfiguration* message to the L2 U2N Relay UE for relaying configuration, which includes at least the L2 U2N Remote UE's local ID and L2 ID, Uu Relay RLC channel and PC5 Relay RLC channel configuration for relaying, and bearer mapping configuration. If the target gNB fails to select one target Relay UE from the list of candidate Relay UEs, the target gNB rejects the handover request from the source gNB.

6. The target gNB sends the HANDOVER REQUEST ACKNOWLEDGE message to the source gNB, which contains RRC configuration for L2 U2N Remote UE at the target side.

7. The source gNB sends the *RRCReconfiguration* message to the L2 U2N Remote UE, which includes at least the target L2 U2N Relay UE ID, Remote UE's local ID, PC5 Relay RLC channel configuration for relay traffic and the associated end-to-end Uu radio bearer(s). The L2 U2N Remote UE stops User Plane and Control plane transmission over the (source) indirect path after reception of the *RRCReconfiguration* message from the source gNB.

8. The source gNB sends the SN STATUS TRANSFER message to the target gNB to convey the uplink PDCP SN receiver status and the downlink PDCP SN transmitter status of the L2 U2N Remote UE's DRBs for which PDCP status preservation applies (i.e. for RLC AM).

9. The L2 U2N Remote UE establishes PC5 connection to the target L2 U2N Relay UE.

10. The L2 U2N Remote UE sends the *RRCReconfigurationComplete* message to the target gNB via the target L2 U2N Relay UE.

11. The data path is switched from indirect path to indirect path between the L2 U2N Remote UE and the target gNB via the target L2 U2N Relay UE.

12. The target gNB sends the UE CONTEXT RELEASE message to inform the source gNB about the success of the path switch.

13. The source gNB sends the *RRCReconfiguration* message to the source L2 U2N Relay UE to reconfigure the connection between the source L2 U2N Relay UE and the source gNB. The *RRCReconfiguration* message to the source L2 U2N Relay UE can be sent any time after step 7 based on source gNB implementation (e.g., to release Uu Relay RLC channel and PC5 Relay RLC channel configuration for relaying, and bearer mapping configuration related to the L2 U2N Remote UE).

14. Either L2 U2N Relay UE or L2 U2N Remote UE's AS layer indicates upper layer to release PC5 unicast link after receiving the *RRCReconfiguration* message from the source gNB. The timing to execute link release is up to UE implementation.

If the target path is multi-hop, it is assumed that all L2 U2N Relay UEs along the target path are in the RRC\_CONNECTED. However, if the target path is a single-hop, the target U2N Relay UE can be in any RRC state.

In case the selected L2 U2N Relay UE for multi/single-hop indirect to single-hop indirect path switch is in RRC\_IDLE or RRC\_INACTIVE, after receiving the path switch command, the L2 U2N Remote UE establishes a PC5 link with the L2 U2N Relay UE and sends the *RRCReconfigurationComplete* message via the L2 U2N Relay UE, which triggers the L2 U2N Relay UE to enter RRC\_CONNECTED state. The above procedures for L2 U2N Remote UE switching to indirect path can be also applied for the case that the selected L2 U2N Relay UE for indirect to indirect path switch is in RRC\_IDLE or RRC\_INACTIVE with the exception that the *RRCReconfiguration* message is sent from the gNB to the L2 U2N Relay UE after the L2 U2N Relay UE enters RRC\_CONNECTED state, which happens during step 6 in Figure 16.12.6.3-1a, and during step 10 in Figure 16.12.6.3-2.

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