**3GPP TSG-RAN WG2 Meeting #117 Electronic R2-220wxyz**

**Online Meeting, 21st February – 3rd March 2022**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.300** | **CR** | **0403** | **rev** | **2** | **Current version:** | **16.8.0** |  |
|  | | | | | | | | |
| *For* [***HELP***](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:*** | Introduction of Sidelink Relay | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | MediaTek Inc. | | | | | | | | | |
| ***Source to TSG:*** | RAN2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_SL\_relay-Core | | | | |  | ***Date:*** | | | 2022-3-3 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | ***B*** |  | | | | | ***Release:*** | | | Rel-17 |
|  | *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-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | This CR introduces the support of sidelink relay in NR | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Introduction of general description, protocol architecture, relay discovery, relay selection/reselection, control plane procedures and service continuity aspects for sidelink relay | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Sidelink Relay is not supported in NR | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 3.1, 3.2, 16.x (New), 16.9.y (New) | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... 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:*** | |  | | | | | | | | |

*First Modified Subclause*

# 2 References

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

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

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

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

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

[2] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

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

[4] 3GPP TS 38.401: "NG-RAN; Architecture description".

[5] 3GPP TS 33.501: "Security Architecture and Procedures for 5G System".

[6] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[7] 3GPP TS 38.322: "NR; Radio Link Control (RLC) protocol specification".

[8] 3GPP TS 38.323: "NR; Packet Data Convergence Protocol (PDCP) specification".

[9] 3GPP TS 37.324: " E-UTRA and NR; Service Data Protocol (SDAP) specification".

[10] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in Idle mode and RRC Inactive state".

[11] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".

[12] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[13] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".

[14] 3GPP TS 22.168: "Earthquake and Tsunami Warning System (ETWS) requirements; Stage 1".

[15] 3GPP TS 22.268: "Public Warning System (PWS) Requirements".

[16] 3GPP TS 38.410: "NG-RAN; NG general aspects and principles".

[17] 3GPP TS 38.420: "NG-RAN; Xn general aspects and principles".

[18] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[19] 3GPP TS 22.261: "Service requirements for next generation new services and markets".

[20] 3GPP TS 38.202: "NR; Physical layer services provided by the physical layer"

[21] 3GPP TS 37.340: "NR; Multi-connectivity; Overall description; Stage-2".

[22] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[23] IETF RFC 4960 (2007-09): "Stream Control Transmission Protocol".

[24] 3GPP TS 26.114: "Technical Specification Group Services and System Aspects; IP Multimedia Subsystem (IMS); Multimedia Telephony; Media handling and interaction".

[25] Void.

[26] 3GPP TS 38.413: "NG-RAN; NG Application Protocol (NGAP)".

[27] IETF RFC 3168 (09/2001): "The Addition of Explicit Congestion Notification (ECN) to IP".

[28] 3GPP TS 24.501: "NR; Non-Access-Stratum (NAS) protocol for 5G System (5GS)".

[29] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[30] 3GPP TS 38.415: "NG-RAN; PDU Session User Plane Protocol".

[31] 3GPP TS 38.340: "NR; Backhaul Adaptation Protocol (BAP) specification".

[32] 3GPP TS 38.470: "NG-RAN; F1 application protocol (F1AP) ".

[33] 3GPP TS 38.425: "NG-RAN; NR user plane protocol".

[34] 3GPP TS 23.216: "Single Radio Voice Call Continuity (SRVCC); Stage 2".

[35] 3GPP TS 38.101-2: "User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[36] 3GPP TS 38.101-3: "User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

[37] 3GPP TS 37.213: "Physical layer procedures for shared spectrum channel access".

[38] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[39] 3GPP TS 22.104 "Service requirements for cyber-physical control applications in vertical domains".

[40] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[41] 3GPP TS 23.285: "Technical Specification Group Services and System Aspects; Architecture enhancements for V2X services".

[42] 3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN".

[43] 3GPP TS 37.355: "LTE Positioning Protocol (LPP)".

[44] 3GPP TS 29.002: "Mobile Application Part (MAP) specification".

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

# 3 Definitions and Abbreviations

## 3.1 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], in TS 36.300 [2] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1] and TS 36.300 [2].

5GC 5G Core Network

5GS 5G System

5QI 5G QoS Identifier

A-CSI Aperiodic CSI

AKA Authentication and Key Agreement

AMBR Aggregate Maximum Bit Rate

AMC Adaptive Modulation and Coding

AMF Access and Mobility Management Function

ARP Allocation and Retention Priority

BA Bandwidth Adaptation

BCH Broadcast Channel

BH Backhaul

BL Bandwidth reduced Low complexity

BPSK Binary Phase Shift Keying

C-RNTI Cell RNTI

CAG Closed Access Group

CAPC Channel Access Priority Class

CBRA Contention Based Random Access

CCE Control Channel Element

CD-SSB Cell Defining SSB

CFRA Contention Free Random Access

CHO Conditional Handover

CIoT Cellular Internet of Things

CLI Cross Link interference

CMAS Commercial Mobile Alert Service

CORESET Control Resource Set

CPC Conditional PSCell Change

DAG Directed Acyclic Graph

DAPS Dual Active Protocol Stack

DFT Discrete Fourier Transform

DCI Downlink Control Information

DCP DCI with CRC scrambled by PS-RNTI

DL-AoD Downlink Angle-of-Departure

DL-SCH Downlink Shared Channel

DL-TDOA Downlink Time Difference Of Arrival

DMRS Demodulation Reference Signal

DRX Discontinuous Reception

E-CID Enhanced Cell-ID (positioning method)

EHC Ethernet Header Compression

ETWS Earthquake and Tsunami Warning System

FS Feature Set

GFBR Guaranteed Flow Bit Rate

HRNN Human-Readable Network Name

IAB Integrated Access and Backhaul

I-RNTI Inactive RNTI

INT-RNTI Interruption RNTI

KPAS Korean Public Alarm System

LDPC Low Density Parity Check

L2 Layer-2

L3 Layer-3

MDBV Maximum Data Burst Volume

MIB Master Information Block

MICO Mobile Initiated Connection Only

MFBR Maximum Flow Bit Rate

MMTEL Multimedia telephony

MNO Mobile Network Operator

MPE Maximum Permissible Exposure

MT Mobile Termination

MU-MIMO Multi User MIMO

Multi-RTT Multi-Round Trip Time

NB-IoT Narrow Band Internet of Things

NCGI NR Cell Global Identifier

NCR Neighbour Cell Relation

NCRT Neighbour Cell Relation Table

NGAP NG Application Protocol

NID Network Identifier

NPN Non-Public Network

NR NR Radio Access

P-MPR Power Management Maximum Power Reduction

P-RNTI Paging RNTI

PCH Paging Channel

PCI Physical Cell Identifier

PDCCH Physical Downlink Control Channel

PDSCH Physical Downlink Shared Channel

PLMN Public Land Mobile Network

PNI-NPN Public Network Integrated NPN

PO Paging Occasion

PRACH Physical Random Access Channel

PRB Physical Resource Block

PRG Precoding Resource block Group

PS-RNTI Power Saving RNTI

PSS Primary Synchronisation Signal

PUCCH Physical Uplink Control Channel

PUSCH Physical Uplink Shared Channel

PWS Public Warning System

QAM Quadrature Amplitude Modulation

QFI QoS Flow ID

QPSK Quadrature Phase Shift Keying

RA Random Access

RA-RNTI Random Access RNTI

RACH Random Access Channel

RANAC RAN-based Notification Area Code

REG Resource Element Group

RIM Remote Interference Management

RMSI Remaining Minimum SI

RNA RAN-based Notification Area

RNAU RAN-based Notification Area Update

RNTI Radio Network Temporary Identifier

RQA Reflective QoS Attribute

RQoS Reflective Quality of Service

RS Reference Signal

RSRP Reference Signal Received Power

RSRQ Reference Signal Received Quality

RSSI Received Signal Strength Indicator

RSTD Reference Signal Time Difference

SD Slice Differentiator

SDAP Service Data Adaptation Protocol

SFI-RNTI Slot Format Indication RNTI

SIB System Information Block

SI-RNTI System Information RNTI

SLA Service Level Agreement

SMC Security Mode Command

SMF Session Management Function

S-NSSAI Single Network Slice Selection Assistance Information

SNPN Stand-alone Non-Public Network

SNPN ID Stand-alone Non-Public Network Identity

SPS Semi-Persistent Scheduling

SR Scheduling Request

SRAP Sidelink Relay Adaptation Protocol

SRS Sounding Reference Signal

SRVCC Single Radio Voice Call Continuity

SS Synchronization Signal

SSB SS/PBCH block

SSS Secondary Synchronisation Signal

SST Slice/Service Type

SU-MIMO Single User MIMO

SUL Supplementary Uplink

TA Timing Advance

TPC Transmit Power Control

TRP Transmit/Receive Point

U2N UE-to-Network

UCI Uplink Control Information

UL-AoA Uplink Angles of Arrival

UL-RTOA Uplink Relative Time of Arrival

UL-SCH Uplink Shared Channel

UPF User Plane Function

URLLC Ultra-Reliable and Low Latency Communications

V2X Vehicle-to-Everything

Xn-C Xn-Control plane

Xn-U Xn-User plane

XnAP Xn Application Protocol

## 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].

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

**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.

**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.

**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.

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

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

**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.

**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.

**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.

**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.

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

**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.

**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], between two or more nearby UEs, using NR technology but not traversing any network 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 next hop neighbour node; the parent node can be IAB-node or IAB-donor-DU

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

**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).

**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.

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

**U2N Relay UE:** a UE that provides functionality to support connectivity to the network for U2N Remote UE(s).

**U2N Remote UE:** a UE that communicates with the network via a U2N Relay UE.

**Upstream**: Direction toward parent node in IAB-topology.

**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.

*Next Modified Subclause (new)*

## 16.x Sidelink Relay

### 16.x.1 General

Sidelink relay is introduced to support 5G ProSe UE-to-Network Relay (U2N Relay) function (specified in TS 23.304 [xx]) to provide 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 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 [xx].

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 U2N Relay UE and U2N Remote UE shall be in RRC CONNECTED to perform transmission/reception of relayed unicast data.

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

For L2 U2N Relay, the 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.

. A single unicast link is established between one L2 U2N Relay UE and one L2 U2N Remote UE. The traffic of U2N Remote UE via a given U2N Relay UE and the traffic of the U2N Relay UE shall be separated in different Uu RLC channels over Uu.

### 16.x.2 Protocol Architecture

#### 16.x.2.1 L2 UE-to-Network Relay

The protocol stacks for the user plane and control plane of L2 U2N Relay architecture are presented in Figure 16.x.2.1-1 and Figure 16.x.2.1-2. 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 L2 U2N Relay UE 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 sublayer is not present over PC5 hop, but the SRAP sublayer is present over Uu hop for both DL and UL.



Figure 16.x.2.1-1: User plane protocol stack for L2 UE-to-Network Relay



Figure 16.x.2.1-2: Control plane protocol stack for L2 UE-to-Network Relay

For L2 U2N Relay, for uplink:

- The Uu SRAP sublayer supports UL bearer mapping between ingress PC5 RLC channels for relaying and egress Uu RLC channels over the L2 U2N Relay UE Uu interface. For uplink relaying traffic, the different end-to-end RBs (SRBs or DRBs) of the same Remote UE and/or different Remote UEs can be multiplexed over the same Uu RLC channel.

- The Uu SRAP sublayer supports L2 U2N Remote UE identification for the UL traffic. The identity information of L2 U2N Remote UE 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 Uu Radio Bearer of a Remote UE.

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

For L2 U2N Relay, for downlink:

- The Uu SRAP sublayer supports DL bearer mapping at gNB to map end-to-end Radio Bearer (SRB, DRB) of Remote UE into Uu RLC channel over Relay UE Uu interface. The Uu SRAP sublayer supports 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 RLC channel over the Relay UE Uu interface.

- The Uu SRAP sublayer supports Remote UE identification for DL traffic. The identity information of Remote UE Uu Radio Bearer and a local Remote UE ID are included into the Uu SRAP header by the gNB at DL in order for Relay UE to map the received packets from Remote UE Uu Radio Bearer to its associated PC5 RLC channel.

- The PC5 SRAP sublayer at the Relay UE supports DL bearer mapping between ingress Uu RLC channels and egress PC5 RLC channels.

- The PC5 SRAP sublayer at the Remote UE correlates the received packets for the specific PDCP entity associated with the right Uu Radio Bearer of a Remote UE based on the identity information included in the Uu 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 to be used in SRAP header. Remote UE obtains the local Remote ID from the gNB via Uu RRC messages including *RRCSetup*, *RRCReconfiguration*, *RRCResume* and *RRCReestablishment*. Uu DRB(s) and Uu SRB(s) are mapped to different RLC channels in both PC5 hop and Uu hop.

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 ID via *RRCReconfiguration* message to the Relay UE. The serving gNB can perform local Remote UE ID update independent of the PC5 unicast link L2 ID update procedure.

### 16.x.3 Relay Discovery

Model A and Model B discovery models as defined in TS 23.304 [xx] are supported for U2N Relay discovery. The protocol stack used for discovery is presented in Figure 16.x.3-1.



Figure 16.x.3.1: Protocol Stack of Discovery Message for UE-to-Network Relay

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

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

The network may provide the Relay discovery configuration using broadcast or dedicated signalling for Relay discovery. In addition, the U2N Remote UE and U2N Relay UE may use pre-configuration for Relay discovery.

The resource pool(s) used for NR sidelink communication can be used for Relay discovery or the network may configure a 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 a dedicated resource pool(s) for Relay discovery is 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 transmission resource pool(s) can be used for Relay discovery and sidelink communication.

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

The Relay discovery reuses NR sidelink resource allocation principles for in-coverage U2N Relay UE, and for both in-coverage and out of coverage U2N Remote UEs.

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 UE can determine from SIB12 whether the gNB supports Relay discovery, Non-Relay discovery, or both of them. Whether gNB supports L2 U2N Relay is explicitly indicated in SIB12.

### 16.x.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 [xx]. 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 U2N Relay 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 criterias (see TS 23.304 [xx]). 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 (re)selection, handover or Uu RLF has been indicated by U2N Relay UE via PC5-RRC signalling;

- When 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/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 UE implementation to select either a cell or a U2N Relay UE. A L3 U2N Remote UE may select a cell and a U2N Relay UE simultaneously and this is up to implementation of L3 U2N Remote UE.

For both L2 and L3 U2N Relay UEs in RRC\_IDLE/INACTIVE, the PC5-RRC message(s) are used to inform their connected Remote UE(s) when U2N Relay UEs select a new cell. The PC5-RRC message(s) are also used to inform their connected L2 or L3 U2N Remote UE(s) when L2/L3 U2N Relay UE performs handover or detects Uu RLF. Upon reception of the PC5 RRC message for notification, it is up to U2N Remote UE implementation whether to release or keep the unicast PC5 link. If U2N Remote UE decides to release the unicast PC5 link, it triggers the L2 release procedure and may perform relay reselection.

### 16.x.5 Control plane procedures for L2 U2N Relay

#### 16.x.5.1 RRC Connection Management

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

The NR V2X PC5 unicast link establishment procedures can be reused to setup a secure unicast link between U2N Remote UE and U2N Relay UE before U2N Remote UE establishes a Uu RRC connection with the network via U2N Relay UE. U2N Remote UE uses different fields of the existing timers in SIB1 for access, resume and re-establishment compared to those for Uu procedures.

The establishment of Uu SRB1/SRB2 and DRB of the 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.x.5.1-1 applies to L2 U2N Relay:



Figure 16.x.5.1-1: Procedure for L2 U2N Remote UE connection establishment

1. The U2N Remote and U2N Relay UE perform discovery procedure, and establish PC5-RRC connection using NR V2X procedure.

2. The U2N Remote UE sends the first RRC message (i.e., RRCSetupRequest) for its connection establishment with gNB via the Relay UE, using a specified PC5 RLC channel configuration. If the U2N Relay UE is not in RRC\_CONNECTED, it needs to do its own connection establishment upon reception of a message on the specified PC5 RLC channel. During Relay UE’s RRC connection establishment procedure, gNB may configure SRB0 relaying Uu RLC channel to the U2N Relay UE. The gNB responds with an RRCSetup message to U2N Remote UE. The RRCSetup message is sent to the U2N Remote UE using SRB0 relaying channel over Uu and a specified PC5 RLC channel over PC5.

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

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

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

6. The gNB sends an RRCReconfiguration message to the U2N Remote UE via the U2N Relay UE, to setup the SRB2/DRBs for relaying purpose. The U2N Remote UE sends an RRCReconfigurationComplete message to the gNB via the U2N Relay UE as a response. In addition, the gNB configures additional Uu RLC channels between the gNB and U2N Relay UE, and PC5 RLC channels between U2N Relay UE and U2N Remote UE for the relay traffic.

#### 16.x.5.2 Radio Link Failure, RRC Connection Re-establishment and RRC Connection Resume

The U2N Remote UE in RRC\_CONNECTED suspends Uu RLM when U2N Remote UE is connected to gNB via U2N Relay UE. Upon detecting Uu RLF by the U2N Relay UE, a PC5-RRC message can be used for sending an indication from U2N Relay UE to its connected U2N Remote UE(s), which may trigger RRC connection re-establishment for U2N Remote UE. Upon detecting PC5 RLF, the U2N Remote UE may trigger connection re-establishment.

Both Intra-gNB and Inter-gNB RRC connection re-establishment for the U2N Remote UE can be supported. The U2N Remote UE may perform the following actions during the RRC connection re-establishment procedure:

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

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

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

Both Intra-gNB and Inter-gNB RRC connection resume for the U2N Remote UE can be supported. In case the U2N Remote UE initiates RRC resume to a new gNB, the Retrieve UE Context procedure is performed, i.e., the new gNB retrieves the U2N Remote UE context for U2N Remote UE.

#### 16.x.5.3 System Information

The in-coverage U2N Remote UE is allowed to acquire any necessary SIB(s) over Uu interface irrespective of its PC5 connection to Relay UE. The U2N Remote UE can receive the system information from the Relay UE after PC5 connection establishment with U2N Relay UE.

The U2N Remote UE in RRC\_CONNECTED can use the on-demand SIB framework as specified in TS38.331 [12] to request the SIB(s) via U2N Relay UE. The U2N Remote UE in RRC\_IDLE or RRC\_INACTIVE can inform U2N Relay UE of its requested SIB type(s) via PC5-RRC message. Then, U2N Relay UE triggers on-demand SI/SIB acquisition procedure as specified in TS38.331 [12] according to its own RRC state (if needed) and sends the acquired SI(s)/SIB(s) to U2N Remote UE via PC5-RRC.

Any SIB that the RRC\_IDLE/RRC\_INACTIVE U2N Remote UE has a requirement to use (e.g. for relay purpose) can be requested by the U2N Remote UE (from the U2N Relay UE or the network). For SIBs that have been requested by the U2N Remote UE from the U2N Relay UE, the U2N Relay UE forwards them again in case of any requested SIB update. In case of RRC\_CONNECTED U2N Remote UE(s), it relies on the network to send updated SIB(s) to U2N Remote UE(s) when they are updated. The U2N Remote UE de-configures SI request with U2N Relay UE when entering into RRC\_CONNECTED state.

The U2N Remote UE is always considered to request SIB1 from the U2N Relay UE, if it has not received it directly from the gNB. If SIB1 changes, for U2N Remote UE in RRC\_IDLE/RRC\_INACTIVE, both request-based delivery (i.e., SIB1 request by the U2N Remote UE) and unsolicited forwarding are supported by U2N Relay UE, of which the usage is left to U2N Relay UE implementation.

For the L2 U2N Remote UE in RRC\_IDLE/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 are 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.x.5.4 Paging

When both U2N Relay UE and U2N Remote UE are in RRC IDLE/RRC INACTIVE, the U2N Relay UE monitors paging occasions of its PC5-RRC connected U2N Remote UE(s). When a U2N Relay UE needs to monitor paging for a U2N Remote UE, the U2N Relay UE should monitor all POs of the U2N Remote UE.

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

- The U2N Relay UE monitors POs of its connected U2N Remote UE(s) if the active DL BWP of U2N Relay UE is configured with CORESET and common search space.

- The delivery of the U2N Remote UE’s paging can be performed through dedicated RRC message from the gNB to the U2N Relay UE. The dedicated RRC message for delivering Remote UE paging to the RRC\_CONNECTED 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 U2N Relay UE in RRC CONNECTED, if configured with paging common search space, can determine whether to monitor POs for a U2N Remote UE based on PC5-RRC signalling received from the U2N Remote UE.

The U2N Remote UE in RRC\_IDLE provides 5G-S-TMSI and UE specific DRX cycle (configured by upper layer) to the U2N Relay UE to request it for Remote UE’s PO monitoring. The U2N Remote UE in RRC\_INACTIVE provides minimum value of two UE specific DRX cycles (configured by upper layer and configured by RAN), 5G-S-TMSI and I-RNTI to the U2N Relay UE for PO monitoring. The L2 U2N Relay UE can notify Remote UE information (i.e. 5G-S-TMSI/I-RNTI) to the gNB via *SidelinkUEInformationNR* message for paging delivery purpose, which can be used by the gNB as in the second option above. The U2N Relay UE receives paging messages to check the 5G-S-TSMI/I-RNTI and sends relevant paging record to the Remote UE accordingly.

The U2N Relay UE can use unicast signalling to send paging to the U2N Remote UE via PC5.

#### 16.x.5.5 Access Control

The U2N Remote UE performs unified access control as defined in TS 38.331. The U2N Relay UE in RRC-CONNECTED does not perform UAC for U2N Remote UE’s data.

#### 16.x.5.6 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 PC5-RRC connected with the L2 U2N Relay UE. A U2N Remote UE in RRC\_IDLE/RRC\_INACTIVE initiates Mobility Registration Update/RNAU procedure if the serving cell changes (due to cell change by the U2N Relay UE) and the new serving cell is outside of the U2N Remote UE’s configured RNA/TA. For a U2N Remote UE served by indirect path, its serving cell is the serving cell of its connected U2N Relay UE.

#### 16.x.6 Service Continuity for L2 U2N relay

#### 16.x.6.1 Switching from indirect to direct path

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



Figure 16.x.6.1-1: Procedure for U2N Remote UE switching to direct Uu cell

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 U2N Remote UE are reported when configured reporting criteria is met. The SL relay measurement report shall include at least U2N Relay UE’s source L2 ID, serving cell ID (i.e. NCGI), and SL measurement quantity information. SL measurement quantity can be SL-RSRP of the serving Relay UE, and if SL-RSRP is not available, SD-RSRP is used.

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

3. The gNB sends RRCReconfiguration message to the U2N Remote UE. The U2N Remote UE stops UP and CP transmission via U2N Relay UE after reception of RRCReconfiguration message from the gNB.

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

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

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

7. Either U2N Relay UE or U2N Remote UE can initiate the PC5 unicast link release (PC5-S). The timing to execute link release is up to UE implementation. The U2N Relay UE can execute PC5 connection reconfiguration to release PC5 RLC channel for relaying upon reception of RRC Reconfiguration by gNB in Step 6, or the UE (i.e. previous U2N Remote UE) can execute PC5 connection reconfiguration to release PC5 RLC channel for relaying upon reception of RRC Reconfiguration by gNB in Step 3.

8. The data path is switched from indirect path to direct path between the UE (i.e. previous U2N Remote UE) and the gNB. Step 8 can be executed any time after step 4. This step is independent of step 6 and step 7. The DL/UL lossless delivery during the path switch is done according to PDCP data recovery procedure.

#### 16.x.6.2 Switching from direct to indirect path

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

In case the selected U2N Relay UE for the direct to indirect path switch is in RRC\_IDLE or RRC\_INACTIVE, the following procedures are applied. After receiving the path switch command, U2N Remote UE establishes a PC5 link with the U2N Relay UE and sends the RRCReconfigurationComplete message via the U2N Relay UE, which will trigger the U2N Relay UE to enter RRC\_CONNECTED state.

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



Figure 16.x.6.2-1: Procedure for U2N Remote UE switching to indirect path

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

- The UE may filter the appropriate U2N Relay UE(s) according to Relay selection criteria before reporting. The UE shall report only the U2N Relay UE candidate(s) that fulfil the higher layer criteria.

- The reporting can include at least U2N Relay UE ID, U2N Relay UE’ s serving cell ID, and SL measurement quantity information. SL measurement quantity can be SL-RSRP of the candidate U2N Relay UE, and if SL-RSRP is not available, SD-RSRP is used.

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

3. The gNB sends the RRCReconfiguration message to the U2N Remote UE. The contents in the RRCReconfiguration message can include at least U2N Relay UE ID, PC5 RLC channel configuration for relay traffic and the associated end-to-end radio bearer(s). The U2N Remote UE stops UP and CP transmission over Uu after reception of RRCReconfiguration message from the gNB.

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

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

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

*Next Modified Subclause (new)*

### 16.9.y Sidelink Discovery

The UE may perform NR sidelink discovery (i.e. Non-Relay discovery) while in-coverage or out-of-coverage for non-relay operation.

The Relay discovery mechanism described in section 16.x.3 (except the U2N Relay specific threshold based discovery message transmission) is also applied to sidelink discovery.