**3GPP TSG-RAN WG3 Meeting #128R3-253826**

**Malta, MT, 19th – 23rd May 2025**

**Agenda item: 22.2**

**Source: Nokia, Nokia Shanghai Bell, LG Electronics**

**Title: (TP to BL CR for TS 38.401) Support on Multi-hop U2N relay**

**Document for: Discussion and Decision**

# 1 Introduction

This contribution proposes following update to TS 38.401 BL CR:

* + Remove the following Editor’s Notes
    - Editor’s Note: The definition of terminologies related to the Multi-hop relay operation is pending to RAN2 progress.
    - Editor’s Note: Current signaling flows are based on the agreements that the intermediate Relay UE is in RRC\_CONNECTED state. Whether the intermediate Relay UE in RRC\_IDLE/RRC\_INACTIVE state is supported or not is pending to RAN2.
    - Editor’s Note: FFS whether the gNB-DU UE F1AP IDs of the U2N First Relay UE and the U2N Intermediate Relay UE are included in the INITIAL UL RRC MESSAGE TRANSFER message.
    - Editor’s Note: FFS whether and how the gNB-DU becomes aware that the U2N Remote UE is connected to the gNB-DU via the U2N First Relay UE, the U2N Intermediate Relay UE and U2N Last Relay UE.
  + Change the following Editor’s Notes into the Notes.
    - Editor’s Note: FFS whether Step 18 can be performed earlier, e.g., via Steps 6-13.
    - Editor’s Note: FFS whether this step may be performed earlier.
  + Capture the definition of the following terminologies based on RAN2 running CR
    - First U2N Relay UE
    - Intermediate U2N Relay UE
    - Last U2N Relay UE
  + Add the following description “The single-hop relay protocol stack can be applicable to the multi-hop relay case with additional intermediate Relay UEs.”

# TP for TS 38.401 BL CR

***-----------------Start of Change-------------------***

# 3 Definitions and abbreviations

## 3.1 Definitions

For the purpose of the present document, the terms and definitions given in TR 21.905 [1] 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].

**AI/ML Model Inference:** follows the definition of “AI/ML inference” as specified in clause 3.1 of TS 28.105 [34].

**AI/ML Model Training:** follows the definition of “ML model training” as specified in clause 3.1 of TS 28.105 [34].**Associated QoS Flow:** as defined in TS 23.247 [27].

**Associated QoS flow information:** Information encompassing: QoS flow QoS parameters for associated QoS flows and mapping information between mapped (unicast) QoS flows and associated QoS flows. The respective information is included in a way that non-supporting RAN nodes would not establish respective RAN resources irrespective the multicast session state.

**Boundary IAB-node:** anIAB-node with one RRC interface terminating at a different IAB-donor-CU than the F1 interface. This definition applies to partial migration, inter-donor redundancy and inter-donor RLF recovery.

**Conditional Handover:** as defined in TS 38.300 [2].

**Conditional PSCell Addition:** as defined in TS 37.340 [12].

**Conditional PSCell Change:** as defined in TS 37.340 [12].

**DAPS Handover:** as defined in TS 38.300 [2].

**eNB-CP**: as defined in TS 36.401 [28].

**eNB-UP**: as defined in TS 36.401 [28].

**en-gNB**: as defined in TS 37.340 [12].

**Early Data Forwarding**: as defined in TS 38.300 [2].

**F1-terminating IAB-donor**: Refers to the IAB-donor that terminates F1 for the boundary IAB-node or a mobile IAB-node.

**First U2N Relay UE**: as defined in TS 38.300 [2].**gNB:** as defined in TS 38.300 [2].

**gNB Central Unit (gNB-CU):** a logical node hosting RRC, SDAP and PDCP protocols of the gNB or RRC and PDCP protocols of the en-gNB that controls the operation of one or more gNB-DUs. The gNB-CU terminates the F1 interface connected with the gNB-DU.

**gNB Distributed Unit (gNB-DU):** a logical node hosting RLC, MAC and PHY layers of the gNB or en-gNB, and its operation is partly controlled by gNB-CU. One gNB-DU supports one or multiple cells. One cell is supported by only one gNB-DU. The gNB-DU terminates the F1 interface connected with the gNB-CU. For DC operation, the MgNB-DU designates the gNB-DU of an en-gNB or a gNB acting as master node, and the SgNB-DU designates the gNB-DU of an en-gNB or a gNB acting as secondary node.

**gNB-CU-Control Plane (gNB-CU-CP):** a logical node hosting the RRC and the control plane part of the PDCP protocol of the gNB-CU for an en-gNB or a gNB. The gNB-CU-CP terminates the E1 interface connected with the gNB-CU-UP and the F1-C interface connected with the gNB-DU. For DC operation, the MgNB-CU-CP designates the gNB-CU-CP of the gNB-CU for an en-gNB or a gNB acting as master node, and the SgNB-CU-CP designates the gNB-CU-CP of the gNB-CU for an en-gNB or a gNB acting as secondary node.

**gNB-CU-User Plane (gNB-CU-UP):** a logical node hosting the user plane part of the PDCP protocol of the gNB-CU for an en-gNB, and the user plane part of the PDCP protocol and the SDAP protocol of the gNB-CU for a gNB. The gNB-CU-UP terminates the E1 interface connected with the gNB-CU-CP and the F1-U interface connected with the gNB-DU. For DC operation, the MgNB-CU-UP designates the gNB-CU-UP of the gNB-CU for an en-gNB or a gNB acting as master node, and the the SgNB-CU-UP designates the gNB-CU-UP of the gNB-CU for an en-gNB or a gNB acting as secondary node.

**IAB-node**: as defined in TS 38.300 [2].

**IAB-donor**:as defined in TS 38.300 [2].

**IAB-donor-CU**: the gNB-CU of an IAB-donor, terminating the F1 interface towards IAB-nodes and IAB-donor-DU.

**IAB-donor-DU**: the gNB-DU of an IAB-donor, hosting the IAB BAP sublayer (as defined in TS 38.340 [22]), providing wireless backhaul to IAB-nodes.

**IAB-DU**: as defined in TS 38.300 [2].

**IAB-MT**: as defined in TS 38.300 [2].

**IAB Topology**: as defined in TS 38.300 [2].

**Intermediate U2N Relay UE**: as defined in TS 38.300 [2].

**Last U2N Relay UE**: as defined in TS 38.300 [2].

**Mapped QoS flows:** Unicast QoS flows requested to be established, i.e. included in the legacy QoS flow lists in a way, that non-support RAN nodes would attempt to establish unicast QoS flows and supporting RAN nodes can identify them as mapped QoS flows based on the associated QoS information.

**Master node:** as defined in TS 37.340 [12].

**Master gNB:** see TS 37.340 [12].

**MBS session resource**: This term is used for specification of NG, Xn, F1 and E1 interfaces. It denotes NG-RAN interface and radio resources provided to support an MBS Session.

**MP Relay UE**: as defined in TS 38.300 [2].

**MP Remote UE**: as defined in TS 38.300 [2].

**Multi-path**: as defined in TS 38.300 [2].

**NCR-MT**: as defined in TS 38.300 [7].

**ng-eNB:** as defined in TS 38.300 [2].

**ng-eNB Central Unit (ng-eNB-CU):** as defined in TS 37.470 [21].

**ng-eNB Distributed Unit (ng-eNB-DU):** as defined in TS 37.470 [21].

**ng-eNB-CU-Control Plane (ng-eNB-CU-CP):** a logical node hosting the RRC and the control plane part of the PDCP protocol of the ng-eNB-CU for an ng-eNB. The ng-eNB-CU-CP terminates the E1 interface connected with the ng-eNB-CU-UP and the W1-C interface connected with the ng-eNB-DU.

**ng-eNB-CU-User Plane (ng-eNB-CU-UP):** a logical node hosting the user plane part of the PDCP protocol and the SDAP protocol of the ng-eNB-CU for an ng-eNB. The ng-eNB-CU-UP terminates the E1 interface connected with the ng-eNB-CU-CP and the W1-U interface connected with the ng-eNB-DU.

**NG-RAN node:** as defined in TS 38.300 [2].

**Non-F1-terminating IAB-donor of boundary IAB-node**: Refers to the IAB-donor that has an RRC connection with the boundary node but does not terminate F1 with this boundary node.

**PDU Session Resource**: This term is used for specification of NG, Xn, and E1 interfaces. It denotes NG-RAN interface and radio resources provided to support a PDU Session.

**Public Network Integrated NPN:** as defined in TS 23.501 [3].

**RRC-terminating IAB-donor:** Refers to the IAB-donor that terminates the RRC connection of the mobile IAB-node. The RRC-terminating IAB-donor may also be an F1-terminating IAB-donor.

**Secondary gNB:** see TS 37.340 [12].

**Stand-alone Non-Public Network:** as defined in TS 23.501 [3].

Subsequent CPAC: see TS 37.340 [12].

**U2N Relay UE:** as defined in TS 38.300 [2].

**U2N Remote UE:** as defined in TS 38.300 [2].

***-----------------Next Change-------------------***

### 6.1.6 Protocol stacks of L2 UE-to-Network Relay

The protocol stacks for the user plane and control plane of L2 U2N Relay architecture are described in Figure 6.1.6-1 and Figure 6.1.6-2, respectively. The single-hop relay protocol stack can be applicable to the multi-hop relay case with additional intermediate Relay UE(s). The Uu SRAP is terminated between U2N relay UE and gNB-DU.



Figure 6.1.6-1: User plane protocol stack for L2 UE-to-Network Relay



Figure 6.1.6-2: Control plane protocol stack for L2 UE-to-Network Relay

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### 8.19.xx Remote UE initial access for Multi-hop Layer-2 UE-to-Network Relay

The signalling flow for Remote UE Initial access is shown in Figure 8.19.xx-1.



**Figure 8.19.xx-1: Overall procedure for Remote UE’s initial access via multi-hop relay**

1. The U2N Remote UE, the First U2N Relay UE, the Intermediate U2N Relay UE, and the Last U2N Relay UE perform discovery procedure, and establish PC5 connection using NR ProSe procedure.

2. The U2N Remote UE sends an *RRCSetupRequest* message to the First U2N Relay UE via PC5 Relay RLC channel.

3. The First U2N Relay UE withholds the received RRC message. If the First U2N Relay UE is in RRC\_IDLE/RRC\_INACTIVE state, it should send its own *RRCSetupRequest* message to the Intermediate U2N Relay UE via PC5 Relay RLC channel in order to trigger the RRC establishment/resume procedure to enter RRC\_CONNECTED state upon reception of the RRC message from the U2N Remote UE. If the Intermediate U2N Relay UE is in RRC\_IDLE/RRC\_INACTIVE state, it should trigger the RRC establishment/resume procedure in clause 8.19.1 to enter RRC\_CONNECTED state upon reception of the RRC message from the First U2N Relay UE. If all Relay UEs are in RRC\_CONNECTED state, this step could be skipped.

4. The First U2N Relay UE in RRC\_CONNECTED state sends the *SidelinkUEInformationNR* message to the gNB-DU via the Intermediate U2N Relay UE and Last U2N Relay UE.

5. The gNB-DU sends the UL RRC MESSAGE TRANSFER message of the First U2N Relay UE by encapsulating the *SidelinkUEInformationNR* message to gNB-CU, and gNB-CU allocates the local ID of U2N Remote UE.

6. The gNB-CU sends the UE CONTEXT MODIFICATION REQUEST message of the Last U2N Relay UE to gNB-DU. Such message may request the establishment of Uu Relay RLC channel(s) and PC5 Relay RLC channel(s) for the transmission of U2N Remote UE’s SRB0.

7. The gNB-DU sends the UE CONTEXT MODIFICATION RESPONSE message of the Last U2N Relay UE to gNB-CU.

8. The gNB-CU sends the DL RRC MESSAGE TRANSFER message of the Last U2N Relay UE to gNB-DU by encapsulating the *RRCReconfiguration* message, which contains the local ID allocated to the U2N Remote UE. The *RRCReconfiguration* message shall also contain the Uu Relay RLC channel(s) configuration and PC5 Relay RLC channel(s) configuration if not configured and bearer mapping for relaying of U2N Remote UE’s SRB0.

9. The gNB-DU sends the *RRCReconfiguration* message to the Last U2N Relay UE to configure the local ID of the U2N Remote UE, the Uu Relay RLC channel(s) configuration, PC5 Relay RLC channel(s) configuration and bearer mapping for relaying of U2N Remote UE’s SRB0.

10. The Last U2N Relay UE sends the *RRCReconfigurationComplete* message to gNB-DU.

11. The gNB-DU sends the UL RRC MESSAGE TRANSFER message of the Last U2N Relay UE by encapsulating the *RRCReconfigurationComplete* message to gNB-CU.

12. The gNB-CU configures the Intermediate U2N Relay UE with the local ID allocated to the U2N Remote UE, PC5 Relay RLC channel and bearer mapping for relaying of U2N Remote UE’s SRB0. According to the configuration from gNB-CU, the Intermediate U2N Relay UE may establish a PC5 Relay RLC channel for relaying of U2N Remote UE’s SRB0 over PC5. This step follows the same signaling flow as described in steps 6-11.

13. The gNB-CU configures the First U2N Relay UE with the local ID allocated to the U2N Remote UE, PC5 Relay RLC channel and bearer mapping for relaying of U2N Remote UE’s SRB0. According to the configuration from gNB-CU, the First U2N Relay UE may establish a PC5 Relay RLC channel for relaying of U2N Remote UE’s SRB0 over PC5. This step follows the same signaling flow as described in steps 6-11.

14. After receiving the local ID of the U2N Remote UE and the PC5 Relay RLC channel(s) configuration and bearer mapping for relaying of U2N Remote UE’s SRB0, the First U2N Relay UE sends the *RRCSetupRequest* message of the U2N Remote UE to gNB-DU via the Intermediate U2N Relay UE and the Last U2N Relay UE. The local ID of the U2N Remote UE and RB ID for SRB0 are conveyed in the SRAP header.

15. The gNB-DU allocates a C-RNTI and a gNB-DU UE F1AP ID for the U2N Remote UE and sends the INITIAL UL RRC MESSAGE TRANSFER message to gNB-CU by encapsulating the *RRCSetupRequest* message of the U2N Remote UE. In addition, the local ID of the U2N Remote UE, the gNB-DU UE F1AP ID of the Last U2N Relay UE and the sidelink configuration container for the PC5 Relay RLC channel configuration for relaying of U2N Remote UE’s SRB1 are included in the INITIAL UL RRC MESSAGE TRANSFER message.

16. The gNB-CU allocates a gNB-CU UE F1AP ID for the U2N Remote UE and generates a *RRCSetup* message towards the U2N Remote UE. The RRC message is encapsulated in the DL RRC MESSAGE TRANSFER message, and includes the configurations of PC5 Relay RLC channel and bearer mapping at least for the transmission of U2N Remote UE’s SRB1.

17. The gNB-DU sends the *RRCSetup* message to the U2N Remote UE via the First U2N Relay UE, the Intermediate U2N Relay UE and Last U2N Relay UE.

18. The gNB-CU configures the Last U2N Relay UE with PC5 Relay RLC channel, Uu Relay RLC channel and bearer mapping for relaying of U2N Remote UE’s SRB1. According to the configuration from gNB-CU, the Last U2N Relay UE establishes a PC5 Relay RLC channel for relaying of U2N Remote UE’s SRB1 over PC5 and establishes a Uu Relay RLC channel for relaying of U2N Remote UE’s SRB1 towards gNB-DU if not configured yet.

The gNB-CU configures the First U2N Relay UE and the Intermediate U2N Relay UE with PC5 Relay RLC channel and bearer mapping for relaying of U2N Remote UE’s SRB1. According to the configuration from gNB-CU, the First U2N Relay UE and the Intermediate U2N Relay UE establish the PC5 Relay RLC channels for relaying of U2N Remote UE’s SRB1 over PC5 if not configured yet.

NOTE 1: Step 18 can be performed earlier, e.g., via Steps 6-13.

19. The U2N Remote UE sends the *RRCSetupComplete* message to the gNB-DU via the First U2N Relay UE, the Intermediate U2N Relay UE and Last U2N Relay UE.

20. The gNB-DU encapsulates the RRC message in the UL RRC MESSAGE TRANSFER message and sends it to the gNB-CU.

21. Upon receiving the *RRCSetupComplete* message of U2N Remote UE, the gNB-CU sends the INITIAL UE MESSAGE message to the AMF.

22. The AMF sends the INITIAL CONTEXT SETUP REQUEST message to the gNB-CU.

23. The gNB-CU sends the UE CONTEXT SETUP REQUEST message to establish the U2N Remote UE context in the gNB-DU. Such message may request the configuration of PC5 Relay RLC channels for the transmission of U2N Remote UE’s SRB2 and DRBs, and may also encapsulate the *SecurityModeCommand* message.

24. The gNB-DU sends the *SecurityModeCommand* message to the U2N Remote UE via the First U2N Relay UE, the Intermediate U2N Relay UE and Last U2N Relay UE.

25. The gNB-DU sends the UE CONTEXT SETUP RESPONSE message of the U2N Remote UE to the gNB-CU, which contains the configuration of PC5 Relay RLC channels for the transmission of U2N Remote UE’s SRB2 and DRBs.

26. The U2N Remote UE responds with the *SecurityModeComplete* message.

27. The gNB-DU encapsulates the RRC message in the UL RRC MESSAGE TRANSFER message and sends it to the gNB-CU.

28. The gNB-CU generates the *RRCReconfiguration* message for U2N Remote UE and encapsulates it in the DL RRC MESSAGE TRANSFER message. The *RRCReconfiguration* message contains the configuration of PC5 Relay RLC channels and bearer mapping for the transmission of U2N Remote UE’s SRB2 and DRBs.

29. The gNB-DU sends *RRCReconfiguration* message to the U2N Remote UE via the First U2N Relay UE, the Intermediate U2N Relay UE and Last U2N Relay UE.

30. The U2N Remote UE sends *RRCReconfigurationComplete* message to the gNB-DU via the First U2N Relay UE, the Intermediate U2N Relay UE and Last U2N Relay UE.

31. The gNB-DU encapsulates the RRC message in the UL RRC MESSAGE TRANSFER message and send it to the gNB-CU.

32. The gNB-CU sends the INITIAL CONTEXT SETUP RESPONSE message to the AMF.

33. The gNB-CU configures additional Uu Relay RLC channels between the gNB-DU and the Last U2N Relay UE, and additional PC5 Relay RLC channels for the First U2N Relay UE, the Intermediate U2N Relay UE, and the Last U2N Relay UE for relaying of U2N Remote UE’s DRBs and SRBs. Also, such step may configure the bearer mapping between U2N Remote UE’s DRB/SRB and PC5/Uu Relay RLC channel at the First U2N Relay UE, the Intermediate U2N Relay UE, and the Last U2N Relay UE.

NOTE 2: This step can be performed earlier.

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