**3GPP TSG-RAN WG2 #124 *R2-231xxxx***

**Chicago, USA, November 13 - 17, 2023**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  | **38.323** | **CR** | **0127** | **rev** | **1** | **Current version:** | **17.5.0** |  |
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| *For [HELP](http://www.3gpp.org/3G_Specs/CRs.htm%22%20%5Cl%20%22_blank)**on using this form: comprehensive instructions can be found at <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 Enhanced NR Sidelink Relay |
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| ***Source to WG:*** | InterDigital |
| ***Source to TSG:*** | R2 |
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| ***Work item code:*** | NR\_SL\_relay\_enh-Core |  | ***Date:*** | 2023-11-01 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | This CR introduces the support for the enhanced Sidelink Relay feature in NR. |
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| ***Summary of change:*** | * Section 3.1 & 3.2: Added definitions and abbreviations
* Section 4.2: Added architecture descriptions for L2 U2U relay and multipath
* Section 5.2: Added the transmit operation for multipath
* Section 5.6, 5.11.2: Added consideration of multipath in, data volume calculation, and duplicate discard.
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| ***Consequences if not approved:*** | If the CR is not approved, enhanced Sidelink Relay is not supported in NR. |
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| ***Clauses affected:*** | 3.1, 3.2, 4.2, 5.2, 5.6, 5.11.2 |
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|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 38.331 CR 4432, 4441, 4400  |
| ***affected:*** |  | **X** |  Test specifications | TS 38.321 CR 1703  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS 38.322 CR 0054 TS 38.351 CR 0027TS 38.304 CR 0365TS 38.300 - |
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| ***Other comments:*** |  |
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| ***This CR's revision history:*** |  |

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| *Start of change* |

# Definitions and abbreviations

## 3.1 Definitions

For the purposes 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].

**AM DRB**:a data radio bearer which utilizes RLC AM.

**AM MRB:** an MRB associated with at least one AM RLC bearer for PTP transmission.

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

**DAPS bearer**:a bearer whose radio protocols are located in both the source gNB and the target gNB during DAPS handover to use both source gNB and target gNB resources.

**MBS Radio Bearer:** a radio bearer that is configured for MBS delivery.

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

**Multi-path:** Mode of operation of a remote UE in RRC\_CONNECTED configured with one direct path on which the UE connects to the gNB using NR Uu and one indirect path on which the UE connects to the same gNB via another UE using PC5 unicast link or Non-3GPP Connection.

**Multi-path split bearer:** In multi-path, a bearer in which one PDCP entity is mapped to one (direct) Uu RLC entity and either one SRAP entity of a SL indirect path or non-3GPP connectivity.

**N3C indirect path:** In multi-path, the indirect path on which the remote UE connects to the network via a relay UE using non-3GPP connectivity.

**Non-split bearer**: a bearer whose radio protocols are located in either the MgNB or the SgNB to use MgNB or SgNB resource, respectively.

**NR sidelink communication**: AS functionality enabling at least V2X communication as defined in TS 23.287 [13] and ProSe communication (including ProSe non-Relay, UE-to-Network Relay, and UE-to-UE Relay communication) as defined in TS 23.304 [18], 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, ProSe UE-to-Network Relay discovery, and ProSe UE-to-UE Relay discovery for Proximity based Services as defined in TS 23.304 [18] between two or more nearby UEs, using NR technology but not traversing any network node.

**NR sidelink transmission**: any NR Sidelink-based transmission, including both transmission for NR sidelink discovery and transmission for NR sidelink communication.

**PDCP data volume**: the amount of data available for transmission in a PDCP entity.

**Primary Path**: In multi-path for a split DRB, the primary path is configured by RRC to be either the direct path or the indirect path. For a split SRB in multi-path, the primary path is always the direct path.

**Secondary Path**: In multi-path, for a split DRB, the path (either direct or indirect) which is not configured by RRC as the primary path. For a split SRB in multi-path, the secondary path is always the indirect path (SL or N3C).

**SL indirect path**: In multi-path, the indirect path on which the L2 U2N Remote UE connects to the network via a L2 U2N Relay UE.

**Split bearer**: in dual connectivity, a bearer whose radio protocols are located in both the MgNB and the SgNB to use both MgNB and SgNB resources.

**Split secondary RLC entity**: in dual connectivity, the RLC entity other than the primary RLC entity which is responsible for split bearer operation. If the PDCP entity is associated with two RLC entities, the split secondary RLC entity is the RLC entity other than the primary RLC entity. If the PDCP entity is associated with more than two RLC entities, the split secondary RLC entity is configured by upper layers.

**UM DRB**:a data radio bearer which utilizes RLC UM.

**UM MRB:** an MRB associated with only RLC UM.

**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.

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

**U2U Remote UE**: a UE that communicates with another UE via a U2U Relay UE

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] 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].

AM Acknowledged Mode

ARP Address Resolution Protocol

CID Context Identifier

DAPS Dual Active Protocol Stack

DRB Data Radio Bearer carrying user plane data

EHC Ethernet Header Compression

FIFO First In First Out

gNB NR Node B

HFN Hyper Frame Number

IETF Internet Engineering Task Force

IP Internet Protocol

MAC Medium Access Control

MAC-I Message Authentication Code for Integrity

MBS Multicast/Broadcast Services

MRB MBS Radio Bearer

MTCH MBS Traffic Channel

MP Multi-path

N3C Non-3GPP Connectivity

PDCP Packet Data Convergence Protocol

PDU Protocol Data Unit

RB Radio Bearer

RFC Request For Comments

RLC Radio Link Control

ROHC Robust Header Compression

RRC Radio Resource Control

RTP Real Time Protocol

SAP Service Access Point

SCCH Sidelink Control Channel

SDU Service Data Unit

SLRB Sidelink Radio Bearer carrying NR sidelink communication or NR sidelink discovery

SN Sequence Number

SRAP Sidelink Relay Adaptation Protocol

SRB Signalling Radio Bearer carrying control plane data

STCH Sidelink Traffic Channel

TCP Transmission Control Protocol

UDC Uplink Data Compression

UDP User Datagram Protocol

UE User Equipment

UM Unacknowledged Mode

U2N UE-to-Network

X-MAC Computed MAC-I

# 4 General

## 4.1 Introduction

The present document describes the functionality of the PDCP.

## 4.2 Architecture

### 4.2.1 PDCP structure

Figure 4.2.1-1 represents one possible structure for the PDCP sublayer. Figure 4.2.1-2 represents one possible structure for the PDCP sublayer used in L2 U2N relay case, L2 U2U relay case, and for the indirect path in the case of multi-path with SL indirect path. Figure 4.2.1-3 represents one possible structure for PDCP sublayer used for the indirect path in the case of multi-path with N3C indirect path. These structures should not restrict implementation. The figures are based on the radio interface protocol architecture defined in TS 38.300 [2].

NOTE: The structure and interface of non-3GPP connectivity for the case of multi-path with N3C indirect path is out of the scope of this specification.



Figure 4.2.1-1: PDCP layer, structure view (normal)



Figure 4.2.1-2: PDCP layer, structure view (L2 U2N relay, L2 U2U relay and SL indirect path in multi-path)



Figure 4.2.1-3: PDCP layer, structure view (N3C indirect path in multi-path)

The PDCP sublayer is configured by upper layers TS 38.331 [3]. The PDCP sublayer is used for RBs mapped on DCCH, DTCH, MTCH, SCCH, and STCH type of logical channels. The PDCP sublayer is not used for any other type of logical channels.

Each RB (except for SRB0 for Uu interface) is associated with one PDCP entity. Each PDCP entity is associated with one, two, three, four, six, or eight RLC entities depending on the RB characteristic (e.g. uni-directional/bi-directional or split/non-split) or RLC mode:

- For split bearers, each PDCP entity is associated with two UM RLC entities (for same direction), four UM RLC entities (two for each direction), or two AM RLC entities;- For RBs configured with PDCP duplication, each PDCP entity is associated with N UM RLC entities (for same direction), 2 × N UM RLC entities (N for each direction), or N AM RLC entities, where 2 <= N <= 4;

- For DAPS bearers, each PDCP entity is associated with two UM RLC entities (for same direction, one for source and one for target cell), four UM RLC entities (two for each direction on source cell and target cell), or two AM RLC entities (one for source cell and one for target cell);

- For UM MRBs, each PDCP entity is associated with one UM RLC entity (for MTCH or for downlink DTCH), two UM RLC entities (one for MTCH and one for downlink DTCH, or one for downlink DTCH and one for uplink DTCH), or three UM RLC entities (one for MTCH, one for downlink DTCH, and one for uplink DTCH);

- For AM MRBs, each PDCP entity is associated with one AM RLC entity (for downlink DTCH and uplink DTCH), or one UM RLC entity (for MTCH) and one AM RLC entity (for downlink DTCH and uplink DTCH);

- For MP split bearers with SL indirect path, each PDCP entity is associated with one Uu RLC entity and one SRAP entity.

- For MP split bearers with N3C indirect path, each PDCP entity is associated with one Uu RLC entity and the N3C.

- Otherwise, each PDCP entity is associated with one UM RLC entity, two UM RLC entities (one for each direction), or one AM RLC entity.

For the case of L2 U2N relay, L2 U2U relay and SL indirect path of multi-path, all PDCP entities are associated with one SRAP entity. For the case of N3C indirect path for multi-path, all PDCP entities are associated with the N3C.

### 4.2.2 PDCP entities

The PDCP entities are located in the PDCP sublayer. Several PDCP entities may be defined for a UE. Each PDCP entity is carrying the data of one radio bearer. A PDCP entity is associated either to the control plane or the user plane depending on which radio bearer it is carrying data for.

Figure 4.2.2-1 represents the functional view of the PDCP entity for the PDCP sublayer; it should not restrict implementation. The figure is based on the radio interface protocol architecture defined in TS 38.300 [2].

For split bearers, MP split bearers, and DAPS bearers, routing is performed in the transmitting PDCP entity.

A PDCP entity associated with DRB can be configured by upper layers TS 38.331 [3] to use header compression or uplink data compression (UDC). A PDCP entity associated with MRB can be configured by upper layers TS 38.331 [3] to use header compression. In this version of the specification, the robust header compression protocol (ROHC), the Ethernet header compression protocol (EHC) and UDC are supported. Each header compression protocol is independently configured for a DRB/MRB.



Figure 4.2.2-1: PDCP layer, functional view

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### 4.3.2 Services expected from lower layers

A PDCP entity expects the following services from lower layers per RLC entity (for a detailed description see TS 38.322 [5]):

- acknowledged data transfer service, including indication of successful delivery of PDCP PDUs;

- unacknowledged data transfer service.

A PDCP entity expects the following service from SRAP entity (for a detailed description see TS 38.351 [22]), if the PDCP entity is associated with an SRAP entity:

- data transfer.

A PDCP entity expects the following service from the N3C if the PDCP entity is associated with the N3C:

- data transfer.

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## 5.2 Data transfer

### 5.2.1 Transmit operation

At reception of a PDCP SDU from upper layers, the transmitting PDCP entity shall:

- start the *discardTimer* associated with this PDCP SDU (if configured).

For a PDCP SDU received from upper layers, the transmitting PDCP entity shall:

- associate the COUNT value corresponding to TX\_NEXT to this PDCP SDU;

NOTE 1: Associating more than half of the PDCP SN space of contiguous PDCP SDUs with PDCP SNs, when e.g., the PDCP SDUs are discarded or transmitted without acknowledgement, may cause HFN desynchronization problem. How to prevent HFN desynchronization problem is left up to UE implementation.

- perform header compression of the PDCP SDU using ROHC as specified in the clause 5.7.4 and/or using EHC as specified in the clause 5.12.4;

- perform uplink data compression of the PDCP SDU as specified in clause 5.14.4;

- perform integrity protection, and ciphering using the TX\_NEXT as specified in the clause 5.9 and 5.8, respectively;

- set the PDCP SN of the PDCP Data PDU to TX\_NEXT modulo 2[*pdcp-SN-SizeUL*];

- increment TX\_NEXT by one;

- submit the resulting PDCP Data PDU to lower layer as specified below.

When submitting a PDCP PDU to lower layer, the transmitting PDCP entity shall:

- if the transmitting PDCP entity is associated with one SRAP entity:

- submit the PDCP PDU to the associated SRAP entity;

- else, if the transmitting PDCP entity is associated with one RLC entity:

- submit the PDCP PDU to the associated RLC entity;

- else, if the transmitting PDCP entity is associated with one RLC entity and, either one SRAP entity or the N3C

- if PDCP duplication is activated for the RB:

- if the PDCP PDU is a PDCP Data PDU:

- duplicate the PDCP Data PDU and submit the PDCP Data PDU to both the primary path and secondary path;

- else

- submit the PDCP Control PDU to the primary path;

- else (i.e., PDCP duplication is deactivated for the RB)

- if the total amount of PDCP data volume, RLC data volume pending for initial transmission (as specified in TS 38.322 [5]) in the RLC entity, and data volume pending for transmission in the N3C (if available) or mapped SL RLC entity associated with the SRAP entity is equal to or larger than *ul-DataSplitThreshold*:

- submit the PDCP PDU to either the primary path or secondary path;

- else:

- submit the PDCP PDU to the primary path.

- else, if the transmitting PDCP entity is associated with at least two RLC entities:

- if the PDCP duplication is activated for the RB:

- if the PDCP PDU is a PDCP Data PDU:

- duplicate the PDCP Data PDU and submit the PDCP Data PDU to the associated RLC entities activated for PDCP duplication;

- else:

- submit the PDCP Control PDU to the primary RLC entity;

- else (i.e. the PDCP duplication is deactivated for the RB or the RB is a DAPS bearer):

- if the split secondary RLC entity is configured; and

- if the total amount of PDCP data volume and RLC data volume pending for initial transmission (as specified in TS 38.322 [5]) in the primary RLC entity and the split secondary RLC entity is equal to or larger than *ul-DataSplitThreshold*:

- submit the PDCP PDU to either the primary RLC entity or the split secondary RLC entity;

- else, if the transmitting PDCP entity is associated with the DAPS bearer:

- if the uplink data switching has not been requested:

- submit the PDCP PDU to the RLC entity associated with the source cell;

- else:

- if the PDCP PDU is a PDCP Data PDU:

- submit the PDCP Data PDU to the RLC entity associated with the target cell;

- else:

- if the PDCP Control PDU is associated with source cell:

- submit the PDCP Control PDU to the RLC entity associated with the source cell;

- else:

- submit the PDCP Control PDU to the RLC entity associated with the target cell;

- else:

- submit the PDCP PDU to the primary RLC entity.

NOTE 2: If the transmitting PDCP entity is associated with two RLC entities or with an RLC entity and either an SRAP entity or the N3C, the UE should minimize the amount of PDCP PDUs submitted to lower layers before receiving request from lower layers and minimize the PDCP SN gap between PDCP PDUs submitted to two associated RLC entities, or to the RLC entity and either the SRAP entity or the N3C, to minimize PDCP reordering delay in the receiving PDCP entity.

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## 5.3 SDU discard

When the *discardTimer* expires for a PDCP SDU, or the successful delivery of a PDCP SDU is confirmed by PDCP status report, the transmitting PDCP entity shall discard the PDCP SDU along with the corresponding PDCP Data PDU. If the corresponding PDCP Data PDU has already been submitted to lower layers, the discard is indicated to lower layers.

For SRBs, when upper layers request a PDCP SDU discard, the PDCP entity shall discard all stored PDCP SDUs and PDCP PDUs.

NOTE: Discarding a PDCP SDU already associated with a PDCP SN causes a SN gap in the transmitted PDCP Data PDUs, which increases PDCP reordering delay in the receiving PDCP entity. It is up to UE implementation how to minimize SN gap after SDU discard.

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## 5.6 Data volume calculation

For the purpose of MAC buffer status reporting, the transmitting PDCP entity shall consider the following as PDCP data volume:

- the PDCP SDUs for which no PDCP Data PDUs have been constructed;

- the PDCP Data PDUs that have not been submitted to lower layers;

- the PDCP Control PDUs;

- for AM DRBs, the PDCP SDUs to be retransmitted according to clause 5.1.2 and clause 5.13;

- for AM DRBs, the PDCP Data PDUs to be retransmitted according to clause 5.5.

If the transmitting PDCP entity is associated with at least two RLC entities, or with an RLC entity and either an SRAP entity or the N3C, when indicating the PDCP data volume to a MAC entity for BSR triggering and Buffer Size calculation (as specified in TS 38.321 [4] and TS 36.321 [12]), the transmitting PDCP entity shall:

- if the PDCP duplication is activated for the RB:

- indicate the PDCP data volume to the MAC entity associated with the primary RLC entity or primary path;

- indicate the PDCP data volume excluding the PDCP Control PDU to the MAC entity associated with the RLC entity other than the primary RLC entity or primary path activated for PDCP duplication;

- indicate the PDCP data volume as 0 to the MAC entity associated with RLC entity deactivated for PDCP duplication;

- else (i.e. the PDCP duplication is deactivated for the RB or the RB is a DAPS bearer):

- if the split secondary RLC entity is configured; and

- if the total amount of PDCP data volume and RLC data volume pending for initial transmission (as specified in TS 38.322 [5]) in the primary RLC entity and the split secondary RLC entity is equal to or larger than *ul-DataSplitThreshold*:

- indicate the PDCP data volume to both the MAC entity associated with the primary RLC entity and the MAC entity associated with the split secondary RLC entity;

- indicate the PDCP data volume as 0 to the MAC entity associated with RLC entity other than the primary RLC entity and the split secondary RLC entity;

- else if the total amount of PDCP data volume, RLC data volume pending for initial transmission (as specified in TS 38.322 [5]) in the RLC entity, and data volume pending for transmission in the N3C (if available), or mapped SL RLC entity associated with the SRAP entity, is equal to or larger than *ul-DataSplitThreshold*:

- indicate the PDCP data volume to both the MAC entity associated with the primary path and the MAC entity associated with the secondary path;

- else, if the transmitting PDCP entity is associated with the DAPS bearer:

- if the uplink data switching has not been requested:

- indicate the PDCP data volume to the MAC entity associated with the source cell;

- else:

- indicate the PDCP data volume excluding the PDCP Control PDU for interspersed ROHC feedback associated with the source cell to the MAC entity associated with the target cell;

- indicate the PDCP data volume of PDCP Control PDU for interspersed ROHC feedback associated with the source cell to the MAC entity associated with the source cell;

- else:

- indicate the PDCP data volume to the MAC entity associated with the primary RLC entity or primary path;

- indicate the PDCP data volume as 0 to the MAC entity associated with the RLC entity other than the primary RLC entity or primary path.

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### 5.11.2 Duplicate PDU discard

For the PDCP entity configured with *pdcp-Duplication*, the transmitting PDCP entity shall:

- if the successful delivery of a PDCP Data PDU is confirmed by one of the associated AM RLC entities and the AM RLC entity is not associated with an SRAP entity:

- indicate to the other AM RLC entities to discard the duplicated PDCP Data PDU;

- if the deactivation of PDCP duplication is indicated for the DRB:

- indicate to the RLC entities other than the primary RLC entity to discard all duplicated PDCP Data PDUs;

- if the deactivation of PDCP duplication is indicated for at least one associated RLC entities:

- indicate to the RLC entities deactivated for PDCP duplication to discard all duplicated PDCP Data PDUs.