**3GPP TSG-RAN2 Meeting #124 R2-2313697**

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

**Agenda item: 7.5.1**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.323** | **CR** | **0128** | **rev** | **1** | **Current version:** | **17.5.0** |  |
|  | | | | | | | | |
| *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 XR Enhancements | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | LG Electronics Inc. (Rapporteur) | | | | | | | | | |
| ***Source to TSG:*** | RAN2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_XR\_enh-Core | | | | |  | ***Date:*** | | | 2023-12-01 |
|  |  | | | |  | |  | | |  |
| ***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 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:*** | | In Rel-18, new functionalities were agreed for NR to provide enhanced support of XR services, which requires PDCP protocol modifications. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Following new functionalities are introduced for XR.   1. PDU Set discard 2. PSI based SDU discard at congestion 3. Data volume calculation for Delay Status Reporting | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | NR enhancements related to XR services cannot be supported in Rel-18. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 3.1, 3.2, 4.4, 5.1.2, 5.1.5, 5.2.1, 5.3, 5.X, 7.3 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **Y** |  | Other core specifications | | | | TS/TR 38.300 CR 0724  TS/TR 38.306 CR 1015  TS/TR 38.321 CR 1698  TS/TR 38.322 CR 0053  TS/TR 38.331 CR 4436  TS/TR 38.331 CR 4510 | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

====================================CHAGNE BEGIN====================================

# 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 38.300: "NG Radio Access Network; Overall description".

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

[4] 3GPP TS 38.321: "NR Medium Access Control (MAC) protocol specification".

[5] 3GPP TS 38.322: "NR Radio Link Control (RLC) protocol specification".

[6] 3GPP TS 33.501: "Security Architecture and Procedures for 5G System ".

[7] IETF RFC 5795: "The RObust Header Compression (ROHC) Framework".

[8] IETF RFC 3095: "RObust Header Compression (ROHC): Framework and four profiles: RTP, UDP, ESP and uncompressed".

[9] IETF RFC 4815: "RObust Header Compression (ROHC): Corrections and Clarifications to RFC 3095".

[10] IETF RFC 6846: "RObust Header Compression (ROHC): A Profile for TCP/IP (ROHC-TCP)".

[11] IETF RFC 5225: "RObust Header Compression (ROHC) Version 2: Profiles for RTP, UDP, IP, ESP and UDP Lite".

[12] 3GPP TS 36.321: "Evolved Universal Terrestrial Radio Access (E-UTRA) Medium Access Control (MAC) protocol specification".

[13] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[14] 3GPP TS 33.536: "Security Aspect of 3GPP Support for Advanced V2X Services".

[15] IEEE Standard 802.3™-2018: "Ethernet".

[16] 3GPP TS 24.587: "Vehicle-to-Everything (V2X) services in 5G System (5GS), Stage 3".

[17] 3GPP TS 33.401: "3GPP System Architecture Evolution (SAE); Security Architecture".

[18] 3GPP TS 23.304: "Proximity based Services (ProSe) in the 5G System (5GS)".

[19] IETF RFC 1951: "DEFLATE Compressed Data Format Specification version 1.3".

[20] IETF RFC 3485: "The Session Initiation Protocol (SIP) and Session Description Protocol (SDP) Static Dictionary for Signaling Compression (SigComp)".

[21] IETF RFC 1979: "PPP Deflate Protocol".

[22] 3GPP TS 38.351: "NR; Sidelink Relay Adaptation Protocol (SRAP) Specification".

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

## 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.

**Delay-critical PDCP SDU**: if *pdu-SetDiscard* is not configured, a PDCP SDU for which the remaining time till *discardTimer* expiry is less than the *remainingTimeThreshold*. If *pdu-SetDiscard* is configured, a PDCP SDU belonging to a PDU Set of which at least one PDCP SDU has the remaining time till *discardTimer* expiry less than the *remainingTimeThreshold*.

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

**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 and UE-to-Network 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 and ProSe UE-to-Network 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.

**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) etc. for XR services), as defined in TS 23.501 [xx]. A PDU in the PDU Set corresponds to a PDCP SDU.

**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.

## 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

PDCP Packet Data Convergence Protocol

PDU Protocol Data Unit

PSI PDU Set Importance

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

## 4.4 Functions

The PDCP layer supports the following functions:

- transfer of data (user plane or control plane);

- maintenance of PDCP SNs;

- header compression and decompression using the ROHC protocol;

- header compression and decompression using the EHC protocol;

- uplink data compression and decompression using the UDC protocol;

- ciphering and deciphering;

- integrity protection and integrity verification;

- timer based SDU discard;

- PDU Set discard;

- PSI based SDU discard;

- for split bearers and DAPS bearer, routing;

- duplication;

- reordering and in-order delivery;

- out-of-order delivery;

- duplicate discarding.

### 5.1.2 PDCP entity re-establishment

When upper layers request a PDCP entity re-establishment, the UE shall additionally perform once the procedures described in this clause for Uu or PC5 interface. After performing the procedures in this clause, the UE shall follow the procedures in clause 5.2.

When upper layers request a PDCP entity re-establishment, the transmitting PDCP entity shall:

- for UM DRBs and AM DRBs, reset the ROHC protocol for uplink and start with an IR state in U-mode (as defined in RFC 3095 [8] and RFC 4815 [9]) if *drb-ContinueROHC* is not configured in TS 38.331 [3];

- for UM DRBs and AM DRBs, reset the EHC protocol for uplink if *drb-ContinueEHC-UL* is not configured in TS 38.331 [3];

- for AM DRBs, reset the UDC compression buffer to all zeros and prefill the dictionary if *drb-ContinueUDC* is not configured in TS 38.331 [3];

- for SRBs and UM DRBs, set TX\_NEXT to the initial value;

- for SRBs, discard all stored PDCP SDUs and PDCP PDUs;

- apply the ciphering algorithm and key provided by upper layers during the PDCP entity re-establishment procedure;

- apply the integrity protection algorithm and key provided by upper layers during the PDCP entity re-establishment procedure;

- for UM DRBs, for each PDCP SDU already associated with a PDCP SN but for which a corresponding PDU has not previously been submitted to lower layers, and;

- for AM DRBs for Uu interface whose PDCP entities were suspended, from the first PDCP SDU for which the successful delivery of the corresponding PDCP Data PDU has not been confirmed by lower layers, for each PDCP SDU already associated with a PDCP SN:

- consider the PDCP SDUs as received from upper layer;

- perform transmission of the PDCP SDUs in ascending order of the COUNT value associated to the PDCP SDU prior to the PDCP re-establishment without restarting the *discardTimer* or the *discardTimerForLowImportance*, as specified in clause 5.2.1;

- for AM DRBs whose PDCP entities were not suspended, from the first PDCP SDU for which the successful delivery of the corresponding PDCP Data PDU has not been confirmed by lower layers, perform retransmission or transmission of all the PDCP SDUs already associated with PDCP SNs in ascending order of the COUNT values associated to the PDCP SDU prior to the PDCP entity re-establishment as specified below:

- 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;

- If *drb-ContinueUDC* is configured and if the PDCP SDU has been compressed before:

- submit the PDCP SDU previously compressed to integrity protection and ciphering function;

- else:

- perform uplink data compression of the PDCP SDU as specified in clause 5.14.4, and submit the PDCP SDU to integrity protection and ciphering function;

- perform integrity protection and ciphering of the PDCP SDU using the COUNT value associated with this PDCP SDU as specified in the clause 5.9 and 5.8;

- submit the resulting PDCP Data PDU to lower layer, as specified in clause 5.2.1.

When upper layers request a PDCP entity re-establishment, the receiving PDCP entity shall:

- process the PDCP Data PDUs that are received from lower layers due to the re-establishment of the lower layers, as specified in the clause 5.2.2.1;

- for SRBs, discard all stored PDCP SDUs and PDCP PDUs;

- for SRBs, UM DRBs and UM MRBs, if *t-Reordering* is running:

- stop and reset *t-Reordering*;

- for UM DRBs and UM MRBs, deliver all stored PDCP SDUs to the upper layers in ascending order of associated COUNT values after performing header decompression;

- for AM DRBs and AM MRBs for Uu interface, perform header decompression using ROHC for all stored PDCP SDUs if *drb-ContinueROHC* is not configured in TS 38.331 [3];

- for AM DRBs for PC5 interface, perform header decompression using ROHC for all stored PDCP IP SDUs;

- for AM DRBs and AM MRBs for Uu interface, perform header decompression using EHC for all stored PDCP SDUs if *drb-ContinueEHC-DL* is not configured in TS 38.331 [3];

- for UM DRBs, AM DRBs, UM MRBs and AM MRBs, reset the ROHC protocol for downlink and start with NC state in U-mode (as defined in RFC 3095 [8] and RFC 4815 [9]) if *drb-ContinueROHC* is not configured in TS 38.331 [3];

- for UM DRBs, AM DRBs, UM MRBs and AM MRBs, reset the EHC protocol for downlink if *drb-ContinueEHC-DL* is not configured in TS 38.331 [3];

- for SRBs and UM DRBs, set RX\_NEXT and RX\_DELIV to the initial value;

- for UM MRBs and AM MRBs, set RX\_NEXT and RX\_DELIV to the initial value if *initialRX-DELIV* is configured in TS 38.331 [3];

- apply the ciphering algorithm and key provided by upper layers during the PDCP entity re-establishment procedure;

- apply the integrity protection algorithm and key provided by upper layers during the PDCP entity re-establishment procedure.

NOTE 1: After PDCP re-establishment on a sidelink ‎SRB/DRB, UE determines when to transmit and receive with the new key and discard the old key as specified in TS ‎‎33.536 [14].‎

NOTE 2: At PDCP re-establishment, the MRB type (i.e. UM MRB or AM MRB) is determined by the target configuration.‎

### 5.1.5 PDCP entity reconfiguration

When upper layers reconfigure the PDCP entity to configure DAPS, the UE shall:

- establish a ciphering function for the radio bearer and apply the ciphering algorithm and key provided by upper layers for the ciphering function;

- establish an integrity protection function for the radio bearer and apply the integrity protection algorithm and key provided by upper layers for the integrity protection function;

- establish a header compression protocol for the radio bearer and apply the header compression configuration provided by upper layers for the header compression protocol.

When upper layers reconfigure the PDCP entity to release DAPS, the UE shall:

- release the ciphering function associated to the released RLC entity for the radio bearer;

- release the integrity protection function associated to the released RLC entity for the radio bearer;

- release the header compression protocol associated to the released RLC entity for the radio bearer.

NOTE 1: The state variables which control the transmission and reception operation should not be reset, and the timers including *t-Reordering*, *discardTimer*, and *discardTimerForLowImportance* keep running during PDCP entity reconfiguration procedure.

NOTE 2: Before releasing the header compression protocol associated to the released RLC entity, how to handle all stored PDCP SDUs received from the released RLC entity is left up to UE implementation.

NOTE 3: No special handling for the header compression protocol is defined to avoid potential security issue (e.g. keystream reuse) for DAPS handover with no security key change.

### 5.2.1 Transmit operation

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

- if *discardTimerForLowImportance* is configured and PSI based SDU discard is activated, and the PDCP SDU belongs to a low importance PDU Set:

- start the *discardTimerForLowImportance* associated with this PDCP SDU;

- else:

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

NOTE 1: Identification of PSI of a PDU Set and determination of low importance PDU Set are left up to UE implementation.

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 2: 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 an 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 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 3: If the transmitting PDCP entity is associated with two RLC entities, 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 to minimize PDCP reordering delay in the receiving PDCP entity.

## 5.3 SDU discard

When 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.

When the *discardTimer* or *discardTimerForLowImportance* expires for a PDCP SDU, the transmitting PDCP entity shall:

- if *pdu-SetDiscard* is configured:

- discard all PDCP SDUs belonging to the PDU Set to which the PDCP SDU belongs along with the corresponding PDCP Data PDUs;

NOTE 1: PDCP SDUs subsequently received from upper layers are also discarded if they belong to the PDU Set.

- else:

- 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 2: 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.

## 5.X Data volume calculation for delay status reporting

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

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

- the PDCP Data PDUs that contain the delay-critical PDCP SDUs and 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 a PDCP SDU becomes a delay-critical PDCP SDU, and if the corresponding PDCP Data PDU has already been submitted to lower layers, the delay-critical indication for the PDCP Data PDU is provided to lower layers.

## 7.3 Timers

The transmitting PDCP entity shall maintain the following timers:

a) *discardTimer*

This timer is configured only for DRBs. The duration of the timer is configured by upper layers TS 38.331 [3]. In the transmitter, a new timer is started upon reception of an SDU from upper layer as specified in clause 5.2.1.

b) *discardTimerForLowImportance*

This timer is configured only for DRBs. The duration of the timer is configured by upper layers TS 38.331 [3]. In the transmitter, a new timer is started upon reception of an SDU belonging to a low importance PDU Set from upper layer as specified in clause 5.2.1.

The receiving PDCP entity shall maintain the following timers:

c) *t-Reordering*

The duration of the timer is configured by upper layers TS 38.331 [3], except for the case of NR sidelink communication or sidelink SRB4. For NR sidelink communication or sidelink SRB4, the *t-Reordering* timer is determined by the UE implementation. This timer is used to detect loss of PDCP Data PDUs as specified in clause 5.2.2. If *t-Reordering* is running, *t-Reordering* shall not be started additionally, i.e. only one *t-Reordering* per receiving PDCP entity is running at a given time.

====================================CHAGNE STOP====================================