3GPP TSG-RAN WG2 #116-e R2-21xxxxx

Electronic meeting 1st - 12th November, 2021

Agenda Item:

Source: Lenovo, Motorola Mobility

Title: [Post115-e][092][MBS] Remaining User plane issues (Lenovo)

Document for: Discussion and Decision

# 1 Introduction

This document captures the outcome of the following email discussion:

* [Post115-e][092][MBS] Remaining User plane issues (Lenovo)

       Scope: Determine and address MBS Remaining UP issues

       Intended outcome: Report with open issues, and proposed resolutions as far as reasonable.

       Deadline: Long

Please provide your comments for phase I before 10/15/2021 23:59 UTC and for phase II before 10/21/2021 23:59 UTC.

Phase I: progress on identified issues and potential agreements

* Expected outcome: List of identified issues and potential agreements

Phase II: progress on agreeable proposals

* Expected outcome: agreeable proposals

# 2 Discussion

Rapporteur encourages the participating delegates to provide their contact information in this table.

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| --- | --- |
| Company | Contact: Name (E-mail) |
| OPPO | wangshukun@oppo.com |
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## 2.1 PDCP handling for RRC configured MRB bearer type change

**PDCP entity for RRC based MRB bearer type change**

In RAN2#115e, regarding RRC configured MRB bearer type and bearer type change, the following agreements were made [1]:

* In RRC signalling, one MRB can be configured with PTM only or PTP only or both PTM and PTP. Whether PTM, PTM+PTP or PTP-only can be changed from one to other via RRC signaling.
* In RRC signalling, Support DL only UM RLC configuration for PTM, both DL and UL AM RLC configuration for PTP, DL only UM RLC configuration for PTP, FFS both DL and UL UM RLC configuration for PTP.
* FFS whether PDCP SR can be triggered due to bearer type change in RRC signaling and FFS how to trigger PDCP SR if need.

There are two ways to realize bearer type change between PTM-only MRB, PTP-only MRB, and split MRB (‘both PTM and PTP’ as mentioned in chairman agreements) as following:

- Option 1: Separate PDCP entities are used for PTM-only MRB, PTP-only MRB, and split MRB.

- Option 2: Common PDCP entity is used for PTM-only MRB, PTP-only MRB, and split MRB.

The option 1 has more spec impact e.g. it needs new functionalities in SDAP layer such as re-ordering, retransmission for service continuity. Option 2 can reuse the existing PDCP functions as much as possible. The assumption is that both PTP and PTM use the same security scheme (pending to SA3)

**Rapporteur understanding:** A common PDCP entity is used for bearer type change between PTM-only MRB, PTP-only MRB and split MRB assuming that both PTP and PTM use the same security scheme (pending to SA3)

**Q1: Do companies agree that a common PDCP entity is used for bearer type change between PTM-only MRB, PTP-only MRB and split MRB?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Qualcomm | Yes | In case of switching between MRB and DRB, PDCP will not be common and RRC signalling based switching need to be supported. |
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**PDCP entity reestablishment**

In case of PDCP anchor change, e.g. during handover, PDCP entity reestablishment is usually configured and performed. During PDCP entity reestablishment, the UE shall reset the RoHC protocol if d*rb-ContinueRoHC* is not configured, apply new security algorithm and keys, and reset PDCP variables for UM DRB. For a MRB, the PDCP anchor change is also possible e.g. during handover with RRC based bearer type change. However, security algorithm and key may not be relevant which is pending to SA3. And the initial values PDCP variables needs special handling as discussed in the section 2.2. The remaining issue is whether ROHC protocol can be reset if *RoHC continuity* is not configured.

**Rapporteur understanding:** NW should have the flexibility to decide whether to configure *RoHC continuity for the MRB* or not during handover or RRC based MRB bearer type change*.* In this case, PDCP entity reestablishment should be allowed if *RoHC continuity* is not configured for the MRB during handover or RRC based MRB bearer type change.

**Q2: Do companies agree that PDCP entity reestablishment is allowed if RoHC continuity is not configured for the MRB during handover or RRC based MRB bearer type change.**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Qualcomm | Yes |  |
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**PDCP data recovery for RRC based MRB bearer type change**

In case of PDCP anchor is unchanged and RoHC continuity is configured of a MRB, PDCP reestablishment is not necessary. Instead, PDCP data recovery can be performed during RRC based MRB bearer type change.

In current PDCP specification, PDCP data recovery may be performed for AM DRBs, as specified in section 5.5 of TS 38.323:

*For AM DRBs, when upper layers request a PDCP data recovery for a radio bearer, the transmitting PDCP entity shall:*

*- perform retransmission of all the PDCP Data PDUs previously submitted to re-established or released AM RLC entities in ascending order of the associated COUNT values for which the successful delivery has not been confirmed by lower layers, following the data submission procedure in clause 5.2.1.*

There are several cases for MRB bearer type change, e.g. PTM only -> PTP RLC AM; PTP RLC AM -> PTM only and etc. For PTM only -> PTP RLC AM, the issue is the PTM transmission is RLC UM only and the transmitting PDCP entity is unable to know the successful delivery status in lower layers for the UE. For PTP RLC AM -> PTM only, the issue is that PTM transmission is for a group of UEs, and it is not efficient to perform PDCP data recovery via PTM retransmission for an individual UE.

**Rapporteur understanding:** Since MBS data is DL only and the PDCP data recovery is specified from transmitting PDCP entity point of view, it’s easier to leave it up to gNB implementation on how to perform PDCP data recovery for MRB bearer type change.

**Q3: Do companies agree that it is up to NW implementation on how to perform PDCP data recovery for MRB bearer type change?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Qualcomm | Yes |  |
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**PDCP SR for RRC based MBR bearer type change**

In order to minimize the data loss during bearer type change, it is beneficial to support PDCP status reporting once the MRB bearer type is changed. Considering a bidirectional PTP leg is required to transmit the PDCP status report, the PDCP status report could be triggered if the new MRB has a bidirectional PTP leg, e.g. when a PTM-only MRB is changed to a PTP-only MRB of RLC AM, or a PTM-only MRB is changed to a split MRB with RLC AM PTP leg. NW is required to configure a bidirectional PTP leg for PDCP status reporting.

**Rapporteur understanding:** For MRB configured by upper layers to send a PDCP status report in the uplink (field *statusReportRequired* in PDCP-Config IE in RRC), the receiving PDCP entity shall trigger a PDCP status report in case of MRB type change. NW is required to configure a bidirectional PTP leg (e.g. either PTP-only MRB or split MRB) if *statusReportRequired* is provided.

**Q4: Do companies agree with the following statement for PDCP SR for MRB bearer type change:**

**- In order to minimize the loss during MRB bearer type change, it is beneficial to support PDCP status reporting once the MRB bearer type is changed;**

**- For MRB configured by upper layers to send a PDCP status report in the uplink (field *statusReportRequired* in PDCP-Config IE in RRC), the receiving PDCP entity shall trigger a PDCP status report in case of MRB type change;**

**- NW is required to configure a bidirectional PTP leg (e.g. either PTP-only MRB or split MRB) if *statusReportRequired* is provided. It is up to network in which case *statusReportRequired* is configured.**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes | In last RAN2 meeting, RAN2 agreed that:   * In RRC signalling, Support DL only UM RLC configuiration for PTM, both DL and UL AM RLC configuiration for PTP, DL only UM RLC configuiration for PTP, FFS both DL and UL UM RLC configuiration for PTP.   Whether it means that both DL and UL UM RCL configuration for PTP is supported.  We support both DL and UL UM RCL configuration for PTP and also support the PDCP status report due to bearer type change for data loss reduction purpose and the flexibility of RRC configuration should also be allowed. |
| Qualcomm | Yes | For PTP RLC UM, we should allow both DL and UL UM RLC configuration to allow UE to report PDCP Status Report. |
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**PDCP SR trigger(s) for RRC based MRB bearer type change**

The existing triggers of PDCP status report are specified as in TS 38.323:

*For AM DRBs configured by upper layers to send a PDCP status report in the uplink (statusReportRequired in TS 38.331 [3]), the receiving PDCP entity shall trigger a PDCP status report when:*

*- upper layer requests a PDCP entity re-establishment;*

*- upper layer requests a PDCP data recovery;*

*- upper layer requests a uplink data switching;*

*- upper layer requests a PDCP entity reconfiguration and the associated RLC entity is released for a radio bearer.*

Some companies think that when bearer type change among PTM-only MRB, PTP-only MRB, and split MRB, one issue is that the PDCP status report may not be triggered according to existing triggers due to:

a) The PTM can only be configured as RLC-UM mode.

b) The PDCP entity re-establishment may not be needed e.g. the security may not be needed for PTP-only MRB as well.

c) The PDCP data recovery is not applicable to RLC-UM mode.

Some companies have different understanding. If we agree to apply PDCP data recovery or PDCP entity re-establishment for any MRB bearer type change, the PDCP data recovery indicator or PDCP entity re-establishment indicator as configured by RRC can be reused for triggering PDCP SR. in other words, the legacy triggers of PDCP SR as ‘upper layer requests a PDCP data recovery’ or ‘upper layer requires a PDCP entity re-establishment’ can be reused.

**Q5: Companies are invited to provide their view on the following options:**

- Option 1: New trigger(s) of PDCP status report should be defined for MRB bearer type change? If option 1 is preferred, please provide your views on what the new trigger(s) should be.

- Option 2: The legacy triggers of PDCP SR as ‘upper layer requests a PDCP data recovery’ or ‘upper layer requires a PDCP entity re-establishment’ are reused for MRB bearer type change.

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| **Company** | **Preferred option** | **Comments** |
| OPPO | Option 1 | In DAPS HO, new trigger for PDCP status report is introduced for both AM and UM RLC.  ========  For AM DRBs configured by upper layers to send a PDCP status report in the uplink (*statusReportRequired* in TS 38.331 [3]), the receiving PDCP entity shall trigger a PDCP status report when:  - upper layer requests a PDCP entity re-establishment;  - upper layer requests a PDCP data recovery;  - upper layer requests a uplink data switching;  - upper layer reconfigures the PDCP entity to release DAPS and *daps-SourceRelease* is configured in TS 38.331 [3].  For UM DRBs configured by upper layers to send a PDCP status report in the uplink (*statusReportRequired* in TS 38.331 [3]), the receiving PDCP entity shall trigger a PDCP status report when:  - upper layer requests a uplink data switching.  ========  So it is better to define new trigger for both AM and UM RLC and it will not impact legacy trigger application.  For the bearer type change due to RRC configuration, it is possible to configuration indication from network to trigger PDCP SR. However, for dynamic PTP/PTM switching, it is transparent to UE and it is up to UE to evaluate dynamic PTP/PTM switching happening.  So we think the new trigger can be “PTP/PTM switching detection indication from lower layer”. |
| Qualcomm | Option 1 | Since existing conditions are limited to RLC AM, PDCP Re-establishment cases, instead of using legacy conditions, it is clean approach to specify new trigger for MRB switching based on RRC signalling procedure. |
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## 2.2 Initial value of PTM PDCP state variables

**Initial HFN synchronization**

The initial value of PTM PDCP state variables was discussed and the following agreement was made:

* For PTM PDCP state variables setting while configured, the SN part of COUNT values of these variables are set according to the SN of the first received packet (by the UE) and the HFN indicated by the gNB, if needed.

It was agreed that the HFN is indicated by the gNB, if needed. It is not clear enough whether HFN is needed to be indicated. The HFN may be used for1) security and 2) PDCP SR. Whether HFN is used for security purpose is pending to SA3. In the PDCP status report, FMC (First Missing Count) in included for indicating the COUNT value of the first missing PDCP SDU within the reordering window. As discussed in the section 2.1, PDCP SR may be triggered for RRC based MRB type change. In this case, the initial value of HFN should be indicated by the gNB. On the other side, some companies think that the HFN value of FMC in PDCP the SR is not essential since the NW can ignore the HFN value in the PDCP SR and deduce the correct HFN value for PDCP retransmission.

**Q6: Companies are invited to provide their view on whether the initial value of HFN should be indicated by the gNB in condition that RAN2 agree that PDCP SR is performed during RRC based MRB bearer type change.**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes | HFN should be indicated by network. |
| QC | Yes | We prefer network to provide HFN value. |
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If the initial value of HFN is indicated by gNB, as mentioned during online discussion, there may be HFN desynchronization issue. Due to propagation delay, UE processing delay and misalignment transmission between gNB-CP and gNB-UP (e.g. since the RRC configuration is provided by gNB-CP while the SN in the PDCP header is added by gNB-UP, there is extra timing misalignment between CP/RRC configuration and UP/data transmission in case of gNB-CP and gNB-UP split architecture), the UE may receive the initial HFN after the SN wrapping around while the gNB sent it before the SN wrapping around. Then the UE uses indicated HFN in the RRC signalling as the initial HFN, however, the real HFN should be HFN+1, in which case HFN desynchronization between UE and gNB happens.

[3] pointed it out that one may argue that the state variables can be determined by V2X rule using the first received packet. However, V2X mechanism inherits reordering delay by the intentional SN gap generation between RX\_DELIV and RX\_NEXT, which is set because of absence of any reordering information. In Uu interface between gNB and UE, this unnecessary reordering delay can be avoided by gNB to provide the initial values appropriately. As shown in Figure 1, the reordering delay occurs at every beginning of MRB configuration, which is roughly hundreds of milliseconds and definitely redundant degradation.



**Figure 1. Issue of HFN desynchronization between UE and NW for a MRB due to SN wrapping around**

**Q7: If the initial value of HFN is indicated by gNB, do companies think HFN desynchronization between UE and NW can happen, and if yes, whether the HFN desynchronization should be solved by standardization and how?**

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| **Company** | **Comments** |
| OPPO | HFN desynchronization should be solved by standardization.  The solution can be discussed in next meeting. |
| Qualcomm | It can happen. Prefer to have spec based solution even if it is not 100% ideal solution. |
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In the 38.331 running CR [6], there is an FFS:

*Editor’s note: If needed (pending SA3 conclusion on secuirty and/or RAN2 conclusion on PDCP SR), HFN should be indicated by the gNB for PTM PDCP state variables setting (FFS whether via RRC or other means).*

There are three possible options to support the indication of initial value of HFN by gNB:

- Option 1: the initial value of HFN is indicated by RRC signalling, e.g. in the *PDCP-Config* IE.

- Option 2: the initial value of HFN is indicated by a new PDCP control PDU.

- Option 3: the initial value of HFN is indicated in the PDCP header of PDCP PDU.

Option 1 may have HFN desynchronization issue as discussed above. Option 2 may relieve the HFN desynchronization issue, but it cannot solve the issue completely and it requires PTP transmission for the transmission of the PDCP control PDU. Option 3 needs extra overhead in PDCP header.

**Q8: If the initial value of HFN is indicated by gNB, companies are invited to provide their view on the options to support the indication of initial value of HFN by gNB.**

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| **Company** | **Preferred option** | **Comments** |
| OPPO | Option 1 | In RRC signalling. |
| Qualcomm | Option 1 or 2 |  |
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**PDCP window initialization**

For NR sidelink communication for broadcast and groupcast, the initial value of the SN part of RX\_NEXT is (x +1) modulo (2[*sl-PDCP-SN-Size*]), where x is the SN of the first received PDCP Data PDU. Similarly, for MRB, the initial value of the SN part of RX\_NEXT is (x +1) modulo (2[*PDCP-SN-Size*]), where x is the SN of the first received PDCP Data PDU.

**Q9: Do companies agree that for multicast MRB, the initial value of the SN part of RX\_NEXT is (x +1) modulo (2[*PDCP-SN-Size*]), where x is the SN of the first received PDCP Data PDU?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Qualcomm | Yes |  |
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According to the current specs (TS 38.323), due to out-of-order delivery from RLC to PDCP, after the UE’s PDCP received “the first packet”, the packets with SNs sent before “the first packet” will be discarded by the UE even if they have been correctly received, which may cause some data loss at MRB setup.

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| - if RCVD\_COUNT < RX\_DELIV; or  - if the PDCP Data PDU with COUNT = RCVD\_COUNT has been received before:  - discard the PDCP Data PDU; |

During email discussion [2], some companies think the issue do not need to be addressed and think that UE late joining an ongoing MBS session will miss some data anyway. And it can be up to UE implementation to handle it.

On the other side, as summarized in [5], some companies indicated that such packet loss was intolerable, since RAN2 agreed that the UE can be released to RRC\_IDLE/RRC\_INACTIVE when there is no data. When there is new data coming, the UE would enter RRC\_CONNECTED again and initiate PDCP entity, so ***packet loss would happen for each time when the UE enters RRC\_CONNECTED***.

In order to avoid packet loss, some companies proposed RX\_DELIV can be set to a value before RX\_NEXT (i.e. SN of the first received PDU), which is similar to sidelink broadcast/groupcast. This operation enables UE to receive the packet which SN smaller than the SN of the first received packet to prevent packet loss caused by out of order transmission.

**Q10: Companies are kindly invited to provide their preference on the options:**

* Option 1: the initial value of RX\_DELIV is set to a value before RX\_NEXT, e.g. the initial value of the SN part of RX\_DELIV is (x – 0.5 × 2[*PDCP-SN-Size*–1]) modulo (2[*PDCP-SN-Size*]), where x is the SN of the first received PDCP Data PDU, which is similar to sidelink broadcast/groupcast;
* Option 2: the initial value of RX\_DELIV is set to the same as RX\_NEXT.

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| **Company** | **Option1/2** | **Comments** |
| OPPO | Option 1 | For data loss reduction purpose, we can do it in R17. |
| Qualcomm | Option 1 |  |
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## 2.3 Ethernet header compression for MRB

In RAN2#115e, it was confirmed that

* ROHC O/R-mode can be used for MRB, for cases when feedback path is available (UL RLC). R2 assumes the detailed operation is up to implementation and expect no further optimizations to be needed.

However, during discussion of 38.331 running CR [6], whether ethernet header compression should be supported for MRB was raised. From moderator’s view, it is straightforward to reuse the existing EHC for MRB without additional standard effort and it could be beneficial to extend MBS use cases and scenarios.

**Q11: Do companies agree with that EHC can be used for MRB for cases when feedback path is available (UL RLC) and it is expected that no further optimizations are needed?**

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| **Company** | **Yes or No** | **Comments** |
| OPPO | Yes |  |
| Qualcomm | Yes |  |
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## 2.4 Initial value of PTM RLC state variables

Regarding the initial value of PTM RLC state variables, it was agreed that

* Initialize the PTM RLC entity for an MRB configuration, the value of RX\_Next\_Highest and RX\_Next\_Reassembly are set according to the SN of the first received packet containing an SN.

For groupcast and broadcast of NR sidelink communication, RX\_Next\_Highest is initially set to the SN of the first received UMD PDU containing an SN.

Similarly, for MRB PTM RLC entity, the RX\_Next\_Highest is initially set to the SN of the first received UMD PDU containing an SN.

**Q12: Do companies agree that for multicast PTM, the RX\_Next\_Highest is initially set to the SN of the first received UMD PDU containing an SN?**

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| **Company** | **Yes or No** | **Comments** |
| OPPO | Yes |  |
| Qualcomm | Yes |  |
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As summarized in [5], if the value of RX\_Next\_Reassembly and RX\_Next\_Highest are set to the same value, the same packet loss issue as PDCP may occur. That is, due to out-of-order delivery, the packets with SNs sent before “the first packet” will be discarded by the UE even if they have been correctly received, which may cause some data loss when the UE joins the MBS reception. RAN2 also agreed that the UE can be released to RRC\_IDLE/RRC\_INACTIVE when there is no data. When there is new data coming, the UE would enter RRC\_CONNECTED again and initiate PDCP entity, ***so packet loss would happen for each time when the UE enters RRC\_CONNECTED***.

While some companies suggest the same method as the PDCP, i.e., RX\_Next\_Reassembly should be set to a value smaller than the SN of the first received packet containing an SN. Some papers suggest that this part of packet loss can be left to PDCP, or not to optimize possible initial packet loss and indicate that when UE joins an ongoing MBS session delivered through UM RLC mode, the initial loss should be acceptable.

**Q13: Companies are kindly invited to provide their preference on the options:**

* **Option 1**: For multicast PTM, the initial value of RX\_Next\_Reassembly is set to a value before RX\_Next\_Highest.
* **Option 2**: For multicast PTM, the initial value of RX\_Next\_Reassembly is set to the same as RX\_Next\_Highest.

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| **Company** | **Preferred Option** | **Comments** |
| OPPO | Option 1 | For data loss reduction purpose, no matter it is late join or not. |
| Qualcomm | Option 1 |  |
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In the running CR [6], there is an FFS

*FFS whether some explicit indication is needed for the UE to know that an RLC entity is configured for PTM transmission.*

As discussed in Q13, the initial value of RX\_Next\_Highest and RX\_Next\_Reassembly are different for PTM RLC entity (the initial value is set according to the SN of the first received packet) and PTP RLC entity (the initial value is set as 0). From this point of view, the UE need to know which RLC entity is configured for PTM or PTP transmission. It would be better to have an explicit indication for UE to know that an RLC entity is configured for PTM transmission or PTP transmission.

**Q14: Do companies agree that an explicit indication is needed for the UE to know that an RLC entity is configured for PTM or PTP transmission?**

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| **Company** | **Preferred Option** | **Comments** |
| OPPO | Yes | We are confused about the FFS in RRC running CR and the Q14, the RLC entity for both PTM and PTP are explicit configured in RRC and UE will know it. The LCID will be used to distinguish the PTP RLC or PTM RLC. |
| Qualcomm |  | If PTM RLC entity logical channel space is reserved, then there is no need to have explicit indicator. If LCID space is shared between DTCH and MTCH then some explicit indicator is needed. |
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## 2.5 RLC handling for RRC based MRB bearer type change

There are two main scenarios regarding RLC entity handling:

1. Split MRB <-> PTM only/PTP only MRB
2. PTM only <-> PTP only

For the case 1) RRC based bearer type change between split MRB and PTM only/PTP only MRB, it would be straight forward to use RLC entity establishment/release procedure to establish/release RLC entity. For example, when a split MRB is reconfigured to PTM only MRB, the RLC entity of PTP transmission should be released. When a PTP only MRB is reconfigured to a split MRB, the RLC entity of PTM transmission should be established.

For the case 2 RRC based bearer change between PTM only and PTP only, whether RLC entity re-establishment should be performed should be discussed. Since the PTM transmission can only be RLC-UM and PTP transmission can be RLC-AM, it would be better not to perform RLC entity re-establishment. Instead, it could be simpler to perform RLC entity release and establishment. For example, when a PTM only MRB is reconfigured to a PTP only MRB, the RLC entity of PTM only MRB should be released and a new RLC entity should be established for PTP only MRB.

**Q15: Do companies agree that the RLC entity release and/or establishment procedures are performed during RRC based MRB bearer type change for PTM only <-> PTP only?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Qualcomm | Yes |  |
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## 2.6 Bidirectional RLC configuration for PTP

There is remaining FFS on whether unidirectional or bidirectional UM RLC should be configured for PTP: **FFS both DL and UL UM RLC configuration for PTP**.

From rapporteur point of view, it can leave it to NW implementation to decide whether to configure a bidirectional UM RLC or DL only UM RLC for PTP transmission.

**Q16: Do companies agree that it is up to NW implementation to configure bidirectional UM RLC or DL only UM RLC for PTP transmission?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Qualcomm | Yes | If PDCP Status Report is configured by network then NW is expected to configure DL/UL RLC UM for PTP. |
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## 2.7 LCID ID Related Issues

**LCID space for multicast PTM**

n RAN2#115e, it was agreed that

* FFS whether to share common LCID space for Multicast PTM and Unicast DTCH. FFS How many PTM LCIDs to be reserved if separate space is used.

Proponents of shared LCID space between Multicast PTM and DTCH/DRB argue that in order to distinguish whether MAC SDUs in a MAC PDU by PTP retransmission in PHY are for MTCHs or DTCHs, the LCIDs for multicast MTCHs should be configured differently to LCIDs for DTCHs for a UE, which basically means that they should share a same LCID space. However, some companies think that HARQ soft combination are performed by L1 before identifying LCID other than using LCID. And separate LCID space enables simplified management of LCID allocation.

In RAN1#104, it was agreed that

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| Agreement:  For RRC\_CONNECTED UEs, if ACK/NACK based HARQ-ACK feedback is supported for PTM scheme 1, and if initial transmission for multicast is based on PTM transmission scheme 1, support retransmission(s) using PTP transmission.   * The HARQ process ID and NDI indicated in DCI is used to associate the PTM scheme 1 and PTP transmitting the same TB. |

In RAN1#105e, it was agreed that

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| For HARQ process management, further study whether/how to differentiate the HARQ process ID used for PTP (re)transmission for unicast and PTP retransmission for multicast. |

Above RAN1 agreement implies that the NW may need to allocate proper HARQ process ID and NDI so that the UE can distinguish PTP re-transmissions of MRB from DTCH/DRB. However, it seems RAN1 has not reached a firm agreement so far.

From Rapporteur perspective, both common LCID space and separate LCID space are possible solutions and HARQ soft combining is still possible even if separate LCID space is reserved. Whether separate LCID space can work relies on RAN1’s discussion on how to differentiate the PTP retransmission for PTM from unicast DTCH.

**Q17: Companies are invited to provide their preference on common LCID space or separate LCID space for Multicast PTM and Unicast DRB.**

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| **Company** | **Common or separate LCID space** | **Comments** |
| OPPO | Separate LCID space | 1. For common PDCP anchor-based architecture, it is reasonable to use a separate LCID space (i.e. the LCID for PTM and unicast are overlapped.) for PTM leg and unicast. 2. For PTP for PTM retransmission case, the LCID for PTP will share the same LCID space as RAN2 agreed. It is not clear whether the LCID is one for both PTM and PTP. If yes, we think the separate LCID is also OK and the PTP leg will share the LCID with DRB and the other part of LCID overlapped with unicast will not be used. |
| Qualcomm | Separate LCID space | LCID is used to uniquely identify RLC entity. In case of PTM RLC leg, G-RNTI based initial transmission and C-RNTI based Re-transmissions are transmitting same MAC TB and there is no issue of soft combining. Shared LCID space for MTCH and DTCH is not a requirement for HARQ soft combining.  MTCH is meant for group of UEs and DTCH is meant for UE specific. It is clean approach to have separate LCID space for MTCH and DTCH. |
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**Q18: If separate LCID space is used, how many PTM LCIDs should be reserved?**

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| **Company** | **Companies’ views** |
| OPPO | 32 as unicast. |
| Qualcomm | 32 |
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**eLCID for multicast PTM**

If common LCID space is used for Multicast PTM and Unicast DRB, many LCIDs can be consumed because LCIDs used for unicast cannot overlap with LCIDs used for Multicast PTM. From this perspective, eLCID may need to be supported.

**Q19: If common LCID space is used, do companies agree that eLCID is also applied to MRB PTM.**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | No | No necessary. |
| Qualcomm | Yes |  |
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## 2.8 one-to-many mapping between G-RNTI and MBS sessions

At RAN2#114 it was decided to support one-to-one mapping between G-RNTI and MBS session while leaving other mapping options FFS. A 1:1 mapping between G-RNTI and MBS session benefits the power consumption in the UE as it ensures the UE does not need to receive and decode MBS sessions it is not interested of. On the other hand, this results in complexity in the number of G-RNTIs that each UE needs to receive. Managing restrictions while keeping delay short and efficiency high will be difficult for the network [8]. Compared with the agreed one-to-one mapping between G-RNTI and MBS sessions, supporting one-to-many mapping between G-RNTI and MBS sessions may not introduce additional specification work. the mapping between G-RNTI and MBS sessions can be up to the network implementation based on specific deployment scenario, and there is no need to discuss and specify any restrictions for such mapping [9].

**Q20: Do companies agree to support one-to-many mapping between G-RNTI and MBS sessions assuming that this does not introduce additional specification work and adds flexible configuration for various deployment scenarios?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | No | In R17, we can only consider the basic case and only support one to one mapping between G-RNTI and MBS session. For the one to many mappings, we can consider it in R18.  Furthermore, whether there more cases that UE need to receive more MBS session simultaneously? |
| Qualcomm | Yes | In IIoT cases, often UEs are required to receive multiple services. It is more efficient for UE to receive multiple services by monitoring single G-RNTI and we do not see any specification complexity as well. It is upto network configuration, which services can be mapped to same G-RNTI. |
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## 2.9 MBS DRX related issues

In RAN2#115e, the following agreements were made for multicast DRX:

* For multicast PTM transmission, Multicast DRX pattern is configured on a per G-RNTI basis (i.e. independent of legacy UE-specific DRX for unicast transmission).
* Legacy UE-specific DRX pattern for unicast is reused for PTP transmission of NR MBS, which means the UE specific DRX pattern are for both unicast services and the MBS PTP bearer of UE
* Multicast long DRX support is baseline for PTM. FFS whether to support optional short DRX or not.
* The Multicast Long DRX operation has to support the following parameters which are similar to the UE-specific DRX for unicast, where the last two parameters are needed if the HARQ- feedback is enabled:

- drx-onDurationTimerPTM

- drx-InactivityTimerPTM

- drx-LongCycleStartOffsetPTM

- drx-SlotOffsetPTM

- drx-HARQ-RTT-TimerDLPTM

- drx-RetransmissionTimerDLPTM

* For NR Broadcast, the DRX pattern is configured per G-RNTI.
* For NR Broadcast, DRX configuration includes: drx-onDurationTimerPTM, drx-SlotOffsetPTM, drx-InactivityTimerPTM, drx-CycleStartOffsetPTM.

**CG-PDCCH/G-RNTI and UE specific PDCCH/C-RNTI monitoring**

In RAN1#106e meeting, RAN1 reached a conclusion that

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| Conclusion:  The specification impact of having a new Type-x CSS for GC-PDCCH in RRC\_CONNECTED state can be studied and discussed further. |

That means that the PTM transmission is much possible to have a specific CSS. That means that the PTM transmission may very likely apply a specific CSS. In other words. GC-PDCCH/G-RNTI and UE specific PDCCH/C-RNTI may very likely apply different search spaces. Then, whether a UE needs to always monitor UE specific PDCCH/C-RNTI in Multicast DRX active time needs to be discussed. For a UE, the data transmission may have:

- PTM transmission, that is over GC-PDCCH scrambled by G-RNTI;

- PTP for PTM HARQ retransmission, that is over UE specific PDCCH scrambled by C-RNTI;

- PTP transmission and unicast transmission, that is over UE specific PDCCH scrambled by C-RNTI.

One possible issue is how the UE monitors UE specific PDCCH/C-RNTI in active time of multicast DRX:

- **Option 1:** the UE monitors UE specific PDCCH/C-RNTI when either *drx-onDurationTimerPTM* or *drx-InactivityTimerPTM* or *drx-RetransmissionTimerDLPTM* are running.

- **Option 2:** the UE monitors UE specific PDCCH/C-RNTI only when *drx-RetransmissionTimerDLPTM* is running. For example, when *drx-onDurationTimerPTM* and *drx-InactivityTimerPTM* are running but *drx-RetransmissionTimerDLPTM* is not running, the UE does not monito UE specific PDCCH/C-RNTI.

**Q21: Companies are invited to provide their view on the options of how a UE monitors UE specific PDCCH/C-RNTI in active time of multicast DRX.**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | None | We confused about the question, the UE monitor UE specific PDCCH/C-RNTI based on unicast DRX without considering the MBS DRX. The MBS DRX and unicast DRX are independent. |
| Qualcomm | Option 2 | In our view, new type X CSS used for GC-PDCCH scheduling. DCI format used for GC-PDCCH and PDCCH are not same. So, for C-RNTI based scheduling, UE has to monitor USS. During *drx-onDurationTimerPTM* or *drx-InactivityTimerPTM* timers running, GNB is expected to schedule Initial Transmissions using GC-PDCCH and no need for UE to monitor legacy UE specific USS/C-RNTI. |
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**Short DRX cycle and DRX Command MAC CE**

There are following FFSs have been identified:

* FFS whether to support optional short DRX or not.
* FFS to support DRX Command MAC CE for MBS DRX [10].

**Q22: Companies are invited to provide their view on whether to support optional short DRX cycle for multicast DRX?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Not support | We can not see the necessary to support the short DRX. |
| Qualcomm | Yes | Depending on traffic pattern and latency requirements, short DRX will be helpful. This allows UE to get into short duration sleep , wakeup quickly and enables to reduce UE power consumption. Example: Short DRX can be very useful to provide MCPTT (Voice) type of services using Multicast mode. Since Short DRX is optional, it is upto NW to configure based on application traffic pattern and latency requirements. |
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**Q23: Companies are invited to provide their view on whether to support DRX Command MAC CE for multicast DRX.**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Not sure | In R16, dual DRX is introduced and the DRX command is common for both DRX group.  We are not sure how to impact the spec if we support DRX command for MBS DRX. |
| Qualcomm | Yes |  |
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**Timers setting in case of HARQ ACK/NACK feedback**

As discussed in [7], when HARQ ACK/NACK feedback is configured, it is possible that gNB may configure UE specific PUCCH resources in different slots. In Unicast DRX, UE starts HARQ RTT timer after PUCCH NACK transmission. In case of Multicast HARQ ACK/NACK feedback, to align the start of RTT timer for each Multicast UE (due to different timing of PUCCH resources for different UEs), it is desirable to have a common HARQ RTT start timer. The key reason to have common start time for RTT timer is to align DL DRX Re-transmission timer for all UEs which enables the gNB to trigger re-transmission within common DL RTT Re-transmission timer.

In case of ACK/NACK feedback based on UE specific PUCCH resources, to align start time of HARQ RTT timer for multiple UEs, we can consider following options.

**Option 1:** gNB may configure RTT and DL Re-transmission timer to take different UE feedback time into account as gNB implementation.

**Option 2:** gNB may indicate UEs to start RTT timer at the end of GC-PDCCH/GC-PDSCH reception and UEs still trigger RTT timer after UE specific PUCCH resource based NACK transmission, while RTT timer counts from multicast group GC-PDCCH/GC-PDSCH reception.

**Option 3:** UEs start RTT timer at the end of GC-PDCCH/GC-PDSCH reception.

**Q24: For Multicast HARQ ACK/NACK feedback using UE specific PUCCH resources, companies are asked which option should be adopted.**

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| **Company** | **Option 1/2/3** | **Comments** |
| OPPO | None | We agree that PUCCH resource is configured per UE. However, the network can configure the PUCCH resource only for MBS feedback for UE aligned among UEs in this MBS group. Anyway, it is up to network implementation. |
| Qualcomm | Option 2 | It is key to have RTT timer start for all Multicast UEs is aligned. If UEs start RTT timer after UE specific PUCCH transmission, different UEs will have different time instances of RTT timer expiry and DL Re-Transmission timers will not be aligned. This can cause some UEs missing DL HARQ Re-Transmissions. |
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**Timers setting in case of NACK only feedback**

For group common PTM Multicast HARQ PUCCH resources (NACK only feedback), the same group of UEs have aligned HRAQ RTT and DL Re-Tx timer configuration. HARQ RTT timer counting starts from end of common PUCCH resource based NACK transmission.

**Q25: Do companies agree that for group common PTM Multicast HARQ PUCCH resources (NACK only feedback), the same group of UEs have aligned HRAQ RTT and DL Re-Tx timer configuration. HARQ RTT timer counting starts from end of common PUCCH resource based NACK transmission (i.e. same as Unicast DRX behaviour)?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Qualcomm | Yes | Alternatively, we can have common solution for Q24 and Q25. i..e in case of Multicast DRX, RTT timer can start from GC-PDCCH/GC-PDSCH independent of ACK/NACK based or NACK only based mechanism. |
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## 2.10 PDCP/RLC configuration for broadcast

In [4], it is proposed that PDCP is need for supporting unidirectional DL RoHC functionality, re-ordering function, duplicating detection/discarding for a broadcast MRB. And in the running CR [6], there are FFS:

- For broadcast, it is FFS whether sn-FieldLength (for RLC) and pdcp-SN-SizeDL parameters are configurable or predefined in specifications (related UE capabilities should be considered).

- Editor’s note: For broadcast, it is FFS whether t-Reassembly (in RLC configuration) and t-Reordering (in PDCP configuration) are needed, e.g. considering whether out of sequence reception can happen as there is no HARQ feedback for broadcast.

- Editor’s note: For broadcast, it is FFS whether ROHC, when enabled by the network, has a predefined configuration or ROHC parameters are configurable by the network.

From rapporteur point of view, it is straightforward to support PDCP related functionalities including unidirectional DL RoHC functionality, re-ordering function, duplicating detection/discarding as well as RLC segmentation function for broadcast MRB.

**Q26: Companies are invited to provide their view on for broadcast MRB, whether *sn-FieldLength* (for RLC) and *pdcp-SN-SizeDL* parameters are configurable or predefined in specifications.**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes | We are fine to both configurable and predefined. No strong opinion. |
| Qualcomm | May be pre-defined |  |
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**Q27: Companies are invited to provide their view on for broadcast MRB, whether t-Reassembly (in RLC configuration) and t-Reordering (in PDCP configuration) are needed.**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Not sure | We are not sure whether it is useful when UE support to receive the MBS data from non-serving cell. |
| Qualcomm | May be yes | Strictly speaking, not necessary but to keep same implementation, we can allow to use timers and configure differently for Broadcast and Unicast. |
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**Q28: Companies are invited to provide their view on for broadcast MRB, whether ROHC, when enabled by the network, has a predefined configuration or ROHC parameters are configurable by the network.**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes | We are fine to both configurable and predefined. No strong opinion. |
| Qualcomm | May be pre-defined |  |
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## 2.10 HARQ, Group Common SPS and CFR

Since RAN1 is actively discussing these topics, Rapporteur suggests to wait for RAN1 discussion conclusion.

## 2.11 other issues

**Q29:** Besides the issues listed above, are there any other issues which need to be discussed in this email discussion.

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| **Company** | **Other issues which need to be discussed** |
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# 3 Phase I Conclusion

Based on the discussion, we firstly have a set of potential proposals for RAN2 agreements:

# 4 Phase II

FFS.

# 5 Phase II Conclusion

FFS.

# 6 References

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