**3GPP TSG-RAN WG2 Meeting #112-e *R2-200xxxx***

**Electronic, 02nd – 13th November 2020**

**Agenda item:** x.x.x

**Source:** Huawei

**Title:** Email discussion [Post111-e][904][MBS] L2 Architecture

**Document for:** Discussion and Decision

# Introduction

This paper is aimed at discussing the following topic.

* [Post111-e][904][MBS] L2 Architecture (Huawei)

Scope: L2 architecture, have proposals on the table, find potential agreements. Note that Architecture = function allocation, the aim is to understand a) what functionality we need or potentially need and b) then what protocol layer/entity houses this.

Intended outcome: Report, preparation for decisions.

Deadline: Long

The relevant contributions submitted to RAN2#111-e meeting are reviewed and proposals on L2 architecture/functions are summarized as below:

|  |  |
| --- | --- |
| **Contribution Number** | **Proposals on L2 architecture/functions** |
| R2-2007124 | Proposal 3: NR PTM transmission scheme should support the L1 A/N feedback and HARQ retransmission mechanism.  Proposal 4: The UP architecture for unicast transmission is reused for the MBMS service transmission, which includes MAC, RLC, PDCP and SDAP |
| R2-2006793 | Proposal 3. MRB will support both L1 HARQ and L2 ARQ reliability.  Proposal 4. MRB user plane AS protocol stack includes SDAP to support Multicast QoS flow to MRB/DRB mapping. Details of SDAP is FFS.  Proposal 5. MRB user plane AS protocol stack includes PDCP to support loss-less HO, data recovery etc. It is FFS to support RoHC and Security aspects based on SA3 decision.  Proposal 6. FFS whether to support single PDCP associated with multicast RLC entity and unicast RLC entity to enable dynamic switching between multicast and unicast RLC legs.  Proposal 9. If Multicast RLC entity is configured in UM, allow PDCP entity to support L2 ARQ reliability. PDCP Re-transmission can be either via Multicast RLC entity or unicast entity up to network implementation. |
| R2-2006804 | Proposal 1: the SDAP, PDCP, RLC, MAC, PHY will exist for MBS service from gNB perspective no matter MBS is transmitted via PTM or PTP. The PDCP, RLC, MAC, PHY will exist for MBS service from UE perspective no matter MBS is received via PTM or PTP.  Proposal 2: the option 1 (i.e. PTM and PTP share the SDAP/PDCP/RLC/MAC) and option 2 (i.e. PTM and PTP share the SDAP/PDCP) are agreed as baseline.  Proposal 4: there is only one MAC entity shared with MBS reception and eMBB reception for simplicity. |
| R2-2006952 | Proposal 2: SDAP for MBS bearer uses SDAP Data PDU format without SDAP header, SDAP Control PDU are FFS depending on solution for service continuity in mobility.  Proposal 5: RoHC and security is not supported in PDCP for PTM delivery of MBS. Other PDCP functionality for NR MBS service, especially for reordering, duplication, SN continuity, re-establishment, etc. are FFS depending on solution for service continuity. |
| R2-2007025 | Proposal 3: whether SDAP is needed or not can be decided based on SA2 inputs.  Proposal 4: PDCP sublayer is used for NR MBS, and reordering and duplicate detection are supported.  Proposal 5: RAN2 can further discuss if RoHC is supported in PDCP for MBS.  Proposal 6: Whether security functions are supported in PDCP is subject to SA3. |
| R2-2006574 | Proposal 1: specify both SDAP layer and PDCP layer over Uu interface for NR downlink multicast/broadcast transmission.  Proposal 2: Ask SA3 to understand the consideration of the security aspects for both PTM delivery mode and PTP delivery mode.  Proposal 3: When PTM RB is established to deliver Multicast/broadcast data, unidirectional mode (U-mode) ROHC can be configured for NR multicast/broadcast PDCP packets if there is no support of uplink feedback at PDCP layer. |
| R2-2007442 | Proposal 15 SDAP is needed in NR MBS, functions as the mapping of QoS flows to radio bearers.  Proposal 17 For each data radio bearer that is associated with the MBS session, there is a corresponding PDCP entity and RLC entity.  Proposal 18 LS SA3 if ciphering for MBS session in access network is needed.  Proposal 19 No MAC layer multiplexing among service data from different MBS session. |
| R2-2007550 | Proposal 1: Support having simplified PDCP for shared MBS bearer.  Proposal 4: Adopt RLC, MAC, PHY and SYNC functions similar to MBMS in the protocol stack for MBS. |
| R2-2007672 | Proposal 10: NR PDCP is kept for PTM bearer. ROHC can be supported for MBS.  Proposal 11: If UL feedback mechanism is introduced, PDCP reordering is reused for MBS.  Proposal 12: RLC segmentation/ re-assembly is supported for PTM bearer. |
| R2-2007774 | Proposal 7 RAN2 should discuss if HARQ feedback/retransmission is useful on multicast in NR MBS, for UEs in RRC IDLE, INACTIVE and Connected.  Proposal 8 RAN2 should discuss if RLC AM mode is supported for multicast in NR MBS, at least for UEs in RRC Connected.  Proposal 9 RAN2 should discuss if PDCP layer is supported for groupcast in NR MBS, at least for UEs in RRC Connected. |
| R2-2008031 | Proposal 2. A PTM radio bearer has a PDCP entity.  Proposal 3. A PTM radio bearer is configured with UM RLC.  Proposal 4. A PTP radio bearer can be configured with either UM RLC or AM RLC.  Proposal 5. A PTM radio bearer and the corresponding PTP radio bearer can be bound in the similar manner with user-plane structure for PDCP CA duplication. The PDCP entity can be associated with two RLC entities with different RLC modes. |
| R2-2006794 | Proposal 3. FFS based on SA3 multicast security discussion whether to use common PDCP entity between multicast and unicast radio bearers to enable lossless switching.  Proposal 6. Introduce PDCP status reporting enhancements to enable dynamic switching between multicast bearer and unicast in lossless manner. |
| R2-2007015 | Proposal 2: RAN2 to introduce duplication transmission of multicast and unicast to enhance the reliability of multicast transmission. |
| R2-2007631 | Proposal 3 A common PDCP entity for both MRB and DRB delivering an MBS session is defined.  Proposal 4 No need for SDAP, for an MBS session, a single QoS flow is mapped to MRB/DRB. |
| R2-2007026 | Proposal 2: Dynamic switch between PTP and PTM is up to the gNB and transparent to the UE, i.e. no signalling is needed.  Proposal 3: Support dynamic switch between PTP and PTM within one bearer and one PDCP entity. |
| R2-2006982 | Proposal 3: RAN2 should study how to support the switching between multicast (PTM) and unicast (PTP) based on two alternatives for placement of switching function in the L2 architecture, with a switching function above PDCP and below PDCP. |
| R2-2006594 | Proposal 5: Discuss whether a given UE can receive the specific MBS service via PTM and PTP over radio interface simultaneously.  Proposal 10: Discuss the necessity of functions provided by PDCP one by one and discuss the need of PDCP for MBS.  Proposal 11: Discuss whether RLC AM mode should also be supported for M  Proposal 13: Discuss whether data from different MBS traffic logical channels belonging the same MBS session could be multiplexed in MAC. |
| R2-2007637 | Proposal 2: Introducing the mapping of QoS Flows of an MBS session to different MBS/ unicast radio bearers should be studied in R17.  Proposal 3: Supporting of at least one of the following PDCP reliability mechanisms; PDCP data recovery, PDCP re-establishment or loss-less switching between multicast bearers should be studied in R17.  Proposal 4: Supporting of RLC-AM mode and RLC-TM mode by a multicast radio bearer, logical multicast traffic and/or control channels should be also studied in R17. |
| R2-2006803 | Proposal 6: the UE can receive the PTM and PTP simultaneously at least in a period during MBS switching between PTP and PTM in order to improve the reliability of MBS. |
| R2-2007034 | Proposal 4: The SDAP header is not configured for the MBS session.  Proposal 5: RAN2 is kindly request to discuss whether the PDCP entity is configurable for MRB or DRB.  Proposal 6: For MRB or the multicast leg of the split MRB, the RLC UM is supported.  Proposal 8: RAN2 is kindly requested to discuss whether to support lossless switching and in-order delivery when the MBS service is switched between PTM and PTP. |
| R2-2007413 | Proposal 3: RAN2 should study the latency requirements of MBS services to decide which way is used to perform dynamic delivery mode switch:  - Two protocol stacks are set in UE and network, and related resources are configured, and network could active/deactive one protocol stack via MAC CE or DCI;  - Only one protocol stack is set in UE and network, once the network decides to switch the delivery mode, it sends RRCReconfiguration message with corresponding configurations to UE. |
| R2-2007443 | Proposal 11 The protocol stacks for PTP and PTM delivery mode share the PDCP entity.  Proposal 12 For PTM delivery mode, the corresponding RLC entity is of UM mode; for PTP delivery mode, the corresponding RLC entity can be of both modes. |
| R2-2007466 | Proposal 1 A Multicast Radio Bearer (MRB) is configured to UE for 5G MBS, which includes a common PDCP layer associated with one RLC entity for PTM mode (PTM RLC Bearer) and/or one RLC entity for PTP mode (PTP RLC Bearer).  Proposal 4 the SDAP entity is not needed in UE side for 5G MBS.  Proposal 7 Sequence Numbering, Routing/Duplication, Reordering and Duplicate Discard functions are needed in PDCP layer.  Proposal 8 It is assumed that ROCH is not supported for 5G MBS.  Proposal 9 Whether security function (ciphering and/or integrity protection) is needed and whether same security function is used for PTM and PTP modes is pending to SA3.  Proposal 10 RLC AM mode does not apply to PTM RLC bearer. RLC AM mode is supported for PTP RLC bearer.  Proposal 11 Multiplexing for 5G MBS services should be supported.  Proposal 12 How to support HARQ feedback and retransmission is pending to RAN1 discussion. |
| R2-2007551 | Proposal 2: Discuss and consider dual PTP/PTM protocol stack pre-configuration for fast dynamic PTP/PTM switch. |
| R2-2007633 | Proposal 2 HARQ feedback and corresponding retransmissions are supported. |
| R2-2008032 | Proposal 1. RAN2 discuss the transmission of the uplink feedback using a layer 2 signaling. |
| R2-2006596 | Proposal 3: In the scenario of multicast only, HARQ retransmission can be considered and the feedback/retransmission mechanism should be decided in RAN1 mostly. |
| R2-2007415 | Proposal 4: It is preferred to utilize the HARQ feedback and CSI reporting to realize the link adaptation and improve the reliability, especially for the UE in the cell edge. |
| R2-2006576 | Proposal 1: specify HARQ feedback from UE to network to enable reliable NR multicast transmission.  Proposal 2: specify RLC layer feedback from UE to network to enable reliable NR multicast transmission.  Proposal 3: support higher layer signalling to indicate the resource assignment for uplink HARQ feedback from UE to network.  Proposal 4: specify a separate RLC channel for transmission of uplink feedback from UE to network to support reliable NR multicast transmission. |
| R2-2008062 | Proposal 1. RLC AM is not supported for MBS.  Proposal 2. Whether and how to support HARQ retransmission is up to RAN1. |
| R2-2007028 | Proposal 1: HARQ feedback and retransmission should be discussed in RAN1 first, and RAN2 can discuss the support of PDCP feedback for NR MBS. |
| R2-2007445 | Proposal 6: NR MRB for PTM delivery mode should be configured with RLC UM mode.  Proposal 7: NR MRB for PTP delivery mode could be configured with RLC UM or RLC AM.  Proposal 8: To improve the reliability of NR broadcast/multicast services, HARQ feedback should be supported for NR MBS. |

The following discussions are conducted in accordance with the agreed scope and the above contributions.

# Discussion

2.1 NR L2 architecture overview

According to TS 38.300, the overall NR L2 protocol architecture is illustrated as below:



**Figure: User Plane Protocol Stack**

According to TS 37.324 and TS 38.32x series, the functions of each L2 sublayer are listed as below:

**SDAP Sublayer:**

- transfer of user plane data;

- mapping between a QoS flow and a DRB for both DL and UL;

- mapping between a PC5 QoS flow and a SL-DRB for NR SL communication;

- marking QoS flow ID in both DL and UL packets;

- marking PC5 QoS flow ID in unicast of NR SL communication packets;

- reflective QoS flow to DRB mapping for the UL SDAP data PDUs.

**PDCP Sublayer:**

- 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;

- ciphering and deciphering;

- integrity protection and integrity verification;

- timer based SDU discard;

- for split bearers and DAPS bearer, routing;

- duplication;

- reordering and in-order delivery;

- out-of-order delivery;

- duplicate discarding.

- feedback and retransmission (which has not been listed in sub-clause 4.4 of TS 38.323).

**RLC Sublayer:**

- transfer of upper layer PDUs;

- error correction through ARQ (only for AM data transfer);

- segmentation and reassembly of RLC SDUs (only for UM and AM data transfer);

- re-segmentation of RLC SDU segments (only for AM data transfer);

- duplicate detection (only for AM data transfer);

- RLC SDU discard (only for UM and AM data transfer);

- RLC re-establishment;

- Protocol error detection (only for AM data transfer).

**MAC Sublayer**

- mapping between logical channels and transport channels;

- multiplexing of MAC SDUs from one or different logical channels onto transport blocks (TB) to be delivered to the physical layer on transport channels;

- demultiplexing of MAC SDUs to one or different logical channels from transport blocks (TB) delivered from the physical layer on transport channels;

- scheduling information reporting;

- error correction through HARQ;

- logical channel prioritisation;

- priority handling between overlapping resources of one UE;

- radio resource selection.

For NR unicast transmission, the above functions of each sublayer are more or less useful at least in some cases. For NR MBS transmission, however, the legacy functions may not be totally applicable, which is the focus of this email discussion. In the following sections, companies are invited to give their opinions on what functions to layout for MBS transmission and which sublayer to accommodate the functions. After these two issues are settled, the L2 architecture will be almost in shape.

2.2 L2 functions for MBS

2.2.1 SDAP functions

* **Mapping from QoS flows to radio bearers**

This function is responsible for mapping QoS flows from CN to multicast radio bearer in RAN. Although QoS modelling for MBS should be finally concluded by SA2, RAN3 has made the following working assumptions:

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| --- |
| Working Assumptions (by RAN3)：   * One or more QoS flows may be used within a single MBS session. * Each MB QoS flow belongs to one MBS Session. * Each MB QoS flow is associated with a QoS profile. * NR MBS supports both GBR and non-GBR QoS. * One Shared NG-U tunnel is used per MBS session.   For multicast, same QoS requirements are applicable regardless of whether PtP or PtM is selected by NG-RAN. |

RAN2 can further discuss this issue based on the working assumption that the QoS flow concept will be reused for NR MBS. Companies are invited to give answers to the following question:

**Q1: Do companies agree that the function of mapping from QoS flows to MBS RBs in SDAP is needed for NR MBS?**

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| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **Yes** | We prefer to reuse the legacy unicast approach as much as possible |
| **Lenovo, Motorola Mobility** | **Yes** | For downlink, when receiving data of a 5G MBS session from core network, the gNB still needs to perform the QoS flows to DRB mapping in SDAP layer. The same principle of unicast service should be applied to 5G MBS.  The SDAP header may not be needed for 5G MBS. |
| **OPPO** | **Yes** | Due to the agreements made in RAN3, i.e. One or more QoS flows may be used within a single MBS session, we think the SDAP is necessary for Qos flow to DRB mapping purpose in gNB side.  The SDAP header may be not needed due to no UL data.  The SDAP layer is not needed in UE side. |
| **ZTE** | **Yes** | We suggest following the design in NR unicast and NR V2X (for Broadcast, Groupcast and Unicast) for the QoS model with SDAP mapping QoS flow(s) to radio bearer(s).  Let's make it a working assumption for NR MBS and see what SA2 has to offer in QoS model. |
| **NEC** | **Yes, with additional comment** | We agree with the above SDAP functions of mapping from QoS flow to MBS RB, but given the QoS flow of the shared NG-U tunnel is mapped to RB, the reflective QoS is not needed for MBS scenario, so the SDAP header is not needed for MBS.  It should be noted that it is FFS whether SDAP control PDU is needed for MBS. |
| **Samsung** | **Yes** | gNB should be responsible for mapping from QF to MBS RB.  Reflective QoS is not necessary for MBS, so SDAP header is not necessary. |
| **Kyocera** | **Yes, if SA2 decides** | We think it’s reasonable to reuse the existing function in SDAP, if SA2 decides QoS flow for MBS. |
| **QC** | **Yes** | In DL, for a given shared MBS session carrying multiple MB QoS flows need to be mapped to either PTP/PTM bearer in SDAP sublayer. However, since there is no UL data, there is no need of AS reflective QoS and no need of SDAP header. |
| **CATT** | **Yes** | As there may be one or more QoS flows within one MBS session according to working assumption by RAN3, mapping from QoS flows to MBS RBs in downlink should be supported in SDAP  Besides this function may only be needed on NG-RAN side, and no SDAP header is needed for MBS. |
| **Huawei, HiSilicon** | **Yes** | Yes, the function of mapping from QoS flows to MBS RBs should be supported in RAN as different RBs may be needed to satisfy the requirement of different QoS flows. Since MBS is only for downlink transmission, gNB implementation can handle the mapping for simplicity. |
| **Spreadtrum** | **Yes** | The mapping between the QoS flow of MBS session and MRB is needed in gNB and this function should locate in SDAP layer as in legacy unicast. |
| **LG** | **Yes** | We think that reflective QoS is not necessary.  However, the need for SDAP header needs further discussion because QFI value in downlink SDAP header may be helpful to classify downlink QoS flows. |
| **CMCC** | **Yes** | We prefer to following the legacy unicast approach of mapping from QoS flows to MBS RBs in SDAP. |
| **Nokia** | **Yes** | SDAP can be kept transparent to the UE though. |
| **Sony** | **Yes** | We think it is reasonable because RAN3 working assumption has a dependency on the presence of SDAP layer and aligns the protocol stack with unicast. |
| **Futurewei** | **Yes** | Since an MBS session can include one or more QoS flows, there is need to map the QoS flow(s) to the RB(s). Reuse as much as possible the existing NR SDAP mechanism in RAN is beneficial for reducing the efforts to support such a function. It will also allow more flexibility and efficiency to make use of the RAN resources to support MBS. |
| **KT** | **Yes** | Agree to reuse the legacy unicast approach as much as possible. |
| **Intel** | **Yes, if SA2 concludes** | We think that there’s no need for SDAP headers and no need of UL reflective QoS in AS. It still depends on SA2’s discussion on whether to reuse unicast QoS approach to MBS. |
| **Ericsson** | **Yes, based on SA2 conclusion** | Depending on if SA2 concludes of adopting the same approach as for unicast PDU Session QoS model. If not, SDAP is not needed as such. |
| **vivo** | **Yes with comments** | Agree with Intel and Ericsson that it is up to SA2. Specially, we need confirmation from SA2 that whether an MBS session can contain multiple QoS flow or not. For example, if multiple QoS flows are only mapped to one RB, the function of mapping from QoS flows to MBS RBs in the SDAP layer is not needed.  Furthermore, the SDAP header is not needed to configure for the MBS session as the MBS service is downlink-only. |
| **Convida Wireless** | **Yes** | Based on the working assumption from RAN3, a single MBS session may have multiple QoS Flows. Logic will be needed to handle the mapping of these flows to radio bearers. We believe that we should follow the same principle as used for a unicast PDU sessions. |
| **Apple** | **Yes** | We prefer to reuse the legacy unicast protocol stack as much as possible. |
| **Sharp** | **Yes** |  |

**Summary:**

**23 companies have provided their views, and all of them replied “yes”, and some of them think this should be confirmed by SA2 at last.**

**Proposal 1: (Working assumption) the function of mapping from QoS flows to MBS RBs in SDAP is needed for NR MBS. This working assumption can be revisited when SA2 concludes the QoS model for MBS.**

* **Other SDAP functions**

There are some other functions in SDAP as listed in section 2.1. Of course, “transfer of user plane data” should be naturally supported if SDAP sublayer is concluded to be needed. Companies are invited to provide views on whether any other functions in SDAP (other than mapping from QoS flows to radio bearers and transfer of user plane data) are needed for NR MBS.

**Q2: Do companies think that any functions in SDAP other than “mapping from QoS flows to radio bearers” and “transfer of user plane data” are needed for NR MBS?**

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| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **Yes for part of them** | The rest SDAP functions other than “mapping from QoS flows to radio bearers” and “transfer of user plane data” are the followings:  - marking QoS flow ID in both DL and UL packets;  - reflective QoS flow to DRB mapping for the UL SDAP data PDUs.  We see the need to have the function of “**marking QoS flow ID in DL packets**” but there is no need to take “reflective QoS flow to DRB mapping for the UL SDAP data PDUs” due to lack of the UL data flow |
| **Lenovo, Motorola Mobility** | **See comments** | The functionality of mapping between a QoS flow and a DRB for downlink is needed.  Since there is no uplink 5G MBS traffic, the following functionalities may not be needed:  - mapping between a QoS flow and a DRB for UL;  - marking QoS flow ID in both DL and UL packets;  - reflective QoS flow to DRB mapping for the UL SDAP data PDUs.  whether to support QoS flows to DRB remapping is to be discussed. To reduce the standard effort, it can be assumed that QoS flows to DRB remapping is not supported for 5G MBS. |
| **OPPO** | **No** |  |
| **ZTE** | **No** | There are other two functions in SDAP sublayer: Reflective QoS, and QoS flow remapping.  - Reflective QoS is definitely not needed for downlink only MBS.  - QoS flow remapping can be done by network implementation without relying on SDAP header of QFI, as in NR V2X Groupcast/Broadcast.  Therefore, the answer is no for Q2 from spec impacts perspective. |
| **Samsung** | **Yes** | Agree with Lenovo |
| **Kyocera** | **No** | We assume MBS data is conveyed on “Data PDU without SDAP header” as specified in section 6.2.2.1 of TS37.324. |
| **QC** | **No** | No need for Reflective QoS, No need of DL header. As there is no UL data, there is no need of any of UL SDAP functions.  Like ZTE mentioned, it should be allowed to re-mapping of DL QoS flow to radio bearers as NW implementation. |
| **CATT** | **No** | All the other functions are used for uplink. They are not needed as there is only downlink data on MRB. |
| **Huawei, HiSilicon** | **No** | The motivation to mark QoS flow ID in DL packets is to realize reflective QoS flow to DRB mapping for the UL packets. Thus no other functions are needed for MBS. |
| **Spreadtrum** | **No** | For the MBS session, there is no UL QoS flow. So the Reflective QoS function and UL QoS flow remapping function in SDAP are not needed. The DL QoS flow remapping can be done by network implementation if QoS flow remapping is supported. |
| **LG** | **Yes** | Marking QoS flow ID in DL packets may be beneficial. |
| **CMCC** | **Yes, part of them** | Since there’s no UL traffic for MBS, the function of making QoS flow ID in UL packets and reflective QoS flew to DRB mapping for the UL SDAP data PDUs may be not needed, while the function of making QoS flow ID in DL packets could be supported if more than one QoS flow is used within a single MBS session as RAN3 assumed. |
| **Nokia** | **No** | We haven’t identified the need for other functions and thus SDAP can be kept transparent to the UE. |
| **Sony** | **No** | We think QoS flow to DRB mapping in DL should be sufficient in this release. |
| **Futurewei** | **No** | Appears no other additional major function is needed. QoS/DRB mapping is only for DL MBS flow(s). |
| **KT** | **No** | Agree with ZTE, QC, Huawei |
| **Intel** | **No** | As there’s no UL traffic in MBS, there’s no need to have reflective QoS, and DL QFI is also not needed if reflective QoS is not supported. |
| **Ericsson** | **No** | Need discussion on what headers are needed for a DL only QoS Flows. |
| **vivo** | **No** | As MBS service is downlink-only, there is no need to support reflective QoS flow to DRB mapping mechanism. Thus it is not necessary to mark QoS flow ID in DL packets. |
| **Convida Wireless** | **Yes**  **See Comments** | We feel it is too early to decide on this. We agree with the arguments above that reflective QoS may not be needed for NR MBS. However, we are not sure if the DL marking will be needed, or if some other functionality will be needed in SDAP (for example in support of PTM/PTP switching) |
| **Apple** | **No** | Since there is no UL traffic for MBS, SDAP layer should only process the DL data, and in DL it doesnot need to support the reflective QoS, and DL SDAP header. |
| **Sharp** | **No** |  |

**Summary:**

**22 companies have provided their views, and of them, 5 companies think that some SDAP functions other than “mapping from QoS flows to radio bearers” and “transfer of user plane data” are needed for MBS, and 16 companies think no other functions are needed. One company mentioned whether to support QoS flows to DRB remapping should be discussed.**

**Proposal 2: (Working assumption) no SDAP functions other than “mapping from QoS flows to radio bearers” and “transfer of user plane data” are supported for MBS. FFS whether to support QoS flows to radio bearers remapping. This working assumption can be revisited when SA2 concludes the QoS model for MBS.**

2.2.2 PDCP functions

* **Security**

Security function includes ciphering/deciphering and integrity protection/ verification. Note that security function is very much related to the parallel discussion in SA3 under their study on security aspects of 5G multicast-broadcast services. RAN2 discussion on security may need to wait for SA3 progress first. Based on the information, companies are invited to give answers to the following questions:

**Q3a: Do companies agree that RAN2 discussion on security function should wait for SA3 progress first?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **Yes** | SA3 input helps |
| **Lenovo, Motorola Mobility** | **Yes** | We agree with waiting for SA3 progress first. Whether security function (ciphering and/or integrity protection) is needed and whether same security function is used for PTM and PTP modes depends on SA3’s progress. |
| **OPPO** | **Yes** | We can wait for SA3’s inputs. |
| **ZTE** | **Yes** | Yes. The decision on whether ciphering in the air interface is needed is up to SA3. LS to SA3 as companies suggested in RAN2 #111e can be sent out asap. |
| **NEC** | **Yes** | We can wait for SA3’s inputs. |
| **Samsung** | **Yes** |  |
| **Kyocera** | **Yes** | We agree with the rapporteur’s view. |
| **QC** | **Yes** | Wait for SA3 progress. We need to understand whether same or different security need to be used for PTM and PTP cases if independent PDCP used? |
| **CATT** | **Yes** | We should wait for SA3’s decision on whether the security function will be located in RAN |
| **Huawei, HiSilicon** | **Yes** | **RAN2 should be involved only if SA3 decides to locate security function in RAN.**  **Regarding Qualcomm’s question, our understanding is that PTM and PTP are only different in terms of scheduling RNTIs. The security function for MBS service should be independent from PTM or PTP. RAN2 can make this working assumption and if there is any doubt SA3 can be consulted with to confirm this working assumption.** |
| **Spreadtrum** | **Yes** | We can wait for SA3’s inputs. |
| **LG** | **Yes** |  |
| **CMCC** | **Yes** | Wait for SA3’s progress. |
| **Nokia** | **Yes** |  |
| **Sony** | **Yes** |  |
| **Futurewei** | **Yes** |  |
| **KT** | **Yes** | Wait for SA3’s input |
| **Intel** | **Yes** | RAN2 should wait for SA3’s decision for detailed solution on security support for MBS. |
| **Ericsson** | **Yes** |  |
| **vivo** | **Yes** | According to the description of TR 23.757, UE can get application layer security information for receiving the multicast service data from the core network. We think there is no need to support the security protection of MBS service at RAN level. Anyway we are fine to wait for SA3’s decision in case they have different opinions. |
| **Convida Wireless** | **Yes** | **We should wait for SA3 progress** |
| **Apple** | **Yes** |  |
| **Sharp** | **Yes** |  |

**Summary: 23 companies have provided their views and all of them think that RAN2 should wait for SA3’s progress first on security discussion.**

**Proposal 3: RAN2 should wait for SA3’s progress before discussing security issues.**

**Q3b: If the answer to Q3a is no, what can be discussed in RAN2 before inputs from SA3?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |
|  |  |
|  |  |

* **Header compression/decompression**

In UMTS and LTE, the header compression/decompression function is supported for MBMS data in BM-SC. This function is especially efficient for voice traffic involved in mission critical services. Based on the information, companies are invited to give answers to the following questions:

**Q4a: Do companies agree that the header compression/decompression function is needed for NR MBS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **Yes** | RoHC should be always supported for IP packets over the air and one further discussion can be which RoHC mode should be selected for the DL MBS traffic. |
| **Lenovo, Motorola Mobility** | **FFS** | It is clear that ROHC is beneficial for header compression of small data as VoIP. However, there may be no UL feedback, and only unidirectional mode can be used. The other way is to introduce UL feedback to support more RoHC modes e.g. Bi-directional RoHC mode.  Furthermore, the potential support of header compression/decompression in RAN also depends on the outcome of SA2’s architecture enhancements for MBS. If it will be supported in core network, then there is no need to duplicate the function in RAN. |
| **OPPO** | **Yes** | The ROHC is beneficial for small IP data. For MBS, we can discuss whether it is necessary for MBS data.  The header compression/decompression function is supported for MBMS data in BM-SC and ROHC is supported for unicsst/multicast/broadcast in V2X.  So it seems it is reasonable to support header compression/decompression function. |
| **ZTE** | **Yes** | Uni-directional ROHC can be at least considered. |
| **NEC** | **Yes, it can be configurable** | In LTE MBMS, there is no PDCP entity at all, namely ROHC is not supported. And it is quite clear that ROHC is usually used for IP packets compression. Given the diversity of NR MBMS service, we think it should be configurable by the network whether this MBS service is supportive for ROHC. |
| **Samsung** | **Yes** | ROHC is useful for small-sized IP packet. It should be one of major use cases of NR MBS. |
| **Kyocera** | **Yes** | We think the header (de)compression is still useful for NR MBS. |
| **QC** | **Yes** | May be unidirectional DL only ROHC as optional can be considered as baseline function. FFS whether to support ROHC feedback or not ? |
| **CATT** | **Yes but** | ROHC is efficient for services like voice call, Maybe we could limit the discussion on whether to support bidirectional mode ROHC as ROHC in unidirectional mode is not efficient and may result in additional delay.  For MBS services received in connected mode only, Bidirectional mode is possible as UL feedback channel could exists, so ROHC could be supported for service received in connected only. |
| **Huawei, HiSilicon** | **Yes** | **ROHC is especially beneficial for public safety services such as voice which is usually of small packets.** |
| **Spreadtrum** | **Yes** | The ROHC is beneficial to the services with small data. |
| **LG** | **Yes** | **It is assumed that it is supported in a limited manner such as supporting U-mode only.** |
| **CMCC** | **Yes** | The header compression/decompression is beneficial in some cases. But we need to wait for SA2’s progress to decide whether it is supported in RAN. |
| **Nokia** | **FFS** | Agree with Lenovo. |
| **Sony** | **Yes** | At least Unidirectional mode can be supported for DL MBS traffic. |
| **Futurewei** | **Yes per need** | NR MBS will support variety of MBS applications. The baseline is ROHC can be configurable per need of an MBS application. More reasonable, the uni-directional ROHC is applied to PTM and bi-directional ROHC can be configured to PTP. Note: it is more tolerable to the air interface overhead if the PTM transmission is shared by large number of UEs. |
| **KT** | **Yes** | Agree with Samsung and Huawei |
| **Intel** | **Yes, but** | At least for RRC\_CONNCTED UE, RoHC can be considered for some MBS services |
| **Ericsson** | **Yes, configurable** | Support for unidirectional as baseline for DL only, other cases need further consideration if needed. |
| **vivo** | **Yes** | ROHC function is beneficial for packets of small size. |
| **Convida Wireless** | **Yes** | **We think that the use cases considered for NR MBS would benefit from header compression.** |
| **Apple** | **Yes** | Considering the high compression efficiency on the small IP packet, ROHC should be considered for MBS transmission. |
| **Sharp** | **Yes** | It is beneficial to have RoHC for IP packet as we have did for non MBS service. |

**Summary:**

**23 companies have provided their views and 21 of them replied “Yes”, and 2 replied “FFS” and think it depends on SA2 architecture. Several companies mentioned that only U-mode is applicable for MBS and RoHC should be configurable.**

**Proposal 4: (Working assumption) RoHC (at least U-mode) can be configured for NR MBS bearers.**

**Q4b: If the answer to Q4a is yes, companies are further invited to give opinions on which sublayer/entity (e.g. PDCP or an entity in CN) to accommodate this function.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer (e.g. PDCP or an entity in CN)** | **Comments** |
| **MediaTek** | **PDCP** | PDCP should be the choice considering that the PTP may be used for the transmission over the air for MBS RB. |
| **Lenovo, Motorola Mobility** | **PDCP** | If header compression/decompression in RAN is needed, then PDCP is the entity which is responsible for RoHC of Uu interface. |
| **OPPO** | **PDCP** | If the PDCP is supported in MBS, and ROHC is in PDCP. So, it is reasonable to support ROGC in PDCP. |
| **ZTE** | **PDCP** | Current design of PDCP just works. |
| **NEC** | **PDCP** | CN makes no sense. |
| **Samsung** | **PDCP** | We do not need BM-SC-like entity only for ROHC.  PDCP seems to be necessary for reordering function. We can just reuse PDCP similar to Uu ROHC. |
| **Kyocera** | **PDCP** | We think RAN2 should consider the case where the UEs late joins the MBS session. We assume to take RoHC as baseline for header (de)compression. |
| **QC** | **PDCP** |  |
| **CATT** | **PDCP** | It is natural for ROHC to be located in PDCP. |
| **Huawei, HiSilicon** | **PDCP** | Maybe the simplest way is to reuse PDCP. |
| **Spreadtrum** | **PDCP** | ROHC should locate in PDCP as in NR. |
| **LG** | **PDCP** | The ROHC function of PDCP can be used for this. |
| **CMCC** | **PDCP** |  |
| **Sony** | **PDCP** |  |
| **Futurewei** | **PDCP** | Reuse NR PDCP existing function. It provides more options to deal with the PTP/PTM dual protocol stack. |
| **KT** | **PDCP** | PDCP as in NR. |
| **Intel** | **PDCP** |  |
| **Ericsson** | **PDCP** |  |
| **vivo** | **PDCP** | If CN is not responsible for IP header compression, the PDCP layer is the best choice to accommodate the ROHC function. |
| **Convida Wireless** | **PDCP** | Likely simplest solution is to reuse the solution for unicast PDU sessions and have header compression in PDCP. |
| **Apple** | **PDCP** |  |
| **Sharp** | **PDCP** | If PDCP is supported, We did not see any necessary or benefit to move it to other entity. |

**Summary:**

**23 companies have provided their views, and all of them think PDCP can be used to accommodate the RoHC function (2 of them actually think *if* RoHC function is located in RAN, it should be at PDCP).**

**Proposal 5: (Working assumption) RoHC is assumed to be located at PDCP. This working assumption should be confirmed with SA2.**

* **Reordering and in-order delivery**

This function is to guarantee that packets are delivered to upper layer in the right order. Companies are invited to give answers to the following question:

**Q5: Do companies agree that the reordering and in-order delivery function in PDCP is needed for NR MBS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **Yes** | The need of reordering and in-order delivery function in PDCP for MBS RB is the same as for legacy unicast based transmission |
| **Lenovo, Motorola Mobility** | **Yes** | In-order delivery is important for TCP based traffic. 5G MBS supports high reliability, in-order delivery should be supported in PDCP.  And considering the service continuity during mobility and during dynamic switching between PTM and PTP, re-ordering and in-order delivery function in PDCP is needed. |
| **OPPO** | **Yes** | NR RLC may not deliver data in order; it is different from LTE RLC (e.g UM mode RLC). The NR PDCP reordering function and in order delivery function are necessary. |
| **ZTE** | **Yes** | Considering the diverse scenarios/requirements of NR MBS, in-order delivery shall be supported first. |
| **NEC** | **Yes, but configurable** | We agree all the scenarios supportive for in-order delivery and reordering. But we believe there are still some delay sensitive scenarios for out-of-order delivery. So we think it should be like unicast, in-order delivery and reordering is configurable. |
| **Samsung** | **Yes** | Since HARQ feedback was agreed to introduce, in-order delivery is essential. |
| **Kyocera** | **Yes** | We think the reordering/in-order delivery is needed at least for dynamic PTM PTP switch. |
| **QC** | **Yes** | Same view as Lenovo. Like unicast both in-order and out of order delivery to be supported based on configuration choice. |
| **CATT** | **Yes** | Reordering function is necessary for services like TCP applications. So in-order delivery is needed at least for normal PTM transmission. And FFS for dynamic PTM/PTP switch.  Both in-order delivery and out of order delivery should be supported. |
| **Huawei, HiSilicon** | **Yes** | As a basic AS function, in-order delivery of upper packets should be guaranteed, which is especially beneficial for MBS services like V2X applications and software update. |
| **Spreadtrum** | **Yes** | The reordering and in-order delivery function is necessary to some MBS services, and it should be supported. |
| **LG** | **Yes** | The reordering and in-order delivery functions in PDCP can be used in MBS transmission and PTM/PTP switching. |
| **CMCC** | **Yes** | Share similar view with Media Tek. |
| **Nokia** | **Yes** |  |
| **Sony** | **Yes** | We see no motivation to deviate from unicast |
| **Futurewei** | **Yes** | NR MBS allows feedback and retransmissions for certain applications. In addition, NR RLC does not support in order delivery. Therefore, PDCP should maintain the reordering and in order delivery function. |
| **KT** | **Yes** | Agree with Lenovo and Samsung |
| **Intel** | **Yes** | In order delivery is always assumed to be supported in L2. Besides, As agreed in RAN1\_102e meeting “For RRC\_CONNECTED UEs, HARQ-ACK feedback is supported for multicast and no additional evaluation is needed to justify this”, reordering function is needed in NR MBS PDCP layer to avoid out-of-order delivery caused by HARQ-ACK. For PTP/PTM and during switching between two within a cell. For service continuity mobility, we should further discuss based on outcome from email discussion [905]. |
| **Ericsson** | **Yes** |  |
| **vivo** | **Yes** | As retransmission of MBS data is supported at least for the MBS session with high-reliability requirements, there is a need to support reordering and in-order delivery. |
| **Convida Wireless** | **Yes** | Some of the use cases considered will benefit from in-order delivery. Various events will likely lead to out-of-order delivery (UE mobility, PTP/PTM switching, etc) |
| **Apple** | **Yes** | In-order delivery is required for some upper layer protocols/APPs. |
| **Sharp** | **Yes** | Reordering and in-order delivery function in PDCP is helpful to fulfil the QoS requirement for some 5G MBS. |

**Summary:**

**23 companies have provided their views and all of them replied “Yes”.**

**Proposal 6: The reordering and in-order delivery function in PDCP is supported for NR MBS.**

* **PDCP feedback (i.e. status reporting) and retransmission**

According to the WID [1], reliability is a significant requirement for NR MBS and reliability can be achieved via feedback and retransmission. Traditional feedback and retransmission mechanisms consist of: HARQ, ARQ and PDCP status reporting. During the 111-e meeting, it is agreed that HARQ is up to RAN1. Based on the information, companies are invited to give answers to the following question:

**Q6: Do companies think that PDCP feedback and retransmission mechanism is needed for NR MBS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **Yes** | The feedback and retransmission mechanism should be support in either RLC layer or PDPC layer other than HARQ layer feedback and retransmission |
| **Lenovo, Motorola Mobility** | **Yes** | PDCP status reporting is needed at least for mobility case. Whether enhancements of PDCP status reporting for PTP and PTM switching needs further discussion. |
| **OPPO** | **Yes** | Considering the MBS mobility and dynamic switching between PTP and PTM, the PDCP feedback and retransmission mechanisms are needed for NR MBS. |
| **ZTE** | **Yes** | PDCP SR is already there or will be beneficial in cases of mobility (especially in intra-CU scenarios) and mode switching. PDCP retransmission as one of the L2 retranmission schemes can be applied without much standardization effort. |
| **NEC** | **Yes** | In order to ensure the reliability for some service, the PDCP feedback and RLC/HARQ retransmission is needed. |
| **Samsung** | **No** | **In unicast, PDCP status report and retransmission are supported only for handover/bearer type change of AM bearer.**  **We think AM can be supported only for PTP bearer. This means that PDCP status report for MBS can be supported only for PTP AM -> PTP AM switching. This is just a unicast handover/BTC. We don’t need to introduce any new usage.** |
| **Kyocera** | **Yes** | We think the PDCP feedback and retransmission mechanism is still useful e.g., for handover. |
| **QC** | **Yes** | **PDCP status reporting is needed to support loss-less RLC AM HO and loss-less switching between PTM and PTP bearer. In order to support high reliability services, we think both RLC AM and HARQ to be supported. R16 DAPS HO supports PDCP status reporting for RLC UM as well. If DAPS is supported for Multicast radio bearer HO, then PDPC SR is need to be supported for RLC UM DAPS bearer as well.** |
| **CATT** | **Maybe** | Whether PDCP feedback is needed depends on requirement on data lossless delivery.  Besides, as mentioned by Samsung, In unicast, PDCP status report and retransmission are supported only RLC AM bearer. So maybe PDCP feedback and retransmission should be discussed later after it is concluded on whether to support RLC AM. |
| **Huawei, HiSilicon** | **Yes** | At least for handover, PDCP retransmission is useful to eliminate packet loss, which is not a new use case.  Whether to extend PDCP status reporting to normal transmission can be further discussed, but it seems the extension is simple and will not introduce many specification changes. |
| **Spreadtrum** | **Yes** | PDCP feedback and retransmission mechanism is needed at least for the mobility case. |
| **LG** | **Yes** | PDCP feedback and retransmission mechanism will provide enhanced reliability in MBS transmission and PTM/PTP switching together with the reordering and in-order delivery functions in PDCP. |
| **CMCC** | **Yes** | It’s reasonable to support the PDCP feedback and retransmission, considering the mobility scenario and dynamic delivery mode switch. |
| **Nokia** | **No in the sense of ARQ like operation** | PDCP Status reports are provided to reduce duplicates over the air, not to trigger retransmissions. Retransmissions of PDUs “for which the successful delivery has not been confirmed by lower layers” should be limited to the same scenarios as in legacy i.e. re-establishment and recovery |
| **Sony** | **Yes** |  |
| **Futurewei** |  | **The need of PDCP feedback and retransmission for PTP/PTM switch can be further discussed.** |
| **KT** | **Yes** | PDCP status report and retransmission are needed for mobility case. |
| **Intel** | **Yes** | It’s not essential for the normal data transmission, but it is needed in mobility case. Agree with Qualcomm that if DAPS is supported for MBS, status reporting and retransmission is applicable for both RLC UM and AM radio bearers. |
| **Ericsson** | **No** | Reliability depends on the requirements, including what is needed for mobility and the resulting complexity. So far, the details have not been discussed sufficiently to conclude on retransmissions on PDCP level. |
| **vivo** | **Yes** | To support lossless mobility, we think PDCP SR and PDCP retransmission are needed. |
| **Convida Wireless** | **Yes** | PDCP feedback and retransmissions may be necessary to meet the reliability requirements of some use cases. Especially in situations resulting from mobility and or PTP/PTM bearer switching. |
| **Apple** | **Yes** | It’s useful for the PTP/PTM switching and MBMS reception during mobility. |
| **Sharp** | **May be** | We think PDCP feedback and retransmission should be discussed after RAN2 decides lossless delivery is supported. |

**Summary:**

**23 companies have provided their views.**

* **Yes: 17 companies;**
* **No: 3 companies. One of them said “No” only to ARQ like operation.**
* **Maybe or FFS: 3 companies.**

**There seems to be a clear majority who prefer PDCP status reporting and retransmission for NR MBS. Some companies have concern on the extension of use cases of PDCP status reporting and retransmission.**

**Proposal 7: PDCP status reporting and retransmission is needed for NR MBS at least in the case of mobility (i.e., legacy case). FFS other cases.**

* **Other PDCP functions**

There are some other functions in PDCP as listed in section 2.1. Of course, “transfer of data” should be naturally supported if PDCP sublayer is concluded as needed. Companies are invited to provide views on whether any other functions in PDCP (other than those discussed above in 2.2.2 and transfer of data) are needed for NR MBS.

**Q7: Do companies think that any functions in PDCP other than those discussed above and “transfer of data” are needed for NR MBS?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **MediaTek** | There may be a need to keep the legacy PDPC function of both maintenance of PDCP SNs and duplicate discarding for NR MBS, since PDCP SN should be consistent during dynamic PTP/PTM switch and the duplicate packets received should be discarded e.g. when PTP/PTM is simultaneously active. |
| **Lenovo, Motorola Mobility** | We prefer to have a common PDCP layer for PTM/PTP switching:  Based on above assumption, the sequence Numbering, Routing/Duplication, and Duplicate Discard functions are needed in PDCP layer. |
| **OPPO** | 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;  - ciphering and deciphering;  - integrity protection and integrity verification;  - timer based SDU discard;  - for split bearers, routing;  - duplication;  - reordering and in-order delivery;  - out-of-order delivery;  - duplicate discarding.  We think all the functions except the security function (wait for SA3) should be supported for NR MBS. |
| **ZTE** | Be aligned with NR design. If PDCP is the anchor layer for mode switching, current duplication function (in NW side) will work. |
| **NEC** | The legacy unicast PDCP functions are the baseline of MBS service. The above questions clarified the controversial PDCP functions. |
| **Kyocera** | We think the “maintenance of PDCP SNs” and “duplicate discarding” will be necessary depending on the solution for dynamic PTM PTP switch. |
| **QC** | We think common PDCP with 2 RLC legs (one RLC leg for Multicast and other RLC leg for unicast can be considered). Security is FFS based on SA3 progress and all other functions needed.  From R2-2006793 |
| **CATT** | Basic functions like PDCP SN maintenance should be supported. Functions like for split bearer is not needed. |
| **Huawei, HiSilicon** | It seems that any functions involving downlink, like“maintenance of PDCP SNs” and “duplicate discarding” should be supported. |
| **Spreadtrum** | The PDCP functions in NR should be the baseline for MBS. |
| **LG** | As commented in Q6, PDCP feedback and retransmission is needed.  Packet loss received by PTM RLC entity is detected by PDCP entity and uplink feedback is transmitted via PTP RLC entity. Retransmission is received by PTP RLC entity. |
| **CMCC** | We prefer to align with the legacy functions as much as possible, at least maintenance of PDCP SNs and duplication related functions. |
| **Nokia** | An easier question to answer would have been which functions are not needed :) |
| **Sony** | NR PDCP should be the baseline |
| **Futurewei** | All the existing functions in NR PDCP should be configurable based on the need of MBS. RAN2 (with SA3 input) can have a final decision on the functions not needed for MBS. |
| **KT** | Agree with CMCC |
| **Intel** | “maintenance of PDCP SNs” – Yes. PDCP SNs maintenance is needed, however for mobility cases, we should further discuss based on outcome from [905] how to maintain PDCP SNs.  “timer based SDU discard” - as it’s a specified functionality at UE side only, there’s no need to use it in MBS  “duplication” – Considering power consumption at UE, duplication may not be suitable for UE receiving MBS service, as UE needs to monitor MBS services in multiple carriers if multi-carrier duplication is applicable.  “duplication discarding” – Yes. In Q8/9, we propose both PTP and PTM supports RLC AM. When NACK RLC SDU retransmits in PTM, there’s a high possibility that some UEs have already received those packet and feedback ACK. Duplication discarding can help those UE discard duplicated packets in PDCP layer. |
| **Ericsson** | As a baseline, maintenance of PDCP SNs and duplicate discarding should be supported. |
| **vivo** | The remaining functions at the PDCP layer are listed below:  - maintenance of PDCP SNs;  - timer based SDU discard;  - for split bearers and DAPS bearer, routing;  - duplication;  - duplicate discarding.  And we think:  - the function of maintenance of PDCP SNs and duplicate discarding is needed to support reordering and retransmission;  - for DL, SDU discard is up to gNB implementation;  - the DAPS bearer is not suggested to be supported in this release;  - the other functions depends on whether a common PDCP layer is used for dynamic PTP/PTM switching. |
| **Convida Wireless** | We feel that a number of the legacy unicast PDCP functions will be needed for MBS, and we should at last use this functionality as a baseline. Depending on the chosen implementations to deal with PTM/PTP switching and UE mobility, PDCP may require:  - maintenance of PDCP SNs;  - timer based SDU discard;  - for split bearers, routing;  - duplication;  As for security, we should likely wait on SA3 progress. |
| **Apple** | NR PDCP for unicast should be the baseline. PDCP SN maintenance and duplication detection should be supported. |
|  |  |

**Summary:**

**There seems to be a majority supporting “maintenance of PDCP SNs” and “duplicate discarding” additionally. Other functions can be further discussed.**

**Proposal 8: The following PDCP functions are additionally supported for NR MBS:**

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

**- maintenance of PDCP SNs;**

**- duplicate discarding.**

**Other PDCP functions are FFS.**

2.2.3 RLC functions

For RLC, there are three transmission modes:

* Acknowledged Mode (AM);
* Unacknowledged Mode (UM); and
* Transparent Mode (TM).

It is assumed that the functions in each transmission mode should be supported as a whole, so we may not need to discuss each functions as listed in 2.1 one by one.

According to proposals submitted in the last meeting, for PTP and PTM transmission, companies have different views on which RLC transmission mode(s) should be supported. Therefore, companies are expected to provide views on the supported RLC transmission mode(s) for NR MBS for PTP and PTM separately.

**Q8: Do companies think that RLC AM is supported for PTP transmission of NR MBS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **Yes** | It should be needed to enable reliable transmission |
| **Lenovo, Motorola Mobility** | **Yes** | RLC AM mode is supported for PTP transmission as unicast. |
| **OPPO** | **Yes** | it is necessary for reliability transmission. |
| **ZTE** | **Yes** | Network decides (AM or UM for PTP transmission) based on QoS requirement. |
| **NEC** | **Yes** | It is necessary for reliability transmission. |
| **Samsung** | **Yes** |  |
| **Kyocera** | **Yes** | We think the PTP transmission should be the same with the current unicast from the RLC point of view. |
| **QC** | **Yes** |  |
| **CATT** | **Yes** | Support RLC AM for PTP transmission will be simple by reusing legacy unicast function |
| **Huawei, HiSilicon** | **Yes** | There should be no specification impact to support this function. |
| **Spreadtrum** | **Yes** | It is necessary to achieve the reliability transmission. |
| **LG** | **Yes** |  |
| **CMCC** | **Yes** | It helps to the reliability transmission. |
| **Nokia** | **Yes** |  |
| **Sony** | **Yes** |  |
| **Futurewei** | **Yes** |  |
| **KT** | **Yes** |  |
| **Intel** | **Yes** | For RRC\_CONNCETED users, use cases such as, V2X normally requires reliability around 99.99% or higher, IIOT with even more critical requirement to both reliability and latency. As agreed in RAN1 #102e, HARQ-ACK is supported. Regarding to TS 38.104 clause 11.3.2.3.1.2, NACK to ACK probability is around 0.1%, indicating the upper bound of HARQ reliability is 99.9%. Considering critical requirement of high reliability of some MBS service, RLC AM can help to improve reliability of some multicast services. |
| **Ericsson** | **Yes** | Configurable for PTP |
| **vivo** | **Yes** | For PTP transmission, AM mode can be supported, similarly to legacy unicast bearer. |
| **Convida Wireless** | **Yes** |  |
| **Apple** | **Yes** |  |
| **Sharp** | **Yes** | Agree with Huawei. |

**Summary:**

**23 companies have provided their views and all of them replied “Yes”.**

**Proposal 9: RLC AM is supported for PTP transmission of NR MBS.**

**Q9: Do companies think that RLC AM is supported for PTM transmission of NR MBS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **No** | It would be too much complicated to maintain the PTM Tx windows for RLC |
| **Lenovo, Motorola Mobility** | **No** | If RLC AM is used for a PTM transmission, how to transmit the RLC status report and retransmission data should be addressed. One possible way is to transmit the RLC status report and retransmission data in a PTP way, which seems a little bit complicated. Since there is already HARQ function in lower layer and if there is higher requirement the PTM transmission can be switched to PTP transmission. The RLC AM for PTM transmission is not needed. |
| **OPPO** | **Maybe no** | If support, the RLC should be enhanced, e.g. Tx window and Rx window maintenance. |
| **ZTE** | **No** | Considering we will have  - PDCP layer reliability (as explained above in PDCP) and  - L1 HARQ, and  - mode switching to RLC AM based PTP transmision if it has to,  we suggest not touching RLC AM based PTM transmission which potentially complicates the design in both NW and UE. |
| **NEC** | **Yes** | If reliability is only guaranteed for PTP, this WI doesn’t make any progressive enhancement compared to LTE MBMS/SC-PTM. Some scenarios like V2X, IOT transmission, PTM is mandated and reliability requirement is necessary. A complementary unicast channel can be established for every UE for the transmission of RLC status report and the re-transmission. |
| **Samsung** | **No** |  |
| **Kyocera** | **Yes** | We think the AM mode for PTM transmission will offer the option for more reliable PTM delivery. |
| **QC** | **Yes** | Main goal of Multicast is to support a similar user experience as if the traffic was mapped to unicast. We should support improved radio efficiency and also meet various high reliability application requirements (Ex: s/w download etc). We think HARQ reliability is not sufficient (e.g. due to NAK->ACK errors) and RLC AM is needed for applications requiring high reliability as configuration choice. As some companies commented for applications requiring high reliability, PTP with RLC AM can be used. If RLC AM is not supported, these high reliability services cannot served by using PTM and motivation of reliable multicast is gone.  PDCP re-transmission based reliability based on PDCP status report mechanism means moving RLC AM reliability functionality one layer above, which is not efficient. As we move re-transmissions from RLC to PDCP, it adds more overhead ,adds more delay and we need to make additional changes to PDCP SR reporting triggers etc, which is not efficient way. |
| **CATT** | **Maybe No** | It seems RLC UM is sufficient to meet the reliability requirement of MBS services. For MCPTT service with high reliability requirement(99.9999%), But it is carried in RLC UM mode in SC-PTM. And it seems no critical issues found.  Besides, complexity of introducing RLC AM for PTM should also be considered, the channel for UL feedback and the channel for retransmission need further.  Therefore, to avoid over design and increase of complexity, no RLC AM for PTM transmission is needed if there is no clear requirement. |
| **Huawei, HiSilicon** | **No** | First, we agree that Multicast should be supported with a similar performance as unicast. In NR MBS, we will support L1 HARQ and repetition, which can basically support reliability requirement of the MBS services in most cases.  Note that in Rel-15/16 even for URLLC services such as V2X, physical layer itself which relies on retransmission and repetition can already meet the requirement of ultra-high reliability.  In Rel-15, when defining packet duplication for URLLC, the baseline was to support two RLC legs with RLC UM, and RLC AM was agreed only at the very end as it has few specification impacts.  Basically we think RLC AM will not bring much gain, and if introducing it for PTM, RLC functions will have to be modified significantly. Note that different from PDCP which only specify UE’s behaviours, RLC should specify both the transmitting and receiving behaviours.  If there is a need to further improve reliability in some cases, it can be considered to extend PDCP status reporting to normal transmission for simplicity. |
| **Spreadtrum** | **Maybe no** | The complexity of introducing RLC AM for PTM should be considered carefully. |
| **LG** | **No** | We think that it is difficult to make PTM receive feedbacks from a set of UEs, which are in different situations and send different feedbacks. Furthermore, to retransmit accordingly will make PTM very complicated. We are negative in supporting RLC AM for PTM. |
| **CMCC** | **Maybe no** | It could be complicated to design RLC AM for PTM transmission. And one potential drawback is the delay could be large, which is not suitable for some scenarios. |
| **Nokia** | **No** | Would be very complex to operate. |
| **Sony** |  | We prefer if MBS design is kept closer to the unicast and in this case, have no strong opinion and would be interesting to see the performance gain and complexity analysis of supporting RLC-AM further. |
| **Futurewei** | **No** | Not efficient. Not needed given the retransmission request is from individual UE(s) and there is PTP support the needs of individual UEs. |
| **KT** | **Maybe no** | Agree with Huawei |
| **Intel** | **Yes** | For RRC\_CONNCETED users, similar as Q8, PTM can also be considered to support RLC AM to improve reliability. However, considering different users receiving the same MBS service via PTM may feedback different status PDU indicating different subset of its RLC packets NACK, AM retransmission can be allowed in either PTP or PTM. RAN should make decision to use either PTP or PTM for retransmission, UE only need to perform duplication discard in PDCP if needed and may not be aware of difference between PTP and PTM. |
| **Ericsson** | **No** | The complexity addition is very large. Given that PTP and unicast can be used for reliable transmission of an MBS Bearer this addition is not warranted. |
| **vivo** | **No** | In our understanding, the HARQ mechanism will be introduced to satisfy the high-reliability requirements of MBS data reception. Thus, we think RLC retransmission for PTM transmission is not needed in this release taking its complexity into account. |
| **Convida Wireless** | **Maybe** | We think that in cases where the RAN delivery method is PTM, there will be use cases where RLC UM and L1 HARQ will not be able to simultaneously meet the reliability and throughput requirements. |
| **Apple** | **No** | It’s complex to support PTM transmission with RLC AM configuration. |
| **Sharp** | **No** | Support AM for PTM would be very complex. |

**Summary:**

**23 companies have provided their views.**

* **Yes (including Maybe): 5 companies**
* **No (including Maybe no): 17 companies.**
* **No strong opinion: 1 company**

**There seems to be a majority not supporting RLC AM for PTM transmission of NR MBS.**

**Proposal 10: RLC AM is not supported for PTM transmission of NR MBS.**

**Q10: Do companies think that RLC UM is supported for PTP transmission of NR MBS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **Yes** | It should be needed dependent on the characteristics of the MBS RB. |
| **Lenovo, Motorola Mobility** | **Yes** | According to the QoS requirements, RLC UM may be configured for the PTP of NR MBS. |
| **OPPO** | **Yes** |  |
| **ZTE** | **Yes** | Network decides (AM or UM for PTP transmission) based on QoS requirement. |
| **NEC** | **Yes** |  |
| **Samsung** | **Yes** |  |
| **Kyocera** | **Yes** | We think the PTP transmission should be the same with the current unicast from the RLC point of view. |
| **QC** | **Yes** |  |
| **CATT** | **Yes** |  |
| **Huawei, HiSilicon** | **Yes** |  |
| **Spreadtrum** | **Yes** |  |
| **LG** | **Yes** |  |
| **CMCC** | **Yes** |  |
| **Nokia** | **Yes** |  |
| **Sony** | **Yes** |  |
| **Futurewei** | **Yes** | Should be configurable based on the requirement of the MBS application. |
| **KT** | **Yes** |  |
| **Intel** | **Yes** | UM can provide flexibility of segmenting MBS packets. |
| **Ericsson** | **Yes** |  |
| **vivo** | **Yes** |  |
| **Convida Wireless** | **Yes** |  |
| **Apple** | **Yes** |  |
| **Sharp** | **Yes** |  |

**Summary:**

**23 companies have provided their views and all of them replied “Yes”.**

**Proposal 11: RLC UM is supported for PTP transmission of NR MBS.**

**Q11: Do companies think that RLC UM is supported for PTM transmission of NR MBS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **Yes** |  |
| **Lenovo, Motorola Mobility** | **Yes** | Segmentation function is beneficial. |
| **OPPO** | **Yes** |  |
| **ZTE** | **Yes** | RLC UM only for PTM transmission is preferred as explained above. |
| **NEC** | **Yes** |  |
| **Samsung** | **Yes** |  |
| **Kyocera** | **Yes** | We think the UM mode is the baseline for PTM transmission since it’s same with eMBMS. |
| **QC** | **Yes** | Both RLC AM and UM as configuration choice to be supported for PTM. |
| **CATT** | **Yes** |  |
| **Huawei, HiSilicon** | **Yes** |  |
| **Spreadtrum** | **Yes** |  |
| **LG** | **Yes** |  |
| **CMCC** | **Yes** |  |
| **Nokia** | **Yes** |  |
| **Sony** | **Yes** |  |
| **Futurewei** | **Yes** |  |
| **KT** | **Yes** |  |
| **Intel** | **Yes** | Same as Q10. UM should be supported to RRC\_IDLE/INACTIVE users. |
| **Ericsson** | **Yes** |  |
| **vivo** | **Yes** |  |
| **Convida**  **Wireless** | **Yes** |  |
| **Apple** | **Yes** |  |
| **Sharp** | **Yes** |  |

**Summary:**

**23 companies have provided their views and all of them replied “Yes”.**

**Proposal 12: RLC UM is supported for PTM transmission of NR MBS.**

**Q12: Do companies think that RLC TM is supported for PTP transmission of NR MBS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **No** |  |
| **Lenovo, Motorola Mobility** | **No** | Segmentation function is beneficial and needed. |
| **OPPO** | **NO** |  |
| **ZTE** | **No** |  |
| **NEC** | **No** |  |
| **Samsung** | **No** |  |
| **Kyocera** | **No** | We don’t think the TM mode is used for MBS data transmission. |
| **QC** | **No** | **There is no segmentation with TM mode and is not efficient for scheduling as well.** |
| **CATT** | **No** | No clear MBS use cases for RLC TM mode. |
| **Huawei, HiSilicon** | **No** |  |
| **Spreadtrum** | **No** |  |
| **LG** | **Yes** | **The difference between RLC UM and RLC TM is whether segmentation is supported or not. For RLC UM, one byte header is always included for the provision of potential segmentation. However, in some MBS service packet size may be small so that segmentation is never needed. In this case, using RLC TM is beneficial. Therefore, RLC TM should be allowed for MBS service.** |
| **CMCC** | **No** |  |
| **Nokia** | **No** |  |
| **Sony** | **No** | This seems like agreeing a restriction |
| **Futurewei** | **No** |  |
| **KT** | **No** |  |
| **Intel** | **No** | gNB should have the flexibility of segmenting MBS packets, therefore RLC TM is not applicable for NR MBS. |
| **Ericsson** | **No** |  |
| **vivo** | **No** |  |
| **Convida Wireless** | **No** | **Unless a clear use case shows a need** |
| **Apple** | **No** |  |
| **Sharp** | **No** |  |

**Summary:**

**23 companies have provided their views.**

* **Yes: 1 company**
* **No: 22 companies.**

**There is a majority not supporting RLC TM for PTP transmission of NR MBS.**

**Proposal 13: RLC TM is not supported for PTP transmission of NR MBS.**

**Q13: Do companies think that RLC TM is supported for PTM transmission of NR MBS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **No** |  |
| **Lenovo, Motorola Mobility** | **No** | Segmentation function is beneficial and needed. |
| **OPPO** | **No** |  |
| **ZTE** | **No** |  |
| **NEC** | **No** |  |
| **Samsung** | **No** |  |
| **Kyocera** | **No** | We don’t think the TM mode is used for MBS data transmission. |
| **QC** | **No** |  |
| **CATT** | **No** | No clear MBS use cases for RLC TM mode. |
| **Huawei, HiSilicon** | **No** |  |
| **Spreadtrum** | **No** |  |
| **LG** | **Yes** | **Please find our comment of Q12.** |
| **CMCC** | **No** |  |
| **Nokia** | **No** |  |
| **Sony** | **No** |  |
| **Futurewei** | **No** |  |
| **KT** | **No** |  |
| **Intel** | **No** | Same as Q12. |
| **Ericsson** | **No** |  |
| **vivo** | **No** |  |
| **Convida Wireless** | **No** | **Unless a clear use case shows a need** |
| **Apple** | **No** |  |
| **Sharp** | **No** |  |

**Summary:**

**23 companies have provided their views.**

* **Yes: 1 company**
* **No: 22 companies.**

**There is a majority not supporting RLC TM for PTM transmission of NR MBS.**

**Proposal 14: RLC TM is not supported for PTM transmission of NR MBS.**

2.2.4 MAC functions

Some of the MAC functions as listed in 2.1 are for UL only, e.g. scheduling information reporting and logical channel prioritisation, which do not need to be discussed for NR MBS. Some functions should be naturally supported in MAC, e.g. mapping between logical channels and transport channels. According to the proposals submitted to RAN2#111-E, the functions that deserve to be specifically discussed here are as follows:

- multiplexing of MAC SDUs from one or different logical channels onto transport blocks (TB) to be delivered to the physical layer on transport channels;

- demultiplexing of MAC SDUs to one or different logical channels from transport blocks (TB) delivered from the physical layer on transport channels;

Whether to allow multiplexing of MAC SDUs from different logical channels onto a same TB is also related to discussion in 2.2.1 about QoS flow mapping, as well as whether different logical channels can be linked to the same G-RNTI. Companies are invited to provide views on the following question:

**Q14: Do companies think that multiplexing/de-multiplexing of different logical channels should be supported in MAC for NR MBS?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **MediaTek** | **No** | We assume there is no need to link different logical channels to the same G-RNTI. One UE interested in only one MBS traffic (carried by one logical chanel) needs to decode a large MAC PDU if multiplexing of MAC SDUs from different logical channels are supported during TB assembly, which is suboptimal. |
| **Lenovo, Motorola Mobility** | **Yes or No** | It depends on QoS flow to DRB mapping and G-RNTI allocation.  If there are multiple DRB/logical channels linked to the same G-RNTI, it is beneficial to support multiplexing of MAC SDUs of the logical channels.  Multiplexing of MAC SDUs of PTM and PTP transmission is FFS.  Multiplexing of MAC SDUs of PTM with different G-RNTIs is FFS. |
| **OPPO** | **Not sure** | It is up to the mapping relationship among MBS session, MRB and G-RNTI. |
| **ZTE** | **See comments.** | For PTM transmission, multiplexing among logical channels associated with same MBS service, if there are any, shall be allowed to enable flexible scheduling.  For PTM transmission, multiplexing among logical channels associated with different MBS service shall NOT be allowed from both UE power consumption and spec impacts perspective. That is to say, one G-RNTI/transport block corresponds to one MBS/MBS session.  For PTP transmission, it is per UE and the multiplexing/de-multiplexing of different LCHs shall be supported. |
| **NEC** | **No** | Different logical channels should be mapped different G-RNTI. |
| **Samsung** | **Yes/No** | When a UE is interested in multiple flows, multiplexing may be beneficial. But it depends on QF to RB mapping discussion.  Note that we think only data from PTM bearer should be transmitted by G-RNTI. PTP bearer should be treated as a unicast bearer. |
| **Kyocera** | **Yes** | We think at least the multiplexing/de-multiplexing will be needed for “PTP-leg” in dynamic PTM PTP switch since we assume it uses C-RNTI.  For PTM transmission, the rapporteur pointed out it’s related to QoS flow mapping and G-RNTI assignment. In LTE SC-PTM, a specific MBMS session (TMGI and optionally Session ID) is associated with a G-RNTI. So, in NR MBS we think the different logical channels can be linked with a G-RNTI as long as these logical channels are associated with a specific MBS session. |
| **QC** | **Yes** | For certain applications like IIoT, where different set of UEs may be subscribed to different services (different services can be mapped to different LCIDs) can be multiplexed into same TB and scheduled using same G-RNTI. This avoids UEs subscribed to multiple services (mapped to different LCIDs) are not required to monitor multiple G-RNTIs which will impact UE power consumption. From specification perspective, we think it should be allowed to support multiplexing of different LCIDs into same TB and each LCID to be mapped to a single TB as well. |
| **CATT** | **Yes** | As discussed in 2.2.1. One or more QoS flows may be used within a single MBS session.  logical channels carrying data from different MBS flows (mapping to different MRBs) of one MBS session could be multiplexed in MAC,in case there is one to one mapping between MBS session and G-RNTI. |
| **Huawei, HiSilicon** | **Yes** | Agree with Kyocera’s analysis.  What Qualcomm pointed out could be another use case, which would allow the network to configure logical channels of different MBS sessions to use the same G-RNTI. |
| **Spreadtrum** | **Not sure** | It should be guaranteed that UE can only receive the service data it interested in to avoid the resource waste and unnecessary power consumption. |
| **LG** | **No** | Logical channel can be identified by using G-RNTI. So there is no need of multiplexing. |
| **CMCC** | **Not sure** | In the last RAN1 meeting, it was agreed that:  **For RRC\_CONNECTED UEs, at least support group-common PDCCH with CRC scrambled by a common RNTI to schedule a group-common PDSCH, where the scrambling of the group-common PDSCH is based on the same common RNTI.**  **o   FFS: whether to support UE-specific PDCCH to schedule a PDSCH for MBS.**  If UE-specific PDCCH to schedule a PDSCH for MBS, it’s naturally to support multiplexing/de-multiplexing of different logical channels. Maybe we can wait for RAN1’s progress on this FFS.  And for G-RNTI scheduling, we share similar view with other companies that it depends on the mapping relationship among MBS session, MRB and G-RNTI. |
| **Nokia** | **Yes** | We do not see a reason to exclude it. |
| **Sony** | **No** | We think that a logical channel should be associated with a unique G-RNTI. However, one logical channel may carry multiplexed QoS flows. |
| **Futurewei** | **Yes with comments** | Different QoS flows associated with different logic channels. Different logic channels can be linked to the same G-RNTI. De-multiplex to the same transport channel/TB could be an option, but it seems loss some of the flexibility for scheduling to multiplex MAC SDUs from different flows/logic channel to the same TB of a transport channel. Different logic channels being mapped to different transport channels/TB should also be allowed under the same G-RNTI. |
| **KT** | **Yes or No** | Agree with Samsung |
| **Intel** | **No for PTM** | By multiplexing/de-multiplexing of different logical channel in single TB, it wastes extra resources and power consumption on certain UE in de-multiplexing if some multiplexed logical channel data do not come from its interested MBS service. Considering one UE may require multiple MBS services simultaneously, UE can receive multiple configurations from RAN for different MBS service, and receive each subscribed MBS service data according to its configuration. RLC ARQ retransmission packets switch from PTM to PTP should also consider a separate MAC PDU for MBS service transmission.  For PTP MBS transmission, multiplexing/demultiplexing can be considered if C-RNTI is used in PTP. |
| **Ericsson** | **Yes** | The details and impact and model w.r.t logical channels vs RNTIs (and if we have QoS Flows) should be discussed. |
| **vivo** | **Yes with comments** | If multiple QoS flows of an MBS session can be mapped to different RBs and only one G-RNTI is allocated for an MBS session, multiplexing among logical channels should be supported. Otherwise, it seems there is no use case for multiplexing among logical channels. |
| **Convida Wireless** | **Yes** | We assume that this question in mostly for the PTM case, as our assumption is that the PTP case will likely use a C-RNTI, and the multiplexing/de-multiplexing of different LCHs is supported as the traffic is to a single UE.  For the PTM case, if we base ourselves on the notion that an MBS session may have more than one MBS QoS flow and that each of these MBS QoS flows may be mapped to a MBS radio bearer, we don’t see why the network should not be allowed to multiplex/de-multiplex different LCHs into a single transport block addressed to a single G-RNTI. For example, the MBS QoS flows may belong to a single MBS service, or the MBS radio bearers may be linked to the same G-RNTI. In such cases, there would be scheduling efficiency in allowing this multiplexing. |
| **Apple** | **FFS** | It’s about how to group the multiple MRB/LCH for PTM transmission.  If multiplexing is supported, the MRBs that UE is interested and not interested should not be grouped into one PTM transmission. |
| **Sharp** | **Not sure** | Agree with OPPO. |

**Summary:**

**23 companies have provided their views:**

* **Yes (including “Yes with comments”): 9 companies;**
* **No (including “No for PTM”): 5 companies;**
* **“Yes or No” or “Not sure” or FFS or others: 9 companies.**

**There does not seems to be a clear majority view. This issue is better to be concluded when the QoS modelling is clear in SA2.**

**Proposal 15: FFS if multiplexing/de-multiplexing of different logical channels are to be supported in MAC for NR MBS.**

2.3 Dynamic switch between PTP and PTM

According to the WID [1], dynamic switch between PTP and PTM is a function to be supported for NR MBS. During the 111-e meeting, it is agreed that the gNB makes the decision of the dynamic switch, while which sublayer handles the details is FFS. Companies are invited to give answers to the following question:

**Q15: Which sublayer acts as the anchor of PTP and PTM dynamic switch, i.e. the splitting and converging sublayer for MBS traffic transmitted via PTP and PTM?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer (e.g. SDAP/PDCP/RLC/MAC)** | **Comments** |
| **MediaTek** | **PDCP or RLC** | We assume the discussion of PTP and PTM dynamic switch can be subject to the modelling of the MBS MRB. So far we see two alternatives, one is PDCP based and the other is RLC based. So accordingly, the PTP and PTM dynamic switch can be conducted at either PDCP or RLC layer. |
| **Lenovo, Motorola Mobility** | **PDCP** | In order to support service continuity, a common sequence numbering function is needed between PTM and PTP. As MR-DC, it is straight forward to use a common PDCP layer for both PTM and PTP modes since the re-ordering function resided in PDCP layer in NR.  In this layer 2 protocol stacks, PTP transmission with RLC AM can be configured to improve the reliability. |
| **OPPO** | **PDCP and MAC** | 1. The common PDCP will make the same packet own the SN number of PTM and PTP. It will help to increase the reliability reception. 2. The common MAC has benefit of soft combination of PTM and PTP. It will also help to increase the reliability reception. If PTP is only for retransmission of PTM, the common MAC is necessary. |
| **ZTE** | **PDCP** | PDCP as the anchor layer naturally fits into the current RAN architecture design with CU/DU split and bearer type change design; while PDCP as the anchor layer introduces least spec impacts in lossless support compared to other solutions.  We suggest separating mode switching and re-transmission schemes in future discussion, although they share some kind of commonality. For mode switching, only one anchor layer is needed, while for retransmission it can be studied in Reliability Enhancement part. |
| **NEC** | **PDCP** | For service continuity and DC, it is always the PDCP entity which acts like an anchor. |
| **Samsung** | **No need**  **(RRC switching)** | **We do not think “dynamic switch” mandates a common sublayer. We think dynamic switch can be accomplished by RRC message indicating switch between PTM and PTP. In this case, split structure is not needed.**  **Under the split bearer Lenovo is referring to, PDCP SN for all UEs receiving the same MBS bearer should be synchronized, even if UE receives the data via PTP bearer. It does not have a value.**  **We think lossless can be achieved by classical AM unicast bearer. Such complicated structure is not necessary.** |
| **Kyocera** | **PDCP (or RLC)** | We think it’s straightforward to reuse the existing split bearer functions in PDCP for MBS PTP PTM switch.  If RLC AM is supported, we think it may also be possible to do this at the RLC layer, but there will likely be more specification impact. |
| **QC** | **PDCP is main anchor and RLC/MAC dynamic re-transmissions to be allowed.** | From above architecture, PDCP can be used as anchor for switching between PTP and PTM legs.  One RLC leg is meant for Multicast, which can operate in AM/UM mode based on configuration and other RLC leg is meant for specific UE, which can be configured in either AM/UM modes. Multicast RLC AM leg can re-transmit either by using multicast LCID or unicast LCID for a specific UE.  At PHY/MAC, for multicast leg, HARQ original transmission can be based on G-RNTI and re-transmission can be either by using G-RNTI or C-RNTI and is dynamically decided by GNB based on whether re-transmissions targeted for one UE or multiple UEs. In cased on PTP leg, original and re-transmissions are based on C-RNTI.  This gives flexibility at different levels.  RRC based switching needed during handover cases. |
| **CATT** | **SDAP,or PDCP or RLC** | Not sure about the detailed function of the “anchor”.  We are open to both common PDCP and separate PDCP. Either solution has both advantages and disadvantages.  It seems common PDCP entity is beneficial for reordering handling during mode switch .but with common PDCP, PTM and PTP of the same MBS session should have the same PDCP configuration. This will put a restriction on the PDCP configuration of PTP transmission. so the question is, for a MBS session, do we assume that the same PDCP functions or configuration are to be used for PTM and PTP? if no, maybe common PDCP is not helpful to the reordering during mode switch because anyway the PDCP will be reconfigured during switching.  For separate PDCP solution, no such limitation, but SN synchronization between PDCPs needs to be maintained between 2 PDCP entities for reordering. |
| **Huawei, HiSilicon** | **PDCP** | Agree with ZTE’s view that dynamic switch should be decoupled with the discussion on retransmission which can be performed at MAC or RLC.  Dynamic switch between PTP and PTM will almost inevitably lead to out-of-order reception of MBS data, which makes PDCP the most suitable anchor entity as reordering function is at PDCP in NR.  Besides, PDCP acting as the splitting and converging sublayer is much similar to the current split bearer architecture and thus can save a lot of specs effort. |
| **Spreadtrum** | **PDCP** | Considering the service continuity during the switch PTP and PTM, the duplication detection and reordering function is needed. The PDCP layer has these functions. Therefore, it is natural for PDCP layer to act as anchor layer.  And we agree with CATT that the whether common PDCP or separate PDCP is applied needed further discussions. |
| **LG** | **PDCP** | The PDCP sublayer should be the anchor point of PTM and PTM dynamic switch. The PDCP entity is associated with a PTM RLC entity and a PTP RLC entity. |
| **CMCC** | **PDCP and/or MAC** | 1. Using PDCP as the anchor also suits for the mobility scenario, it is benefit for the service continuity. Also, in the discussion above, the RLC mode for PTM and PTP leg could be different, which could be achieved by common PDCP. 2. As we mentioned in Q14, RAN1 is discussing about using C-RNTI to schedule a PDSCH for MBS, which means PTM leg could be scheduled by C-RNTI or G-RNTI. If it’s supported, there could be a PTM leg and PTP leg in PHY naturally. Maybe we need to wait RAN1’s progress or at least reach a consensus on the basic definition of PTP leg and PTM leg. |
| **Nokia** | **PDCP** | Service continuity will rely on SN and PDCP is an obvious choice. Note that if duplication is required, it would also be located at PDCP. |
| **Sony** | **PDCP** |  |
| **Futurewei** | **PDCP and/or RLC** | To support PTP/PTM switch, currently there are multiple options of different dual protocol stack structure proposed by companies. Dynamic switch can be initiated/handled at PDCP and/or RLC without signalling involved. Further discussion is needed to determine which way to go. |
| **KT** | **PDCP** | We think split bearer is not necessary because RRC based switching can be used for PTP and PTM dynamic switch, but operation for service continuity during dynamic switch can be performed in PDCP layer. |
| **Intel** | **PDCP or MAC** | **Agree with CMCC’s analysis.** |
| **Ericsson** | **PDCP and/or RLC/MAC**  **TBD** | The decision to make a dynamic switch is based on e.g. HARQ and RLC depending on what functionality is supported (e.g. for reliability). Other aspects are mobility and also architecture impact w.r.t PDCP (CU-DU). In RAN3 there are discussions on PTP/PTM decision in case of *disaggregated gNB* that is important for this discussion. We thus think more time is needed for the details to be decided. |
| **vivo** | **PDCP** | Agree with ZTE. PDCP as the anchor layer naturally fits into bearer type change design and will introduce the least spec impacts in lossless support compared to other solutions.  Further, whether adopting a common PDCP layer or separate PDCP layer or not depends on the interruption time requirement of MBS service reception. A common PDCP layer can realize fast PTM/PTP switching and provide 0 ms interruption. For MBS service without strict service interruption requirement, separate PDCP layer based PTM/PTP switching can also be supported. |
| **Convida Wireless** | **SDAP or PDCP** | We agree that using a common PDCP would be a natural extension of the anchor functionality used in CU/DU split and in DC. However, we do feel that the PDCP functionality may be different in PTP and PTM mode and may require a separate PDCP. As a result, we do have slight preference for SDAP as the anchor layer. |
| **Apple** | **PDCP, MAC** | PTP-PTM switching can be considered in PDCP or MAC.  If PDCP is the anchor, the switching is between PTP RLC and PTM RLC.  If MAC is the anchor, the switching is between the different scheduling DCIs.  In addition, RRC based switching should also be supported. |
| **Sharp** | **No anchor or PDCP** | If an anchor is needed, PDCP is a good choice because PDCP as an anchor has been well studied. |

**Summary: 23 companies have provided their views and some companies have multiple choices, which are summarized as below:**

* **PDCP: 22 companies;**
* **RLC: 5 companies**
* **MAC: 5 companies**
* **RRC: 1 company**

**There is a majority (21 vs 1) who prefer at least PDCP acting as the anchor for PTP and PTM dynamic switch.**

**Proposal 16: PDCP acts as the anchor for PTP and PTM dynamic switch, i.e. the splitting and converging of MBS traffic transmitted via PTP and PTM is done at PDCP.**

2.4 Phase-2 discussion: L2 architecture for MBS

During Phase-1 discussion, there seems to be a clear majority thinking that at least PDCP can be the anchor for PTP and PTM dynamic switch. Further, according to comments and proposals submitted in RAN2#111e meeting, there are several companies who proposed to reuse the split bearer architecture defined in NR, like below.



Fig.2 Split bearer architecture for PTP/PTM dynamic switch

Companies are invited to provide their views on if the split architecture above can be agreeable as the baseline for further discussion on PTP/PTM dynamic switch.

**Q16: Assuming PDCP acting as the anchor for PTP/PTM dynamic, do you think the split bearer architecture can be the baseline for further discussion on PTP/PTM dynamic switch? If not, please provide your suggested architecture.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **Nokia** | **Yes** |  |
| **QC** | **Yes** | **PDCP acts as anchor for dynamic switching between PTP and PTM legs. At the same it should be possible for each RLC leg to support AM mode. For PTM leg, at MAC level HARQ original re-transmission can be based on G-RNTI and tr-tx can be based on either G-RNTI or C-RNTI (This is still under discussion in RAN1). Above diagram assumes only G-RNTI for PTM, which may not be correct.** |
| **Futurewei** | **Yes** | **At mean time PDCP acting as the anchor for PTP/PTM switch can be baseline for further discussion.** |
| **Sharp** | **Yes** |  |
| **MediaTek** | **Yes with comments** | **It would be helpful to clarify if the Split bearer architecture for PTP/PTM dynamic switch is per UE or per cell. It seems the diagram is cell specific and the diagram is described only for gNB.**  **As UE side stack also concerns, we expect addition discussion from per UE point of view.** |
| **CATT** | **Yes** | **If PDCP is chosen as the anchor for PTP/PTM dynamic switch,we see the benefit for in-order delivery and data loss minization with the split architecture.** |
| **OPPO** | **Yes with comments** | **We share the same view as MediaTek.**  **Furthermore, we have confusions about “split bearer architecture” wording.**   1. **We wonder whether the PTM and PTM transmit the different data packet or same data packet? i.e. split bearer mode or PDCP duplication mode?**   **For my understanding, the PTM leg always transmit all the MBS data packet, and for PTP:**   1. **PTP will transmit the copied MBS data packet if one UE’s PTP leg is activated.** 2. **PTP will transmit all the copied MBS data and it is up to UE decision to receive PTM or PTP or both.**   **It is not complete split bearer architecture. It is split bearer like architecture.**  **So, we need more clarification on “split bearer architecture” wording from both gNB and UE point of view.** |
| **vivo** | **Yes with comments** | **Generally, we agree with the proposed split bearer architecture. But, at the first glance of the above figure, it comes to us that PTM/PTP dynamic switch is a part of PDCP functions and it seems that the dynamic switch is performed to select only either PTM or PTP (i.e. we think PTM and PTP can be simultaneously supported for a given CONNECTED UE). To get rid of this potential misunderstanding, we suggest removing the PTP/PTM dynamic switching with the dotted box in the above figure.** |
| **Kyocera** | **Yes** |  |
| **LG** | **Yes** | **We support the architecture for dynamic PTM/PTP switch with service continuity. Also, we think that the architecture can be used for normal MBS transmission and the associated RLC entities can be configured with different RLC modes (e.g. RLC UM for PTM and RLC AM for PTP). Furthermore, status reporting and retransmission can be considered for possible recovery of packet loss during MBS transmission when the PTP leg provides an uplink path.**  **Regarding the wording of “split bearer architecuture”, we have similar opinion with OPPO. It is concerned that it can make misunderstanding that the proposed architecture is the same with the split bearer architecture of DC.** |
| **Ericsson** | **Yes, in principle** | **Some changes should be made. For example, with split bearers the two RLC entities must have the same mode, i.e. both UM or both AM. For MBS the RLC entity corresponding to the "PTM leg" should be UM while the other RLC entity could be AM. All left to configuration of the network.**  **The network should also be able to configure one of the legs (e.g. PTM only).** |
| **Speadtrum** | **Yes** | **We share the views from MediaTek.**  **And we think the service continuity during mobility should also be considered in the PTP/PTM anchor design.** |
| **Lenovo, Motorola Mobility** | **Yes** | We agree that PDCP acts as anchor for dynamic switching between PTP and PTM legs. |
| **Huawei, HiSilicon** | **Yes** | Agree with some companies’ comments on the terminology of split bearer, which can be split-like bearer. |
| **ZTE** | **Yes with comments** | Agree with the concerns on the terminology proposed by above companies:  - the "split bearer" definition in current spec is: "Split bearer: in MR-DC, a radio bearer with RLC bearers both in MCG and SCG." however, the discussion till now has not touched the cell group issue (in RAN3 MRDC support is TBD). so we might need to give some restriction to the current split bearer or start a fresh definition of the new type of bearer arch:  - "in case of PDCP acting as the anchor for PTP/PTM dynamic switching, the PDCP is dynamically associated with different type of RLC bearer (i.e., PTP and PTM)." |
| **CMCC** | **Yes with comments** | We agree that PDCP acting as anchor is a good option, which could help to service continuity, and we share similar view with OPPO about the “split bearer architecture” .  And as we commented in phase-1, RAN 1 is discussing on using C-RNTI to schedule a PDSCH for MBS, which means PTM leg could be scheduled by C-RNTI or G-RNTI. If it’s supported, there could be a PTM leg and PTP leg in PHY naturally. We are wondering what’s the main difference for PTP and PTM leg, just scheduling RNTI or/with different RLC mode? |
| **Intel** | **It depends** | We think we still need time to further discuss whether PDCP or MAC is the anchor the for PTP/PTM dynamic switch. Several benefit we can see if MAC plays as the anchor point:   * + - 1. Unified solution for PTP and PTM (with same PDCP and RLC entity for a MBS bearer) can help to reduce service interruption caused by dynamic switching between PTP an PTM       2. From L2 architecture point of view, there’s no difference for gNB and UE if MAC is the anchor. It also addresses some companies’ concern about whether the above architecture is for gNB or UE.       3. UE may be transparent to switching between PTP and PTM in some scenarios.       4. Both RLC UM and AM can be adopted in PTP and PTM, especially AM for improving reliability purpose (for a single MBS service, reliability requirement should be the same in PTP and PTM. Thus, if AM is used in PTP, there’s no reason to remove it from PTM)   In this case, there’s no need to consider the split bearer architecture when PTP/PTM switching within a cell. For PTP/PTM switching for mobility, PDCP can be considered as the anchor.  We prefer to have single RLC entity in the L2 architecture instead of 2 RLC entities as in split bearer architecture. We’d like to emphasize that two RLC entities are introduced for split bearer since the RLC entities are located in different RAN nodes. In PDCP duplication, two or more RLC entities are introduced for CA duplication to handle LCP restriction in order to avoid duplicated packets transmitted in the same carrier. We can see that additional RLC entities for one bearer are introduced due to various reasons. However in case of MBS L2 architecture, we don’t see the need to introduce two RLC entities for one MBS bearer. One RLC entity is sufficient to handle both PTP and PTM including the dynamic switching and mobility aspects. From past RAN2 discussion (e.g. email discussion [AT110e][017A][NR15] UE cap Number of bearers), we can see that number of RLC entities increases UE complexity and cost. Therefore the introduction of 2 RLC entities should be clearly justified. |

A related question is whether RRC signalling needs to be involved for PTP/PTM dynamic switch.**Q17: Do you think RRC signalling needs to be involved for PTP/PTM dynamic switch?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| **Nokia** | **FFS** | It depends on the configuration, if both bearers are configured, this could be seen as a scheduling decision and remain transparent to the UE. Furthermore, it also depends on the solution for scheduling of common-PDSCH developed in RAN1. If scheduling of common-PDSCH can be done with little added complexity in L1 then the switching could remain transparent to the UE. Feedback from RAN1 is needed. |
| **QC** | **Yes in some cases** | **It depends on how gNB configures multicast and unicast RLC legs. If only one RLC leg associated with PDCP is configured then switching between DRB and MRB needs some RRC signalling.otherwise like Nokia commented, it is scheduling decision and transparent to UE.**  **For HO cases, for mapping between PTP and PTM, RRC siganling is needed but this is not same as intra cell dynamic PTP/PTM switching .**  **From spec perspective, we should allow flexibility to use RRC based switching as well .** |
| **Futurewei** | **FFS** | If for dynamic switch, all the UEs under a MBS service are pre-configured the dual-protocol stack for PTP/PTM, we don’t see a need of RRC ignalling.  For general operations, if for some Ues there is only one bear being configured, RRC ignalling have to be used to configure the switch between PTP/PTM. We can discuss to see if for certain type of Ues RRC is needed. |
| **Sharp** | **FFS** | As other company says, it’s up to the configuration. |
| **MediaTek** | **No** | **We don’t see a need of RRC signalling based switch. We prefer L1/L2 based switch in order to achieve the UE transparent switch performance. Our assumption is the discussion here is not for Handover cases.** |
| **CATT** | **Maybe need** | RRC signalling to inform the PTM/PTP switch event to UE may be necessary.  If the PTM/PTP switch is transparent to UE,it may result in the increase of UE power consumption.  In case both bearers are configured , UE should always monitor G-RNTI and C-RNTI simultaneously during the MBS reception. How serious the increase of UE power consumption is also dependent on whether the physical layer parameters such as BWP,search space,DCI format is same between G-RNTI and C-RNTI. |
| **OPPO** | **Maybe** | We think the RRC signalling can be used to configure the initial leg activation between PTM and PTP under the assumption that the RRC signalling will semi-static configure both PTM and PTP legs for one UE.  Considering the switching delay and service interruption, the L1/2 based switching is needed. |
| **Vivo** | **It depends** | Firstly, we think RAN2 should reach a broad consensus of the meaning of “dynamic”. In our understanding, RRC ignalling related operations are regarded as semi-static, rather than dynamic, and dynamic operations (e.g. dynamic scheduling, Scell Activation/Deactivation) in NR are usually performed by L1/L2 signaling. If this is a common understanding, our answer to this question is No. More specifically, we think that, if both MRB and DRB have been configured via RRC ignalling, the dynamic switch can be decided by NW implementation without any indication, similarly to DL routing in the legacy NR split bearer case. Alternatively, we think the NW can use L1/L2 signaling to inform the UE of the NW decision. |
| **Kyocera** | **Yes for configuration**  **No for swiching** | We assume RRC signalling is used for the PTP/PTM bearer configuration but not for the trigger of switching. However, we think some kind of activation/deactivation mechanism, e.g., by MAC CE, is worth considering for UE power saving. |
| **LG** | **No** | But, PDCP and RLC entities should be properly configured for dynamic PTM/PTP switch in advance of the actual user-plane operation. We assume that the PDCP has both PTM leg and PTP leg when frequent PTM/PTP switching is expected. If activation/deactivation of reception on each leg on UE side is required, L1 or L2 signaling can be considered. |
| **Ericsson** | **No** | For the dynamic switch itself, no. But RRC signalling is needed to configure the MRB.  We think the UE once configured monitors PDCCH for both C-RNTI and G-RNTI and the switch itself is transparent to the UE. Sometimes packets come with G-RNTI and sometimes packets come with C-RNTI. We should inform RAN1 that PHY should support this.  We think handover is a separate case from dynamic switch. |
| **Speadtrum** | **FFS** | The RRC signalling can be used for the configuration.  The L1 or L2 signaling can be used for dynamic switch considering the interruption. |
| **Lenovo, Motorola Mobility** | **FFS** | FFS issues for RRC ignalling include, e.g.  MBS RB configurations for PTP, PTM: semi-static or pre-defined  For dynamic PTP <-> PTM switch: L1/L2 signaling configuration |
| **Huawei, HiSilicon** | **No for dynamic switch, FFS for RRC reconfiguration** | For dynamic switch, split-like bearer can be applied which doesn’t need to involve RRC.  It can be further discussed whether a MBS bearer can be with only a PTP RLC leg and if allowed, RRC based PTP/PTM reconfiguration can be discussed. |
| **ZTE** | **FFS** | Agree with OPPO. The initial bearer configuration itself will be RRC signaling definitely. Whether to introduce lower layer switching mechanism to reduce the switching latency can be FFS. If we are talking about the RRC signaling issue during the switching procedure, the answer shall be FFS, as lower layer signaling can be applied as one of the potential solutions.  Moreover, the concept of "transparent to UE" mentioned by companies above can be misleading: in 3GPP specs the so called "transparent" has different meanings in different context.  If the suggested solution is to pre-configure the receiving UE with both PTM and PTP while network decides which transmission mode without explicit signaling to UE, we think this is not the optimal solution:  - it is not power efficient to require UE to monitor both PTP and PTM transmission blindly;  - reception on both legs can be applied as a network configuration in some cases, however it shall not be default. |
| **CMCC** | **No** | We think RRC signalling is used to configure MRB with PTP leg and/or PTM leg, and if we want to achieve “dynamic” switch, both of PTP and PTM leg need to be configured beforehand. And L1/L2 signalling could be used to inform UE of the network decision with low latency. |
| **Intel** | **FFS** | It depends on the configurations. We would like to first discuss and agree on how PTP and PTM swiching is performed, then discuss the RRC signalling impact. |

# Conclusion

# Reference

1. RP-201038 WID revision: NR Multicast and Broadcast Services, Huawei, HiSilicon