**3GPP TSG-RAN WG2 Meeting #113-eR2-21xxxxx**

**Online, 25th Jan – 5th Feb 2021**

**Agenda item: 8.1.1**

**Source: Chairman (Mediatek Inc)**

**Title: [Offline-038][MBS] UP Architecture Desicions**

**Document for: Discussion**

# 1 Introduction

This is to report the result of the following email discussion.

* [AT113-e][038][MBS] UP architecture decisions (Chairman)

Scope: Gather comments to facilitate a CB to address two decisions: A) on L2 ARQ for PTM, B) for PTM PTP switch, which layer to be the anchor.

Intended outcome: Report with collection of comments

Deadline: Friday Jan 29 1200 UTC

The Discussion scope is to gather comments to facilitate a online CB discussion to address two decisions: A) on L2 ARQ for PTM, B) for PTM PTP switch, which layer to be the anchor.

Companies are strongly encouraged to voice their opinions here.

# 2 Contact Information

To make it easier to find the correct contact delegate in each company for potential follow-up questions, the rapporteur encourages the delegates who provide input to provide their contact information in this table:

|  |  |
| --- | --- |
| Company | Contact: Name (E-mail) |
| Chairman (Mediatek Inc.) | Johan.johansson@mediatek.com |
| LG | Seong Kim (sj117.kim@lge.com) |
| Huawei | Zhenzhen Cao (caozhenzhen@huawei.com) |
| Ericsson | Henrik Enbuske (henrik.enbuske@ericsson.com) |
| Futurewei | Hao Bi (hao.bi@futurewei.com) |
|  |  |
|  |  |
|  |  |
|  |  |

# 3 Discussion

## 3.1 Need for UP decisions

Chairman’s View:

First, pointing out the obvious: The MBS Work Item is large, there is a lot of functionality that need to be supported in RAN2, it impacts many specifications, has impact in all other group with need for work coordination. Both User Plane and Mobility is impacted which both are among the most difficult to progress topics in RAN2. Behind each alternative, also behind the seemingly “simple” alternatives, there is a lot of detailed issues that requires significant work and significant lead times to converge on.

The non-decided architecture blocks the possibility to progress many parts. Architecture = which functionality exists and where is it located (which protocol layer, which peer entity).

The current decision status is that there was a working assumption established last meeting that PTM will not support RLC-AM, and no further decision has been taken since to either overturn or confirm this. For the anchoring of PTP PTM switch there is no present decision.

It is important that RAN2 consolidates MBS user plane architectural decisions soon.

## 3.2 UP decisions

**The main two points that seems to need resolution/consolidation are the following**

*A. L2 ARQ for PTM for normal data transfer*

*B. Which layer anchors the PTM PTP switch, i.e. at PTM PTP switch which layer remains the same, (and might be responsible for service continuity).*

Both point A and B are included here because several companies indicate that they are inter-dependent,

**For A. there seems to be the following options on the table:**

A1. No L2 ARQ for PTM

A2. L2 ARQ by PDCP for PTM

A3. L2 ARQ by RLC-AM for PTM

**For B. There seems to be the following options on the table:**

B1. PDCP anchored PTM/PTP switch

B2. RLC anchored PTM/PTP Switch

Different combinations of Ax/Bx seems to be technically possible, but they seems to come with different complexity, different level of reuse and different characteristics.

## 3.3 This email discussion

The purpose of this discussion is to have opportunity to put on the table opinions and arguments of all interested companies with less time consumption.

As this is a controversial topic it seems there will not be sufficient on-line time to allow everyone to voice their opinions on-line on all these aspects. It is encouraged that companies voice their main opinions / suggestions and supporting arguments relating to the options and combination of A and B.

Similar to online debate It is furthermore encouraged that companies respond to other companies’ comments (not endlessly but maybe one round). Comments are numbered to facilitate this.

# 4 Discussion

**For A. there seems to be the following options on the table:**

A1. No L2 ARQ for PTM

A2. L2 ARQ by PDCP for PTM

A3. L2 ARQ by RLC-AM for PTM

**For B. There seems to be the following options on the table:**

B1. PDCP anchored PTM/PTP switch

B2. RLC anchored PTM/PTP Switch

|  |  |  |
| --- | --- | --- |
| **N** | **COMPANY** | **COMMENT** |
| 1 | Chairman | **My high level understanding of the proposals:**  **A1:** No L2 ARQ for PTM, UNDERSTANDING: For normal data transfer, reliability is handled by L1, HARQ, and switching from PTM to PTP if the link gets bad and vice versa. PTP could be configured different to PTM, e.g. with RLC-AM.  **A2:** L2 ARQ by PDCP for PTM, UNDERSTANDING: In addition to A1, there is possibility to have PDCP retransmission of SDUs across PTP at lost data, which could be triggered by a PDCP status report (other trigger FFS).  **A3**: L2 ARQ by RLC-AM for PTM, UNDERSTANDING: RLC-AM is adapted such that dedicated protocol control and dedicated retransmissions uses the PTP leg. RLC-AM segments are retransmitted at lost data (as normal). It is assumed possible to keep current protocol including also e.g. Poll/Ack Nack supervision and retriggering mechanisms. Further It is proposed that both PTP and PTM is one single RLC-AM protocol instance (same SN, buffer status etc) and this would bring benefits at PTP PTM switching. However, this doesn’t seem to be a core part, so for a good discussion this point could be considered FFS. A1 or A2 could be supported in addition to A3 in order to support RLC-UM.  **B1**: PDCP anchored PTM/PTP switch, UNDERSTANDING: Similar as Mobility, PDCP SN is the basis for service continuity. Receiver packet handling is anyway in PDCP, reordering duplicate handling, triggering of status report (FFS new triggers). When lost data at switch need to be recovered, transmitter can perform retransmissions of SDUs on PTP.  B1 Can work with all of the alternatives of A1 A2 A3 and requires no particular interdependency from the lower protocols (e.g. RLC AM for PTP and RLC-UM for PTM would be ok).  **B2:** RLC anchored PTM/PTP Switch, UNDERSTANDING: RLC anchored PTP PTM switch is intended for the case that both PTP and PTM is one single RLC-AM protocol instance where data lost at the switch is retransmitted as RLC-AM segments by the same protocol mechanisms as during normal data transfer.  For RLC-UM cases, B2 would not be used, in particular if RLC-AM/PTP and RLC-UM/PTM shall be supported (my understanding). |
| 2 | LG | **Summary of LG’s view**:   * A1: strong support * A2: support * A3: not support * B1: strong support * B2: not support   **A1**: We have same understanding with Chairman. Switching from PTM to PTP should be considered for high reliability because A2 and A3 cannot be as reliable as PTP because PTM should consider Ack/Nack feedbacks from multiple UEs. Either the rx and tx windows would be stuck for the worst case UE, or some of UE would suffer packet losses.  **A2**: We have same understanding with Chairman. We can re-use the MRB structure for dynamic PTM/PTP switch where there is a common PDCP and two legs for PTM and PTP. PDCP already essential functionality for retransmission and status report, and the PTP leg can provide PTM with uplink path for UL feedback and additional downlink path for retransmission. We can mainly focus on enhancement of status report triggers. We think, the main benefit of reliability enhancement of PTM is that UEs can be kept more to be served by PTM and this would increase resource efficiency.  **A3**: Although A3 could be considered for enhancing reliability of PTM, we don’t see reasons for adopting A3 rather than A2. We can enhance reliability of PTM by A2. The required functionalities for retransmission and uplink feedback are same for A2 and A3 at high level description. We think that the enhanced reliability levels which can be achieved are expected to be similar considering that PTM should consider multiple UE’s behaviours as mentioned in A1. However, A3 would require new changes which are related to essential RLC function, for example, rx/tx window management, and induce more complexity. We prefer A2 to A3 for enhancing reliability of PTM.  **B1**: We shares Chairman’s understanding. We support B1 (PDCP anchored PTM/PTP switch). We also considered that it is well-aligned with mobility procedure and it can work with A1 A2 A3 as mentioned by Chairman.  **B2**: Basically, states of the RLC entity would be different for PTM and PTP because the state for PTP is specific to the UE and the state of PTM is common for UEs of the group. Moreover, RLC mode can be different between PTM and PTP. So, we believe that PTM/PTP switching may requires full change of RLC state of the RLC entity. We think this kind of change is not desirable for an anchor entity. |
| 3 | Huawei, HiSilicon | First, many thanks to Chair to lead this offline. From rapporteur’s point of view, we really need to conclude the user plane architecture as soon as possible, as many discussions would be stuck if the architecture is not clear in both RAN2 and RAN3.  We share the same understanding with Chair on overall picture of issues and solutions on the table for the architecture discussion. Our view is summarized as below:   * A1: acceptable in Rel-17 * A2: acceptable (a simple solution only in Rel-17) * A3: not support * B1: support * B2: strong concern (not working technically for RLC UM)   **A1**: most of MBS services are video/audio, which mostly use UDP/IP and doesn’t require very high reliability (e.g. lossless). In LTE, these services are supported by eMBMS with RLC UM only without L1 feedback and retransmission. In NR, it has already been agreed that L1 HARQ would be supported for MBS, which is a significant feature to improve the reliability and efficiency for MBS delivery. Therefore, we think it should be acceptable at least for the first release of NR MBS without L2 ARQ.  **A2**: in case people have strong view to support very high reliabilities (lossless) in this release, we can accept a simple PDCP based solution. A benefit of PDCP based solution would be that retransmissions can be delivered on PTP leg, which can improve the transmission reliability.  **A3**: implementation of A3 could be simple from the UE side, but it will introduce significant complexity to the network side, as the RLC entity(ies) at the gNB need to take care of RLC contexts of multiple UEs. The transmission window management at the gNB would be extremely complicated and not possible to be specified. Someone may argue that this can be done up to gNB implementation and doesn’t need standardization, but we still need to assume what kind of gNB implementation could be when discussing if there is any problem, which would be time consuming if there is no common understanding on a gNB implementation.  **B1**: PDCP based split is already a symbol of NR, and a lot of features are now based on this architecture, e.g. duplication, CU-DU and etc, which would make the support PTP/PTM switch easier and require much less specification efforts.  **B2**: The biggest problem in option B2 is the support of RLC UM, which is most practical configuration for MBS as mentioned above. A difference in NR compared to LTE was that for RLC UM only the segmented RLC SDUs are associated RLC SNs (as in NR the re-ordering function has been moved up to PDCP). For RLC AM, each RLC SDU is associated with a SN.  The problem for RLC UM now is that if we support PTP/PTM dynamic switch, PTP scheduling should be adapted to radio links of different UEs, and the scheduled grants would be different for UEs, and for sure will be different from the PTM scheduling. As the consequence the RLC SN allocation would become different if some UEs are scheduled based on PTP and some others are based on PTM, which will make PTM UM+PTP UM not working as SNs are not aligned.  The problem has been illustrated in the following figure of our contribution R2-2101012.  cid:image001.png@01D6F412.F7C83490  Note that it is unacceptable to apply different user plane architectures for UM and AM, e.g. B1 used for UM and B2 used for AM, at least from rapporteur’s point of view, given the heavy work load of this WI already. |
| 4 | MediaTek | One alternative way would be to discuss both issue A and issue B in one shot: L2 based reliability improvement. The reason is that PDCP based architecture may be in a better position to support PDCP anchored PTM/PTP Switch and this applies to RLC based architecture as well. Then the following options are on the table:  **C1:** **PDCP based reliability improvement (split RB alike UP arch).** In addition to L1 based reliability improvement, PDCP packets can be retransmitted via PTP leg, based on PDCP status report (exact trigger is FFS). There are independent RLC entities established for PTM leg and PTP leg and they run in different mode. There is a common PDCP SN allocation for all PDCP packets of MRB (PTM and PTP). UE combines the received packets at PDCP layer based on the unified SN allocation between PTM and PTP leg (where reordering and duplicate handling are supported).  Within C1, it is expected to support PDCP anchored PTM/PTP switch.  In case of dynamic switch between PTM and PTP, consistent PDCP SN is automatically supported. PDCP layer data retransmission may be supported during dynamic switch.  **C2: RLC based reliability improvement (RLC AM for PTM is not supported).**  In addition to L1 based reliability improvement, RLC packets can be retransmitted via PTP leg, based on RLC status report (reuse current RLC SR trigger). There are independent RLC entities established for PTM leg and PTP leg and they may run in different mode. There is a common RLC SN allocation for all RLC packets of MRB (PTM and PTP). UE combines the received packets at RLC layer based on the unified SN allocation between PTM and PTP leg (where reordering and duplicate handling are supported).  Within C2, it is expected to support RLC anchored PTM/PTP switch.  In case of dynamic switch between PTM and PTP, consistent RLC SN is automatically supported. RLC layer data retransmission may be supported during dynamic switch.  **C3: RLC based reliability improvement (RLC AM for PTM is supported).**  In addition to L1 based reliability improvement, RLC packets can be retransmitted via PTM leg (running in RLC AM mode), based on RLC status report from multiple receiving UEs. There is only a single RLC entity for MRB, which runs in AM mode. Mechanisms needs to be defined for the transmitter to handle RLC Tx window movement based on feedback from multiple receivers RLC status reports. Mechanisms needs to be defined in order to avoid the RLC entity being stalled when lack of the feedback from one or a few UEs. UE receiver keeps the similar behaviour as unicast since there is no packet combination between PTM and PTP  Within C3, it is expected to support RLC anchored PTM/PTP switch.  In case of dynamic switch between PTM and PTP, consistent RLC SN is automatically supported. RLC layer data retransmission may be supported during dynamic switch. UE needs to combines the received packets from PTM and PTP during dynamic switch.  **Our comments on C1/C2/C3:**  C1 is feasible but the PDCP SR based PDCP data retransmission basically requires the PDCP RX window movement follows the same principle as RLC ARQ window. In Addition, the triggers for PDCP SR needs to be defined and dynamic control of PDCP SR is expected comparing to legacy RRC controlled PDCP SR.  C2 may be challenging. As there may be difficult for UE to receive both RLC PTM UM leg and RLC PTP AM leg since RLC UM and RLC AM use different Rx window management (one is Pull based, another one is Push based). Then C2 requires the UE to adopt a unified Rx window (UM based or AM based) for RLC packet reception.  C3 is feasible but there is a need to specify new behaviour for the transmitter (at Base Station) to manage the RLC window management to avoid the Tx window stalling (However this aspect may be network implementation). Meanwhile, it seems UE side reception largely follows legacy operation.  In general, it would be helpful to understand the specs impact for each alternative before the decision. |
| 5 | Ericsson | A1: Strong support  A2: Support  A3: Strongly not supporting  B1: Support  B2: Not support  More information can be found in our contribution R2-2101172.  **A1:** It can be assumed that support for PTM using RLC AM would entail numerous RLC status reports from multiple UEs for which a gNB would need to maintain its RLC SN transmit window operation. Ideally, RLC retransmissions would follow for each unsuccessfully transmitted RLC PDU if to fulfil the reliability. These retransmissions should anyway end up on a PTP as performance (e.g. spectral efficiency) would otherwise suffer.  If one assumes that the most common reason for lost packets are due to radio conditions specific and limited to a few particular UEs when receiving the PTM beam scheduled by G-RNTI, one can assume that a switch to a UE specific PTP beam using C-RNTI would be beneficial. Doing so, retransmitted packets are only needed for those UEs. I.e. re-transmission can be sent through unicast (PTP) RLC AM leg only. Ideally, this leads to maintained spectrum efficiency for the MBS service while increasing the reliability.  **A2:** PDCP functionality such as PDCP status reporting can be used to increase reliability. By receiving PDCP status PDU(s) from UEs, the gNB transmitting PDCP entity can detect when one or several PDCP PDUs is missing at the receiver side and initiate a retransmission of those. Currently, this mechanism is limited to HO and would need to be extended if to be used for MRBs.  If the MRB configuration for UEs combines the PTM RLC UM bearer with a PTP RLC AM bearer, it seems reasonable to equivale dynamic switches from PTM to PTP with bearer type change etc., in current functionality. As a result, it may be useful for the gNB to be able to retransmit PDCP PDU(s) after a PTM to PTP switch, where RLC AM can then be used for the PTP RLC AM bearer. By this sufficient reliability for the Multicast service can be met and the use of PDCP ARQ is made redundant for this use case. However, the need for PDCP ARQ is still there when performing handovers, like in legacy unicast. We think is it straight forward to support PDCP ARQ for the legacy use cases also for MRBs.  For dynamic switch, i.e. when a multicast service is transmitted to the UE using a unicast PTP stream with RLC AM, then there may be benefit in retransmitting PDCP PDUs already sent through PTM. This depends on what premises the switch decision is based upon, and if triggered before the detection of loss of data (e.g. HARQ failure).  **A3:** As mentioned, it can be assumed that support for PTM using RLC AM would entail numerous RLC status reports from multiple UEs for which a gNB would need to maintain its RLC SN transmit window operation. Ideally, RLC retransmissions would follow for each unsuccessfully transmitted RLC PDU if to fulfil the reliability.  Related to A2, we think that in case of packet losses on PTM despite of HARQ, PDCP status reports can provide the gNB with sufficient information to be able to retransmit a PDCP PDU as part of the PTM to PTP switch, after where RLC AM can be used for the PTP RLC bearer.  **B1:** A PDCP anchored switch fits well with the split-bearer design and is also already supported for mobility. This will alleviate RAN2 of extra design work.  **B2:** We want the RLC mode to be different in the two legs (PTP and PTM). We don’t understand how to achieve this with an RLC anchored design with reasonable complexity. |
| 6 | Futurewei | **A1:** With the same considerations to have two types of DRB (RLC-AM bearer and RLC-UM bearer), there should be two types of MRB, with and without L2 retransmission. If a bearer type with L2 retransmission is configured for MRB, then retransmission should be performed when transmission failure of PDCP/RLC PDU is detected.  A clarification question on **Chairman’s comment** – “switching from PTM to PTP if the link gets bad and vice versa. PTP could be configured different to PTM, e.g. with RLC-AM” – “switching from PTM to PTP” refers to dynamic switch from PTM leg to PTP leg of a (split bearer like) MRB, right? If PTP is a separate DRB, it is about bearer type change and should be done through RRC reconfiguration. But if UE is already configured with PTM leg, and actively monitoring and receiving data from PTM leg, it would - more often than not - receive transmissions over PTM, wouldn’t it be beneficial to take advantage of those transmissions? After all, the benefit of L2 retransmission – compared to PDCP duplication or blind bundling/repetition - comes from the opportunistic success of the initial transmission.  Hence, if a MRB is of the type requiring L2 retransmission, it doesn’t seem sensible to assume that no transmission over PTM can be received by a UE, or L2 retransmission can’t be done for those transmissions of PDCP/RLC PDU over PTM leg.  **A2:** As analysed in R2-2100354, significant specification change would be needed to PDCP operation for PDCP status report triggering and management of receiving window. These changes basically replicate RLC functionalities at PDCP sublayer, with inferior performance due to additional delay over front-haul between DU and CU and always retransmitting the whole PDCP PDU (vs. only the lost segment in RLC). Furthermore, a new type of PDCP (MRB PDCP) also makes bearer type configuration and mobility complicated –   * An MRB of MRB PDCP+PTM UM+PTP AM means there’d be two loops of L2 retransmission at RLC sublayer and PDCP sublayer, and it is no clear how timers and state variables at PDCP and RLC sublayers can be configured and managed to avoid the intertwining of PDCP retransmission and RLC retransmission – (n+1)th retransmission of a PDCP PDU starts when RLC still performs retransmission on the n-th transmission of a PDCP PDU. * An MRB of MRB PDCP+PTM UM+PTP UM means there’d be two types of PTP operation for reliable transmission – MRB PDCP+RLC UM vs. (normal) PDCP+RLC AM. * An MRB of MRB PDCP (either with PTP AM or PTP UM) means the progress on mobility from RAN2#112e needs to be revisited, as RLC-AM bearer was assumed “at least PTP-PTP”, whose protocol structure is (normal) PDCP+RLC AM.   **A3:** when an MRB requiring L2 retransmission is configured, retransmission can be done over PTP leg for a transmission previously done over PTM leg at RLC sublayer. PTM differs from PTP mainly at transmitter side in terms of scheduling (transmission timing and resource). There shouldn’t be significant difference in L2 operation at UE side, as reception operation doesn’t depend on if and how other UE receives the same packet. In fact, it helps keep specs impact minimal if it is transparent to RLC/PDCP entity whether a packet is received through G-RNTI or C-RNT, as long as a common SN is used. Unlike RLC AM in DRB, RLC transmitter is always at network for MRB. Hence there’d be no extra specs works for transmitter of MRB RLC AM entity. There is additional requirement on network implementation for PTM scheduling, which stems from the fact that one transmission needs to target at multiple UEs. The functional requirement doesn’t change if it is implemented at RLC or PDCP sublayer. That is, if retransmission is done at PDCP layer, then PDCP sublayer also needs to define a transmission window, and to move the transmission window based on the status report of all UE receiving from PTM. As scheduling is at DU (where MAC and RLC sublayers reside), handling transmission window at PDCP sublayer, which reside at CU, further incur front haul delay between CU and DU in transmission window and scheduling operation.  Comparing A2 and A3 in terms of specs impact (and UE implementation), system performance, and network implementation, there doesn’t seem to be any benefit of performing L2 retransmission at PDCP sublalyer, i.e., A2 is inferior to A3.  **B1:** PDCP anchor for PDCP PDU transmission - no **re**transmission based on PDCP status report, duplication or blind retransmission is at network discretion - which is consistent with DC and CA operation.  **B2:** RLC anchor for RLC PDU retransmission based on RLC status report, if L2 retransmission is configured, which is consistent with RLC-AM bearer. At UE side, single RLC AM receiving entity is configured for both PTM and PTP legs. At network side, separate RLC entities for PTM and PTP, as PTM and PTP transmissions may require different segmentation (e.g., common beam vs. dedicated beam).  B1 if L2 retransmission is not required, and B1+B2 if L2 retransmission is required, which is the same as DC. The fact that PTM RLC entity and PTP RLC entity are collocated at a DU in MBS enables dynamic switch between PTM/PTP RLC entities at network and single receiving RLC entity at UE to simplify UE implementation. |
| 7 |  |  |
| 8 |  |  |
| 9 |  |  |
| 10 |  |  |
| 11 |  |  |
| 12 |  |  |
| 13 |  |  |
| 14 |  |  |
| 15 |  |  |
| 16 |  |  |
| 17 |  |  |
| 18 |  |  |
| 19 |  |  |
| 20 |  |  |
| 21 |  |  |
| 22 |  |  |
| 23 |  |  |
| 24 |  |  |
| 25 |  |  |
| 26 |  |  |
| 27 |  |  |
| 28 |  |  |
| 29 |  |  |
| 30 |  |  |
| 31 |  |  |
| 32 |  |  |
| 33 |  |  |
| 34 |  |  |
| 35 |  |  |
| 36 |  |  |
| 37 |  |  |
| 38 |  |  |
| 39 |  |  |
| 40 |  |  |
| 41 |  |  |
| 42 |  |  |
| 43 |  |  |
| 44 |  |  |
| 45 |  |  |
| 46 |  |  |
| 47 |  |  |
| 48 |  |  |
| 49 |  |  |
| 50 |  |  |
| 51 |  |  |
| 52 |  |  |
| 53 |  |  |
| 54 |  |  |
| 55 |  |  |
| 56 |  |  |
| 57 |  |  |
| 58 |  |  |
| 59 |  |  |
| 60 |  |  |