**3GPP TSG-RAN WG2 Meeting #115 electronic R2-21xxxxx**

**Online, Aug. 16th – Aug. 27th, 2021**

**Agenda Item: 8.1.2.3**

**Source: OPPO**

**Title: [Post114-e][072][MBS] Delivery Mode 1 PTM PTP operation (OPPO)**

**Document for: Discussion and decision**

# Introduction

This paper is to trigger the following email discussion for delivery mode 1 MBS after RAN2#114e meeting.

* [Post114-e][072][MBS] Delivery Mode 1 PTM PTP operation (OPPO)

Scope: Including: The need of PTM deactivation/activation at the UE, PTM PDCP/RLC initialization, packet loss at PTM PTP switch

Intended outcome: Report.

Deadline: Long

The topic will focus on delivery mode 1 PTM PTP operation based on anchor PDCP architecture (i.e. separate PDCP for PTM and PTP is not considered in this email discussion) with following topics. The PTP/PTM switching only focus on intra-cell PTP/PTM switching, i.e. inter-cell PTP/PTM switching due to mobility is not considered in this email discussion.

* PTP/PTM switching due to RRC configuration
* Dynamic PTP/PTM switching and packet loss
* MRB PDCP/RLC initialization due to MRB setup or PTM/PTP switching

**Figure 1: Split Bearer Like Architecture for PTP/PTM Dynamic Switch**

The deadline of the email discussion phase 1 is: 20th July, 2021.

**Contact Information**

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| Company | Email |
| MediaTek | Xuelong.wang@mediatek.com |
| Samsung | sangkyu.baek@samsung.com |
| Nokia | benoist.sebire@nokia.com |
| Ericsson | henrik.enbuske@ericsson.com |
| OPPO | wangshukun@oppo.com |
| CATT | zhourui@catt.cn |
| Kyocera | masato.fujishiro.fj@kyocera.jp |
| ZTE | qi.tao3@zte.com.cn |
| NEC | Chen\_zhe@nec.cn |

# Discussion

## ***Issue 1: PTP/PTM switching due to RRC configuration***

In RAN2#113 meeting, RAN2 agreed that MRB may include both PTP and PTM. In RAN2#113bis meeting, RAN2 agreed that split-MRB is configured with PTM leg and PTP leg.

* Confirm P1 P2 P3 (assume that MRB may include both PTP and PTM)
* Assuming a split-MRB (as agreed during the online session) configured with a PTM leg and PTP leg, the usage of the PTP leg cannot be deactivated (i.e. the UE needs to always monitor C-RNTI) after the necessary split-MRB configuration.
* Assuming a split-MRB (as agreed during the online session) configured with a PTM leg and PTP leg, it is FFS whether the usage of the PTM leg of the split-MRB may be subject to activation or deactivation and the details of such.

According to the current agreements, the common understanding is that one MRB can be configured with PTM only or PTP only or both PTM and PTP. The RRC signaling, i.e. RRCReconfiguration message, can be used to reconfigure the MRB from one type to other type, e.g, from PTM only to split.

**Rapporteur understanding:** One MRB can be configured with PTM only or PTP only or both PTM and PTP. The bearer type can be changed from one to other via RRC signaling, e.g. reconfigure the bearer type from PTM only or PTP only to split.

**Q1a: Do companies agree the rapporteur’s understanding about the MRB configuration?**

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| Company | Agree?  (Yes or No) | Comments |
| MediaTek | No | There may be a confusion on the MRB configuration. Specific to MRB, the switch between PTM and PTP may be performed via dynamic switch as discussed at Issue 2. It is unclear why we need both RRC based switch and dynamic switch.  In addition, there may be a possibility to configure the reception of the MBS session via DRB. Then the RRC based switch may be needed to switch the DRB to MRB or vice versa.  For dynamic switch based on the split MRB model, the RRC based configuration should be also supported to different cases as discussed in this section. |
| Samsung | Yes, but | PDCP status report can be transmitted via uplink logical channel. For PTM only MRB, uplink logical channel does not exist. It’s not possible to transmit the status report.  [OPPO] yes, thanks for your comments. 😊 |
| Nokia | Yes and No | Yes, we agree that RRC signalling can be used to switch from one configuration to another (as always).  No, we disagree with how the cases are depicted: 1) PDCP status reports are another issue (reliability) and should not be mixed up in this discussion; 2) all cases involve MRB; 3) not sure why PTM deactivation is listed for Case 3.  [OPPO] thanks for your comments, I revised this part and we call it “bearer type change”. 😊 |
| Ericsson | Yes and No | RRC reconfiguration of a bearer is always supported. The cases here are mixing bearer change with bearer handling with deactivation and PDCP receiver status. We prefer not to call this “switching” as such. To us the switch is still a scheduling decision as a base line.  [OPPO] thanks for your comments, I revised this part and we call it “bearer type change”. 😊 |
| OPPO | Yes | 1. For MRB configuration, RRC signalling can always configuration or reconfiguration the MRB with PTM only or PTP only or both. |
| CATT | Yes | (2)For “One MRB can be configured with PTM only or PTP only or both PTM and PTP.”, it is well aligned with the endorsed 38.300 running CR,caluse 16.x.3.   |  | | --- | | * For multicast session, gNB provides the following one or more MRB configuration(s) to the UE: * MRB with one RLC-UM or RLC-AM entity for PTP transmission; * MRB with one RLC-UM entity for PTM transmission; * MRB with two RLC-UM entities, one RLC-UM entity for PTP transmission and the other RLC-UM entity for PTM transmission as described in section 16.x.5.4; * MRB with two RLC-UM entities, one RLC-AM entity for PTP transmission and the other RLC-UM entity for PTM transmission as described in section 16.x.5.4; |   (2)Agree with that the bearer type can be changed from one to other via RRC signaling. |
| Kyocera | Yes | We agree with Samsung and the rapporteur’s change that after the switching to PTM-only the UE cannot send PDCP Status Report.  We agree with Ericsson and the rapporteur’s change that RRC reconfiguration is not for “switching” but rather for “bearer type change”. |
| ZTE | Yes | We agree with the latest version from rapporteur:  - One MRB can be configured with PTM only or PTP only or both PTM and PTP. The bearer type can be changed from one to other via RRC signaling, e.g. reconfigure the bearer type from PTM only or PTP only to split.  (Although one should be aware that “split bearer” and “bearer type change” are not 100% aligned with the original definition in the specs in 38300/37340)  (We think it is fine to call such RRC reconfig based switch as one of the switch mechanism as what we were aiming at since the WID. The WID tended to have a solution of “switching” in AS layer compared that in service layer in legacy system. To differentiate that from split MRB based dynamic switching, maybe we can call that RRC based switching instead of bearer type change which has already got its own scenario and specific/precise definition) |
| NEC | Yes | Agree the MRB may have two legs, PTP/PTM only or both. And RRC can be used to switch/reconfigure/addition of legs. |
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During bearer type change, there may be data loss in the following cases:

Case 1: Reconfiguration between PTP only and PTM only;

Case 2: Reconfiguration from split MRB to PTM only or PTP only;

Case 3: Reconfiguration from PTM only to split MRB with PTM deactivation if RAN2 agree the PTM deactivation state can be configured in RRC signaling;

The PDCP status report from UE side is useful to reduce the data loss. So the PDCP can be indicated to perform reestablishment via RRC signaling, and PDCP status report will be triggered. However, it is not clear what kind of RLC will be configured for PTM RLC and PTP RLC, i.e. DL only RLC or both DL RLC and UL RLC. If DL only RLC is configured for PTP or PTM, it is impossible to transfer PDCP status report to the network for the UE even if the PDCP reestablishment is triggered.

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| RLC-Config ::= CHOICE {  am SEQUENCE {  ul-AM-RLC UL-AM-RLC,  dl-AM-RLC DL-AM-RLC  },  um-Bi-Directional SEQUENCE {  ul-UM-RLC UL-UM-RLC,  dl-UM-RLC DL-UM-RLC  },  um-Uni-Directional-UL SEQUENCE {  ul-UM-RLC UL-UM-RLC  },  um-Uni-Directional-DL SEQUENCE {  dl-UM-RLC DL-UM-RLC  },  ...  } |

**Q1b: What is the opinion on the RLC configuration for PTP RLC and PTM RLC, i.e. DL only or both?**

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| Company | PTP UM RLC🡺DL only or both?  PTP AM RLC🡺DL only or both?  PTM UM-RLC🡺DL only or both? | Comments |
| OPPO | PTP UM RLC🡺DL only  PTP AM RLC🡺both DL and UL  PTM UM-RLC🡺 DL only | We have no strong view on the UM RLC. I am fine if majority companies think the PDCP status report should be supported and it results in both DL RLC and UL RLC are configured. |
| CATT |  | Our opinions are below:  1. It seems reconfiguration from PTP only to split MRB is missed here. suggest to consider the case 4 below,  Case 4: Reconfiguration from PTP only to split MRB.  2. We think PDCP status report could be triggered to reduce data loss. But PDCP reestablishment is not mandatory in all cases.  3. For RLC mode, we propose:  - RAN2 should support: DL only RLC UM for PTM, and RLC AM for PTP;  - FFS if support 1 DL RLC UM+1 UL RLC UM for PTP. |
| Kyocera | PTP UM RLC 🡪 DL only or both  PTP AM RLC 🡪 both DL and UL  PTM UM RLC 🡪 DL only | We think RLC-AM should be configured with bi-directional, while we assume it’s NW implementation how to configure RLC-UM for PTP. We think it’s straightforward that PTM is only configured with uni-directional DL. |
| ZTE | PTP RLC (AM):  - both DL and UL (for sure)  PTP RLC (UM):  - DL only (when UM is good enough)  - both (feedback beneficial even for UM where minimization of loss is needed)  PTM RLC (UM)  - DL only. | Agree with Kyocera.  We shall allow enough flexibility from network to configure the MRB for different services. |
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| NEC | PTP UM RLC🡺DL only  PTP AM RLC🡺both DL and UL  PTM UM-RLC🡺 DL only | 1: Agree to add case 4 of reconfiguration from PTP only to split MRB  2: PDCP status report can’t be re-established very often other than the case of handover, otherwise the signalling overhead, UE processing delay are unaccepted.  3: RAN2 is suggested to introduce PTP RLC AM leg only re-transmits the RLC PDU that PTM RLC UM leg have not received. |
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**Q1c: If both DL and UL RLC entity are configured for PTM or PTP, do companies agree the PDCP entity re-establishment requested by upper layer is used to trigger PDCP status report for data loss reduction purpose?**

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| Company | Agree?  (Yes or No) | Comments |
| OPPO | Yes | We have no strong view on it. I am fine if majority companies think the PDCP status report should be supported and it results in both DL RLC and UL RLC are configured. |
| CATT | No | We should discuss the trigger of PDCP status report case by case, for example, PDCP reestablishment is not needed for the cases that reconfiguration from PTM only to split MRB, and vice versa. For the cases that reconfiguration between PTP and PTM/split MRB, we need to wait for security mechanism from SA3. |
| Kyocera | Yes, but | We think Rel-15 behaviour is to trigger a PDCP Status Report for “AM DRB” when the upper layer requests either the PDCP entity reestablishment or the PDCP data recovery, which should be applicable as the baseline for MBS.  We’re not sure why “UM DRB” in MBS can trigger a PDCP Status Report as similar with Rel-16 uplink data switching, but we’re open if companies think it’s necessary. |
| ZTE | Yes | Depending on network decision and available configurations (based on result of Q1b). Again, we shall allow enough flexibility from network to configure the MRB. |
| NEC | No | As our answer in Q1b, PDCP re-establishment other than handover doesn’t make any sense. |
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## ***Issue 2: Dynamic PTP/PTM switching and packet loss***

In RAN2#113bis meeting, dynamic PTM/PTP switch is supported for a split MRB bearer (type) with a common (single) PDCP entity. So only both PTM and PTM leg are configured, the dynamic PTM/PTP switch can be supported. The PTP leg cannot be deactivated and FFS for PTM leg.

* Dynamic PTM/PTP switch is supported for a split MRB bearer (type) with a common (single) PDCP entity.
* Assuming a split-MRB (as agreed during the online session) configured with a PTM leg and PTP leg, the usage of the PTP leg cannot be deactivated (i.e. the UE needs to always monitor C-RNTI) after the necessary split-MRB configuration.
* Assuming a split-MRB (as agreed during the online session) configured with a PTM leg and PTP leg, it is FFS whether the usage of the PTM leg of the split-MRB may be subject to activation or deactivation and the details of such.

Some companies wonder whether the dynamic PTM/PTP switching is transparent or not to UE. If so, the UE will monitor both G-RNTI and C-RNTI for MBS reception. Some companies think if PTP leg is used for the UE’s MBS transmission, the UE should stop monitoring G-RNTI for UE power saving purpose. Some proponents also propose to use MAC CE or DCI to indicate the PTM leg deactivation or activation.

On the other hand, if dynamic PTM/PTP switching is transparent to UE, the PTM RLC window may discard some valid MBS data by mistake as pointed out by some companies. If gNB uses PTP leg to transmit MBS data and there is no PTM deactivation command to UE, the UE will continue to receive the MBS data from PTM leg. Due to the bad channel condition, the PTM RLC may not receive data from MAC layer for a long time and the RLC state variables will not change. After that there may be a valid packet received, but the newly received packet may be discarded, e.g if the SN of the newly received packet meets (RX\_Next\_Highest – UM\_Window\_Size) <= SN < RX\_Next\_Reassembly although this is not an out-of-date packet. In this case the RLC reception window of the PTM leg will not be updated.

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| 5.2.2.2.2 Actions when an UMD PDU is received from lower layer When an UMD PDU is received from lower layer, the receiving UM RLC entity shall:  - if the UMD PDU header does not contain an SN:  - remove the RLC header and deliver the RLC SDU to upper layer.  - else if (RX\_Next\_Highest – UM\_Window\_Size) <= SN < RX\_Next\_Reassembly:  - discard the received UMD PDU.  - else:  - place the received UMD PDU in the reception buffer. |





**Q2: Do companies agree to support PTM leg deactivation when switching to PTP? And which signaling is used?**

**Option 1: Do not support PTM deactivation and dynamic PTM/PTP switching is transparent to UE. If option 1 is chosen, please clarify how to address the RLC window un-synchronization issue as clarified above.**

**Option 2: Support PTM deactivation based on MAC CE.**

**Option 3: Support PTM deactivation based on DCI.**

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| Company | Agree?  (option 1,2,3) | Comments |
| MediaTek | Op-2 | We think the PTM deactivation and dynamic PTM/PTP switching should be notified to the UE. MAC CE is preferred as we foresee the information would be not affordable by DCI. |
| Samsung | Option 1 | From the operation perspective, RRC-based MRB type change to PTP only (or legacy DRB) is equivalent to deactivation of PTM RLC. We do not need to have duplication function.  Regarding RLC window un-synchronization would occur only if UE is not able to receive RLC UM data on PTM leg. In this case, the configuration of PTM RLC is no longer needed, so release of the PTM RLC by RRC signalling can be simply used.  Also, dynamic deactivation requires RRC-based switching even if we have another fast mechanism (i.e. MAC CE or DCI). |
| Nokia | Option 1 | If the PTM performance is so bad that no packets are received for a full receive window, surely PTM should be removed by RRC. Thus, this is not a valid issue to worry about.  On the possible gains, how much the UE will benefit depends on PDCCH configuration (CORESET/SS) where DCI scrambled with G-RNTI scheduling PDSCH for a group can be transmitted. This should be assessed in RAN1 but not in isolation from existing mechanisms to control PDCCH monitoring (DRX, SPS, CA activation…). Until then, no new mechanism should be introduced to limit complexity and avoid specifying something that will never be implemented. |
| Ericsson | Option 1 | We think the dynamic switch is a scheduling decision and think that optimising the segmentation case for PTM is not bringing any useful benefit but rather complexity instead. If the reliability for PTM cannot be met, PTP should be used and as we already (before switching) have packet losses, the switch/deactivation itself does not need optimization. |
| Shanghai Jiao Tong University | Option 2 | We think PTM leg deactivation should be supported to avoid the RLC window un-synchronization issue. And L2 signalling (e.g., MAC CE) can be used.  Release of the PTM RLC by RRC signalling will introduce transmission latency when the UE needs to be switched back to PTM. |
| NERCDTV | Option 2 | We think PTM deactivation should be supported to avoid the RLC window un-synchronization issue. And release of the PTM RLC by RRC signalling is not suitable if the UE was switched to PTP temporarily due to temporary bad channel condition.  And MAC CE is preferred for PTM deactivation |
| OPPO | Option 2 | Even if there is no data lossless requirement, we think it is better to have the solution for low data loss. So RLC window un-synchronization issue should be addressed. Furtermore, the UE power consumption should also be considered especially in NR network. |
| CATT | Option 2 or 3 | We think PTM deactivation indication is necessary. For split MRB bearer, the transmission on PTM leg may be deactivated by gNB temporally. We have no strong preference for option 2 or option 3. Option 3 should be decided by RAN1. |
| Kyocera | Option 2 | We prefer to have the deactivation of PTM-leg via MAC CE. |
| ZTE | Option 2 | 1. Explicit signaling is needed.   - UE power consumption is our main concern. For a group of UE with each can have its own unicast services of different traffic characteristics, it will be hard or impossible to have the PTM transmission DRX aligned with per UE DRX.  - And for each UE to monitor a separate DRX of PTM transmission inevitably increase the power consumption.  - Note: efforts in attempting to de-scramble a G-RNTI is low only when UE wakes up for both C-RNTI and G-RNTI. The reality however is DRX of each transmission (among per UE C-RNTI and per group G-RNTI) wont be perfectly overlapped.   1. No strong view, but MAC CE is of greater flexibility. |
| NEC | Option 1 | We think even the PTP leg is configured in addition to the PTM leg, the PTM transmission is still ongoing, so it is still unnecessary to mandate the network to deactivate the PTM leg.  Given the PTP leg and PTM leg have separate RLC entities, the receiving windows of two RLC entities un-synchronization won’t bring any problem. |
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If option 2 or 3 is chosen, and if PTM activation command is not received by the UE, the UE will not start G-RNTI monitoring. However, the gNB will stop PTP leg transmission if gNB activates the PTM leg for the UE. So the UE will not be able to receive MBS data anymore.

If PTM deactivation command is not received by the UE, the UE will keep monitoring G-RNTI. The gNB will start PTP leg transmission after it deactivates the PTM leg. The UE has no problem to receive the MBS data but will waste more power. So the next question is whether the PTM deactivation/activation command needs feedback or confirmation from UE side?

**Q3: Do companies agree the PTM deactivation/activation command need feedback or confirmation from UE side and how?**

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| Company | Agree?  (Yes/No) | Comments |
| MediaTek | No | The feedback may cause unnecessary uplink signalling storm from the involved UEs. |
| Samsung | No for Option 2, Yes for Option 3 | For Option 2 (MAC CE), HARQ ACK can be used as FB. No other feedback is needed.  For Option 3 (DCI), HARQ ACK may be needed. |
| Nokia | - | The problems and corresponding mechanisms to solve them are specific to dynamic activation/deactivation. This demonstrates that dynamic activation/deactivation increases complexity. Yet the gains are yet to be shown. |
| Ericsson | No | We agree with Nokia. Also, the UE anyway monitors for its C-RNTI and the effort in attempting to descramble a G-RNTI is very low. If anything is transmitted in UL (UL-SCH) like MAC CE, there is already reliability mechanisms in place. |
| Shanghai Jiao Tong University | No | HARQ ACK can be used for MAC CE. No new feedback is needed. |
| NERCDTV | No | HARQ ACK can be used for MAC CE. No new feedback is needed. |
| OPPO | No | No strong opinion, it is up to network to ensure PTM A/D command is received by UE. |
| CATT | - | Agree with Samsung. No for option 2. For option 3 (DCI for PTM deactivation), it should be decided by RAN1 on whether the feedback is needed. |
| Kyocera | No | We think the feedback is not needed as same with the existing SCell Activation/Deactivation MAC CE for CA, in case of Option 2 (with MAC CE). |
| ZTE | No | Also, what if it is fine to miss such command?  Network will have to be aware of the reception quality anyway, especially for PTM transmission. |
| NEC | No | HARQ ACK can be used for MAC CE. No new feedback is needed. |
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If the UE switches to PTP and stop PTM monitoring immediately upon receiving PTP/PTM switch command, the data loss may occur because of the packets in the air of the PTM leg.

To ensure reliability, some companies propose to receive MBS data via PTM and PTP simultaneously for a period of time during PTP/PTM switching. Meanwhile, some other companies propose to retransmit these packets via the new leg (i.e. PTP leg). Same as the handover case, PDCP status report can be used to indicate the retransmission during PTP/PTM switching.

The common understanding is that PTP is never deactivated and PTM may be deactivated. The data loss may happen only when the PTM leg is deactivated.

To reduce the data loss, there are 3 options to address the issue.

**Option 1:** PDCP status report is triggered from UE side in case of PTM-to-PTP switch **with PTM deactivation**.

**Option 2.1**: Up to gNB implementation to ensure the PTM data delivery completed between PTP/PTM switching and PTP/PTM switching command delivery.

**Option 2.2**: The UE starts a timer after PTP/PTM switching command reception, and the UE deactivate PTM leg after the timer expires.





For option 2.1, it is simple and UE will execute the command immediately when received. The UE does not need to distinguish whether the command is for PTM activation or deactivation to decide whether to start the timer or not.

**Q4: Which option do companies prefer to address the data loss issue due to PTM-to-PTP switch with PTM deactivation?**

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| Company | Agree?  (option 1,2.1,2.2) | Comments |
| MediaTek | Op-1 | We think UE PDCP status report should be anyway needed during dynamic switch. This is also connected to our answer to Quesiton-9. |
| Samsung | Option 2.1 but | Option 1 is almost same as MRB type change from split to PTP only. So, we do not need any duplicate function.  Option 2-1 is the simplest but it can be discussed after we agree any dynamic deactivation. |
| Nokia | - | If PTM itself cannot be lossless (RLC UM), it does not make sense to try to make the switch lossless. What we should aim at is to minimise the losses. |
| Ericsson | - | Agree w Nokia. As we already (before switching) have packet losses, the switch/deactivation itself does not need optimization.  We do not think any switch command is needed as the switch is transparent to the UE. This is simplest in all regards. |
| OPPO | Option 1 and option 2.1 | To reduce data loss, it is more efficient to use both option 1 and option 2.1 together to reduce the data loss for MBS. |
| CATT | Option 1 | For the multicast with high Qos requirement, PTM/PTP switching is used to avoid data loss. In this case, data loss should also be minimized during PTM/PTP switching. We see benefit to retransmit missing data in PTP leg according to PDCP status report. |
| Kyocera | Option 1 | We understand this email discussion does not discuss the mobility case, but RAN2 agreed “*R2 aim to support lossless handover for MBS-MBS mobility for service that requires this (TBD which detailed scenario but at least PTP-PTP)*”. So, we think the lossless handover for the UE with Split MRB deactivating PTM-leg is the case. In this sense, we think the lossless switching from PTM-leg to PTP-leg should be supported for the preparation of lossless handover, and PDCP Status Report (i.e., Option 1) is straightforward for this purpose. |
| ZTE | Option 1 and option 2.1 | Always good to allow network to minimize the loss, and whether PDCP Status report is enabled shall be of network decision.  Note: enabling PDCP Status report does not mean no packet loss at all. |
| NEC |  | Agree with Nokia/Ericsson, the simple switch between PTM to PTP doesn’t need any optimization. |
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## ***Issue 3: MRB PDCP/RLC initialization due to MRB setup or PTM/PTP switching***

In NR MBS, PDCP entity is common for PTM and PTP and PTM leg is used for multiple UEs. It means for the UE later joins in the multicast session, the initial values for each state variables cannot always be “0” as legacy unicast, regardless of whether the first received MBS data comes from PTM-leg or PTP-leg. For the same reason, the PTM RLC is also for multiple UEs and RLC state variables cannot always be “0” too.

**PDCP reception**

For PDCP entity, only when MRB is setup, the PDCP state variables need to be set.

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| The receiving PDCP entity shall maintain the following state variables:  a) RX\_NEXT  This state variable indicates the COUNT value of the next PDCP SDU expected to be received. The initial value is 0, except for sidelink broadcast and groupcast, and for SRBs configured with state variables continuation. For NR sidelink communication for broadcast and groupcast, the initial value of the SN part of RX\_NEXT is (x +1) modulo (2[*sl-PDCP-SN-Size*]), where x is the SN of the first received PDCP Data PDU. For target SRB configured with state variables continuation, the initial value is the value stored in PDCP entity for the corresponding source SRB. For source SRB configured with state variables continuation, the initial value is the value stored in PDCP entity for the corresponding target SRB.  NOTE: It is up to UE implementation to select HFN for RX\_NEXT as such that initial value of RX\_DELIV should be a positive value.  b) RX\_DELIV  This state variable indicates the COUNT value of the first PDCP SDU not delivered to the upper layers, but still waited for. The initial value is 0, except for sidelink broadcast and groupcast, and for SRBs configured with state variables continuation. For NR sidelink communication for broadcast and groupcast, the initial value of the SN part of RX\_DELIV is (x – 0.5 × 2[*sl-PDCP-SN-Size*–1]) modulo (2[*sl-PDCP-SN-Size*]), where x is the SN of the first received PDCP Data PDU. For target SRB configured with state variables continuation, the initial value is the value stored in PDCP entity for the corresponding source SRB. For source SRB configured with state variables continuation, the initial value is the value stored in PDCP entity for the corresponding target SRB.  c) RX\_REORD  This state variable indicates the COUNT value following the COUNT value associated with the PDCP Data PDU which triggered *t-Reordering*. For target SRB configured with state variables continuation, the initial value is the value stored in PDCP entity for the corresponding source SRB. For source SRB configured with state variables continuation, the initial value is the value stored in PDCP entity for the corresponding target SRB. |

Only RX\_NEXT and RX\_DELIV need to be set with values when MRB is setup. In [2][3], there are 3 options provided for setting the PDCP state variables.

**Option 1: The COUNT values of these variables are indicated by the gNB [2]**

For this option, the gNB has to explicitly send the COUNT values of RX\_NEXT and RX\_DELIV to the UE when the network configures the MRB, and the UE can establish the PDCP entity of the MRB with the indicated COUNT values. In this option, there does not seem to be a need to indicate different values for RX\_NEXT and RX\_DELIV, i.e. a single COUNT value can be applied to both variables initially.

**Option 2: The SN parts of COUNT values of these variables are set according to the SN of the first received packet and the HFN by UE implementation (similar to sidelink) [2]**

This option works similarly to sidelink broadcast and groupcast, where no explicit signalling is needed. The UE sets the SN part of RX\_NEXT to the SN of the first received packet and sets the SN part of RX\_DELIV to (the SN of the first received packet - 0.5 × 2[*sl-PDCP-SN-Size*–1]), and the HFN part is left to UE implementation. This option is simple but may lead to HFN desynchronization between the UE and the gNB. For sidelink, as HFN is not used (no AS security for sidelink), the HFN desynchronization is not an issue at all. But if security for MBS is agreed by SA3 to be performed at RAN, this option cannot work, as the full COUNT value should be the input of security protection and needs to be aligned between UE and gNB.

**Option 3: The SN part of COUNT values of these variables are set according to the SN of the first received packet and the HFN indicated by the gNB [2]**

This option can be seen as the combination of option 1 and option 2.

**Q5: Which options do companies prefer to initialize the PDCP state variables, i.e. RX\_NEXT and RX\_DELIV?**

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| --- | --- | --- |
| Company | Agree?  (option 1/2/3) | Comments |
| MediaTek | Op-2 |  |
| Samsung | Option 1 | We think Option 2 does not work when PDCP security is used. SA3 TR 33.850 already captured this and SA3 is still discussing. We shall not exclude PDCP security at this time.  Also, Option 2 has an inherit problem, i.e. “RX\_DELIV = RX\_NEXT – 0.5\*Window” always trigger T-reordering at the beginning of reception. But most of packets with COUNT between RX\_DELIV and RX\_NEXT will not be received. Depending on size of T-reordering, there will be hundreds of millisecond of delay. In V2X, it cannot be avoided at all because there was no RRC signalling whereas MBS has an RRC signalling for MBS configuration. Thus, we can simply use this RRC signalling to avoid unnecessary reordering delay by configuring appropriate PDCP state variables. |
| Nokia | 1 or 3 | No strong preference between 1 & 3 as long as COUNT is synchronised.  Option 2 is not preferred due to its inherent limitations. |
| Ericsson | 1 or 3 | With a preference to Opt 1. Option 2 we agree w Samsung and Nokia. |
| OPPO | Option 3 | For option 1, we think it is hard for network to make sure the first received data’s SN is network configured SN.  For option 2, we think it is hard or complex for UE to achieve HFN. For security concern, we think it is better to configure the HFN by network for UE.  For option 3, it is easy to achieve for both network and UE. |
| CATT | Option 1 or 3 | No strong preference for option 1 or 3 since they can reach same purpose. |
| Kyocera | Option 1 or 3 | We prefer Option 3, while we’re fine with Option 1. For Option 3, we assume the signalling of HFN is a bit timing-tolerant, compared to one for COUNT (i.e., Option 1) which may need to synchronize tightly with the current PTM transmission.  For Option 2, we see the issue pointed out by Samsung and other companies. |
| ZTE | Option 2 | Option 2 as WA/baseline, we can always come back if option 2 does not work (e.g., in case of AS layer ciphering is needed therefore HFN sync between network and UE is needed) |
| NEC | Option 3 | Compared to option 1, SN doesn’t have to be sent by dedicated signalling. |
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Due to out-of-order delivery from RLC to PDCP, after the UE’s PDCP received “the first packet”, the packets with SNs sent before “the first packet” will be discarded by the UE even if they have been correctly received, which may cause some data loss at MRB setup.

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

RAN2 may need to discuss whether this is an issue to be addressed. If yes, the RX\_DELIV can be set to a value smaller than the SN of the first received packet containing an SN to allow earlier packets to be received.

**Q6: Do companies agree to address the data loss issue when setting PDCP state variables to the SN of the first received packet for MRB configuration, if yes, how?**

|  |  |  |
| --- | --- | --- |
| Company | Agree?  (Yes/No) | Comments |
| MediaTek | Yes | The restriction of “if RCVD\_COUNT < RX\_DELIV” at PDCP layer can be removed for the reception of the packets for MRB. |
| Samsung | Yes but | Conclusion of Q5 (if at least one option is adopted) automatically resolve this issue. All options of Q5 assume configuration of RX\_DELIV < RX\_NEXT. So, RCVD\_COUNT<RX\_DELIV should be discarded anyway. |
| Nokia | - | Obviously, we need to ensure that not starting from 0 will not trigger discarding packets but that should easily be solved. We did not say “yes” because Q6 seems to assume that Option 2 is already agreed. |
| Ericsson | No | At session start (ongoing stream), there will anyway be missing data from the stream itself and thus we do not need any complex mechanism in this very brief transient phase. |
| OPPO | Yes | Even if there is no data lossless requirement, we think it is better to have the solution for low data loss. It is better to set RX\_DELIV smaller than RX\_NEXT controlled by network. |
| CATT | No | Agree with Ericsson that We do not need a complexity mechanism, simply using the SN of the first received packet to construct the RX\_DELIV is simple and sufficient. |
| Kyocera | Yes, but | We assume Q6 intends Option 2 and Option 3 in Q5, since it says “*when setting PDCP state variables to the SN of the first received packet*”. If it’s the case, we’re wondering how the network controls the state variables in the UE precisely.  We have similar view with Ericsson that the UE late joining an ongoing MBS session will miss some data anyway. If it happens in e.g., video streaming, we don’t need to care of this case since the missed data is not so important. However, we’re wondering if it’s really the same for e.g., firmware download, whereby the integrity of whole file is important. In this case, we’re wondering if some sort of file/data recovery may need to be worth considering.  On the other hand, if the missing data happens during the “switching” or “bearer type change”, we assume the data recovery can be done by PDCP Status Report, if PTP-leg is available. |
| ZTE | No | Agree with Ericsson.  Some tips:  - the earlier the App starts, the fewer packets get lost;  - your packets are not yours before you start the App,  - conclusion: no worries, there is no packet loss ^^  Also, it application does ask for no loss of single packet:  - UE should have joined the multicast earlier or  - there can be FEC in application layer or  - it should be unicast since the beginning.  We have millions ways out. No worries again. |
| NEC | No | We can leave it to UE implementation, it is unnecessary to specify the solution. |
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**RLC reception**

There are two cases where the RLC reception window at the PTM leg needs to be initialized or updated:

* when the UE is just configured with an MRB;
* When the MRB is switched from PTP to PTM.

In RAN2#114 meeting, RAN2 agreed that PTM RLC will not support AM RLC. So for PTM RLC state variables initialization will only be UM RLC. The RLC UM state variables are listed below.

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| Each receiving UM RLC entity shall maintain the following state variables:  a) RX\_Next\_Reassembly – UM receive state variable  This state variable holds the value of the earliest SN that is still considered for reassembly. It is initially set to 0. For groupcast and broadcast of NR sidelink communication, it is initially set to the SN of the first received UMD PDU containing an SN.  b) RX\_Timer\_Trigger – UM *t-Reassembly* state variable  This state variable holds the value of the SN following the SN which triggered *t-Reassembly*.  c) RX\_Next\_Highest– UM receive state variable  This state variable holds the value of the SN following the SN of the UMD PDU with the highest SN among received UMD PDUs. It serves as the higher edge of the reassembly window. It is initially set to 0. For groupcast and broadcast of NR sidelink communication, it is initially set to the SN of the first received UMD PDU containing an SN. |

First, when the UE is just configured with an MRB, the PTM RLC window is generally similar to the PDCP window. The simplest way would be to apply the behaviour from sidelink broadcast/groupcast, i.e. set RX\_Next\_Reassembly and RX\_Next\_Highest according to the first received packet containing an SN.

If the MRB is switched from PTP to PTM and PTM is deactivated before, the PTM RLC window initialization is generally similar to the PTM RLC window initialization when MRB is configured.

For UM RLC, only when RLC SDU is segmented, there is SN attached in UMD RLC PDU. The key point of RLC UM mode is that the data loss is allowed. So the UE can discard the RLC PDU if the first received RLC PDU does not contain a complete RLC SDU or the RLC PDU does not contain the first segment, i.e. set the RLC state variables to the initial value 0.

**Option 1:** Initialize the PTM RLC entity for an MRB configuration, or when an MRB is switched from PTP to PTM and PTM is deactivated before, the value of RX\_Next\_Highest and RX\_Next\_Reassembly can be set to initial value, i.e. 0.

**Option 2:** Initialize the PTM RLC entity for an MRB configuration, or when an MRB is switched from PTP to PTM and PTM is deactivated before, the value of RX\_Next\_Highest and RX\_Next\_Reassembly can be set to the SN of the first received packet containing an SN, like sidelink broadcast/groupcast. Note that enhancements to this option to reduce the packet loss can be further discussed based on Question 9.

**Q7: Which option do companies prefer to address the PTM RLC entity initialization for an MRB configuration?**

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| --- | --- | --- |
| Company | Agree?  (option 1/2) | Comments |
| MediaTek | Option-2 |  |
| Samsung | Option 2 or | Alternatively, RRC configuration can deliver initial RLC variables. |
| Nokia | 1 | As we understand it, Option 1 is the current behaviour.  The problems and corresponding mechanisms to solve them are specific to dynamic activation/deactivation. This demonstrates that dynamic activation/deactivation increases complexity. Yet the gains are yet to be shown. |
| Ericsson | 1 | As the switch is triggered by losses or QoS is not met for PTM, discarding a first received PDU seems like not an important issue to resolve. We are not sure segmentation is common for a PTM stream as this would possibly increase the loss rate etc. |
| OPPO | Option 2 | For option 1, there is RLC window un-synchronization issue as discussed in Q2. In order to reduce the data loss, option 2 is better. |
| CATT | Option 2 | Option 1 doesn’t work as it cause mismatch between lower edge of TX window and RX side, when UE start to receive a MBS session which is ongoing. |
| Kyocera | Option 2 | We agree the rapporteur’s analysis that RLC UM allows some data loss, and we think Option 1 is the same behaviour with LTE SC-PTM. However, we think the simple optimization to minimize the data loss is useful. For further data recovery, we wonder if PDCP Status Report can also be used, if PTP-leg is available. |
| ZTE | Option 2 |  |
| NEC | Option 2 | It seems if we set the initial value of RX\_Next\_Highest and RX\_Next\_Reassembly to initial value, i.e. 0, the RLC window un-synchronization issue comes again. |
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**Q8: Should the same PTM RLC entity initialization procedure be applied to PTM leg when an MRB is switched from PTP to PTM and PTM was deactivated before, as the case of MRB configuration?**

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| --- | --- | --- |
| Company | Agree?  (Yes/No) | Comments |
| MediaTek | Yes |  |
| Samsung | (Yes) but too early | It depends on conclusion on Q2. If we go with Option 1 for Q2, nothing is necessary here. |
| Nokia | - | The problems and corresponding mechanisms to solve them are specific to dynamic activation/deactivation. This demonstrates that dynamic activation/deactivation increases complexity. Yet the gains are yet to be shown. |
| Ericson | - | Agree w Nokia. See other responses in scheduling decision/transparent to UE. |
| OPPO | Yes | We also agree it depends Q2. But it is not clear how to align the RLC state variables between UE and network if there is no data reception via PTM leg for a long time due to bad channel condition. |
| CATT | Yes |  |
| Kyocera | Yes |  |
| ZTE | Yes |  |
| NEC | Yes |  |
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In [2][4], companies mentioned the data loss issue when initialize the RLC window. Due to out-of-order delivery from MAC/PHY to RLC, after the UE received “the first packet”, the packets with SNs sent before “the first packet” will be discarded by the UE (according to the highlighted part above) even if they have been correctly received, which may cause some data loss at each switch from PTP to PTM. RAN2 may need analyze whether this is an issue to be addressed. If yes, the RX\_Next\_Reassembly can be set to a value smaller than the SN of the first received packet containing an SN to allow earlier packets to be received [2].

**Q9: Do companies agree to address the data loss issue when setting RLC state variables to the SN of the first received packet containing an SN for MRB configuration or PTP-to-PTM switch, if yes, how?**

|  |  |  |
| --- | --- | --- |
| Company | Agree?  (Yes/No) | Comments |
| MediaTek | Yes | We think that the data loss issue as discussed could be valid. However, we are wondering if we can just allow this data loss at RLC layer. We assume that we can apply data recovery mechanism at PDCP layer (e.g. with some necessary data retransmission based on the status report from the UE) to handle such data loss. This means that the PTP leg can not be teared down immediately during PTP-PTM switch. |
| Samsung | Yes |  |
| Nokia | No | The problems and corresponding mechanisms to solve them are specific to dynamic activation/deactivation. This demonstrates that dynamic activation/deactivation increases complexity. Yet the gains are yet to be shown. |
| Ericsson | No | Agree w Nokia |
| OPPO | Yes | Even if there is no data lossless requirement, we think it is better to have the solution for low data loss. It is better to set RX\_Next\_Reassembly smaller than RX\_Next\_Highest controlled by network. |
| CATT | No | It does not make sense to consider this as anyway UE may not start to receive the MBS data from the beginning of the data transmission. |
| Kyocera | Yes, but | In dynamic switching from PTP-leg to PTM-leg case, we assume PDCP layer handles the data recovery (e.g., with PDCP Status Report), and PTP-leg compensates the missing packets on PTM-leg, i.e., the UE receives data from PTP-leg and PTM-leg simultaneously during a certain period, in case PTP-leg is configured with AM mode. On the other hand, if the PTP-leg is configured with UM mode, we assume the data loss is acceptable.  In RRC reconfiguration from PTP-only to PTM-only, we assume the data loss is acceptable as well, since PTM can be only configured with UM mode. |
| ZTE | No | Basically we don’t think data loss after initial configuration or during mode switch is a problem.  As our answer in Q4, PDCP SR can be enabled for certain services is minimization of loss is indeed needed.  For others, data loss is fine:  - application layer that FEC/other mechanisms in application layer are very common for MBS.  - If data loss is not acceptable, mode switching to PTM shall not be applicable in the first place |
| NEC | No | The data loss should be considered after the UE joint the MBS service. |
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There are also two cases where the RLC reception window at the PTP leg may need to be initialized or updated:

* when the UE is just configured with an MRB;
* When the MRB is switched from PTM to PTP.

No matter which cases, the PTP leg is UE specific, the PTP reception window can be set to initial value, i.e. 0.

**Q10: Do companies agree to PTP reception window can be set to initial value, i.e. 0, due to MRB configuration?**

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| --- | --- | --- |
| Company | Agree?  (Yes/No) | Comments |
| MediaTek | Yes |  |
| Samsung | Yes | gNB can send RLC PDU from SN0. |
| Nokia | Yes | In our understanding, this is the current behaviour. |
| Ericsson | Yes | We assume this is not a “switch” as such but a bearer initiation. |
| OPPO | Yes | PTP is UE specific, it is reasonable to set the RLC state variables to 0 as legacy when PTP RLC is configured. |
| CATT | Yes | No optimization is needed here. |
| Kyocera | Yes | We assume the current unicast behaviour can be applied. |
| ZTE | Yes |  |
| NEC | Yes | PTP is UE specific. |
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**Q11: Should the same PTP RLC entity initialization procedure be applied to PTP leg when an MRB is switched from PTM to PTP, i.e. PTP reception window can be set to initial value, i.e. 0?**

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| --- | --- | --- |
| Company | Agree?  (Yes/No) | Comments |
| MediaTek | Yes |  |
| Samsung | No | PTP is not deactivated at all. Resume of RLC SN has no problem. |
| Nokia | No | Agree with Samsung. |
| Ericsson | No | Agree w Samsung. |
| OPPO | Yes or no | No strong view, it is feasible to set the PTP RLC state variables to 0 or continue to use history value when switching to PTP. If history value is used for PTP RLC, it is complex for the network to remember which SN is the start value to use when switching to PTP. |
| CATT | No | Agree with Samsung. |
| Kyocera | Yes, but | We tend to agree with Samsung, in case of dynamic switching from PTM-leg to PTP-leg, i.e., no initialization is needed for “switching”.  On the other hand, we wonder if the reception window should be set to the initial value, in case of RRC reconfiguration from PTM-only to PTP-only (i.e., “bearer type change”), which is same with Q10 above. |
| ZTE | No | We have already agreed that “the usage of the PTP leg cannot be deactivated”. Just leave the PTP as legacy, and nothing needs to be done. |
| NEC | No | PTP RLC AM RLC SN can be resumed. |
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# Conclusions

Based on the discussion above, we propose:

# Reference

[1] the Email discussion refers to the Tdocs in section 8.1.2.2 in RAN2#113bis and part Tdocs in section 8.1.2.3 in RAN2#114.

[2] [R2-2103524](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103524.zip) PTP/PTM dynamic switch and MRB initialization Huawei, CBN, HiSilicon RAN2#113bis

[3] [R2-2103373](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103373.zip) Consideration of dynamic PTM - PTP switching with service continuity for NR MBS Kyocera RAN2#113bis

[4] [R2-2105796](file:///C:\Users\c00444523\AppData\Local\Microsoft\Windows\INetCache\Content.Outlook\AppData\Local\Microsoft\Windows\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105796.zip) PTM/PTP mode switching InterDigital RAN2#114

# Agreements

## ***RAN2#114***

* RLC-AM is not supported for PTM (for MBS R17 WI).

## ***RAN2#113bis***

* For a given UE, if the MRB’s QoS requirements are not met via PTM, switching to PTP with RLC-AM shall be supported.

Agreements

Chair: NOTE that the below agreements are only based on architecture decisions so far. The reliability discussion not concluded yet i.e. other cases than RLC UM + RLC UM. PTM PTP switch for such other cases is FFS

* Dynamic PTM/PTP switch is supported for a split MRB bearer (type) with a common (single) PDCP entity.
* As a baseline, no new UE based signalling is introduced to support gNB switch decision (e.g. PDCP SR for high reliability is still TBD)
* Assuming a split-MRB (as agreed during the online session) configured with a PTM leg and PTP leg, the usage of the PTP leg cannot be deactivated (i.e. the UE needs to always monitor C-RNTI) after the necessary split-MRB configuration.
* Assuming a split-MRB (as agreed during the online session) configured with a PTM leg and PTP leg, it is FFS whether the usage of the PTM leg of the split-MRB may be subject to activation or deactivation and the details of such.

## ***RAN2#113***

* Confirm P1 P2 P3 (assume that MRB may include both PTP and PTM)
* For the case that both PTM and PTP are RLC-UM, configuration with No L2 ARQ and with PDCP anchored PTM – PTP switching shall be supported (e.g. for services that would typically be configured with RLC UM for unicast).

## ***RAN2#112***

* whether any SDAP header is needed.
* (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.
* In general: RAN2 wait for SA3’s progress for discussing security issues. TBD whether we need to send LS to SA3.
* RoHC (at least U-mode) can be configured for NR MBS bearers. This is applicable for Mcast, assume this is applicable also to broadcast.
* RoHC is located at PDCP.
* The reordering and in-order delivery function in PDCP is supported for NR MBS.
* The following PDCP functions are also supported for NR MBS: transfer of data; maintenance of PDCP SNs; duplicate discarding. Other PDCP functions are FFS.
* RLC AM is supported for PTP transmission of NR MBS.
* RLC UM is supported for PTP transmission of NR MBS.
* RLC UM is supported for PTM transmission of NR MBS.
* RLC TM is not supported for PTP transmission of NR MBS.
* RLC TM is not supported for PTM transmission of NR MBS.
* FFS for PTM if multiplexing/de-multiplexing of different logical channels are to be supported in MAC for NR MBS.

## ***RAN2#111***

* For a UE, gNB dynamically decides whether to deliver multicast data by PTM or PTP (Shared delivery)
* FFS which layer(s) handles reliability (in general), inorder delivery / duplicate handling, and it is FFS how it works at PTM PTP switch.