3GPP TSG-RAN WG2 Meeting #125bis Tdoc R2-24xxxxx

Changsha, China, April 15th – April 19th, 2024

Source: Ericsson (rapporteur)

Title: [POST125bis][016][XR] PDCP SN gap reporting

Agenda item: 7.5.3.2

Document for: Discussion, Decision

# 1 Introduction

This contribution intends to provide a report for the post meeting discussion as below:

* [POST125bis][016][XR] PDCP SN gap reporting (Ericsson)

Intended outcome: Review and address concerns with PDCP TP, including question on the need of additional condition in [R2-2403361](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\TSGR2_125bis\Docs\R2-2403361.zip)

Deadline: two weeks

The questionnaire below is for companies to provide their view on the additional condition in R2-2403361 and like last time, the TP is provided for further perusal and comments. Please provide your comments to the TP in the form of word comment bubbles and refrain from changing the text directly.

The deadline for providing company views and comments on the TP is May 3rd, 10 UTC.

# 2 Triggering of the PDCP SN gap report

The following agreement was made in the last meeting regarding the triggering condition for the PDCP SN gap report [1].

PDCP Tx entity triggers the PDCP SN gap report when there is a buffered SDU associated with an SN higher than the SN of the discarded SDU(s) (due to expiry of the discard timer) and these SDU(s) have not been submitted by RLC to lower layers.

With the current agreement, the PDCP SN gap report is triggered when the higher SN(s) than the SN of the discarded SDU(s) is buffered in the queue and that these SDU(s) have not been submitted by RLC to lower layers i.e., not been transmitted yet. However, [2] cites an example where the last SDU of a previous burst is transmitted by the PDCP/RLC but is not successfully delivered thereby unecessarily delaying the delivery of the next burst to upper layers. The proposal is to trigger the PDCP SN gap report when the discard timer expires for the most recent PDCP SDU after it has been submitted to lower layers (but is not ACKed). Hence, we would like to check if companies believe the trigger condition for the PDCP SN gap report should be expanded.

**Should the PDCP SN gap report be triggered when the discard timer expires for the most recent PDCP SDU after it has been submitted to lower layers (but is not ACKed)?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| LGE | No | For RLC AM, the RLC will keep retransmitting the PDCP SDU until it is successfully received by the receiver. So, there is no need to trigger SN gap reporting for RLC AM.  For RLC UM, the transmitter does not know whether the transmitted PDCP SDU is successfully received by the receiver. So, there is no need to trigger SN gap reporting for RLC UM as well. |
| Nokia | Yes but align the lower-layer consideration with the above agreement. | Taking into account the above agreement:  PDCP SN gap report is triggered when discard timer expires for the most recent PDCP SDU after it has been submitted by RLC to lower layers (but is not ACKed).  **In response to LG**:  1. The successful delivery of the PDCP SDU can take very long, and the gap report may reach the receiving PDCP before the SDU (because RLC does not re-order), resulting in reordering-delay reduction.  2. For the very same reason (the transmitter does not know), there is a need to trigger the report: for all the transmitter knows, the PDCP SDU may be lost, and the report provides reordering-delay reduction.  **In response to Xiaomi and Futurewei**: the only purpose of the “(but is not ACKed)” is to note that it is pointless to indicate discard for SDUs whose successful delivery is confirmed by RLC or by PDCP status report.  **In response to Xiaomi**: in line with the current specifications, the “but is not ACKed” means “but its successful delivery is not confirmed by lower layer or by PDCP status report”. The condition is equally applicable to RLC UM, it just always applies in that case.  **In response to Futurewei**: 2. No acknowledgement is necessary for the proposed trigger, only the trigger is pointless for SDUs whose successful delivery is known (which is never known in case of RLC UM). Given the “after it has been submitted by RLC to lower layers”, the trigger cannot be premature since the SDU’s COUNT can no longer be re-assigned. |
| Xiaomi | Comments | Some clarification is needed regarding "but is not ACKed". Does ACK refer to HARQ ACK or ARQ ACK? Our understanding is that it refers to ARQ ACK since in general, there is no explicit HARQ ACK sent by gNB.  With the assumption that ACK is ARQ ACK, we understand that the proposal is for RLC AM only. In NR up to Rel-18, RLC AM operates in lossless mode, i.e. a RLC SDU submitted to MAC will be eventually delivered even if there is PDCP discard indication. Therefore it is not clear why SN gap report should be triggered for the corresponding PDCP SDU. Note that triggering a PDCP SN gap report will move the receiver PDCP window (RX\_DELIV), which will result in discard of the corresonding PDCP SDU which will be eventually received.  It seems that the proposal is more related to Rel-19 XR RLC enhancement direction of avoiding unnecessary retransmissions. |
| Futurewei | Comments | 1. If we understand the proposal correctly, it will not affect the operations at the RLC layer for R18, as the RLC retransmission(s) (for AM) and transmission(s) of remaining segment(s) (for AM and UM) will continue as today. The only effect is that the receiving PDCP entity will no longer wait for them, if not received yet. We are OK with this intention. 2. However, the way the trigger being described implies that there is some sort of acknowledgement needed. If waiting for ARQ ACK, it would add delay for sending the PDCP SN gap report, defeating the purpose. Besides, “discard timer expires for the most recent PDCP SDU” implies that there is no new SDU with a COUNT higher than the COUNT values being discarded yet. So, the trigger may be premature as the gap has not formed yet. We think a simple way to expand the triggering conditions and in-line with the proposal is to remove the last bullet as below:  5.X.1 Transmit operation For AM DRBs and UM DRBs configured by upper layers to send a PDCP SN gap report in the uplink (*sn-GapReport* in TS 38.331 [3]), the transmitting PDCP entity shall trigger a PDCP SN gap report when:  - the PDCP SDU(s) are already associated with a COUNT value; and  - the PDCP SDU(s) are discarded as specified in clause 5.3; and  - there is at least one stored PDCP SDU which is associated with a COUNT value larger than the COUNT value associated to the discarded PDCP SDU(s)~~; and~~  ~~- the PDCP SDU(s) have not been transmitted by lower layers~~.   1. With the above change, those PDCP PDU(s) may eventually be received before or after the PDCP SN gap report is received. If it is received after the PDCP SN gap report, it is outside the receiving window and hence will be discarded. No issue in this case. If it is received before the PDCP SN gap report, there is no harm for the UE to store and deliver the associated SDU (even if it is indicated as being discarded) to upper layer. The application layer can decide what to do with the SDU. If the application layer is capable of performing error concealment, every extra SDU successfully received may be helpful. So for the second case, we would like to suggest the following change to ensure that SDUs received are not considered as discarded:  5.X.2 Receive operation At reception of a PDCP SN gap report from lower layers, the receiving PDCP entity shall consider each PDCP SDU, if any, with the bit in the discard bitmap set to ‘1’, or with the associated COUNT value equal to the value of FDC field as discarded, if not received yet, and:   1. We share the view with Xiaomi and other proponents (in RAN plenary) that further enhancements to RLC may be needed in R19, e.g., to avoid unnecessary RLC (re)transmission(s) for PDUs already indicated as being discarded. For such RLC enhancements to work, the above two changes to PDCP spec seem necessary in R19 anyway, if not already done in R18. So, we may as well begin R18 XR with these two changes in PDCP spec to minimize the difference between R18 and R19. |
| Fujitsu | No | This scenario is not strictly associated with an SN gap, so not aligned with the intention of SN Gap reporting.  Anyway this seems to be an (over) optimization. We don’t think it is critical and it will adds more overheads on SN gap reporting. |
| Huawei, HiSilicon | Not sure | On one hand, there is some value to the proposal because we can speed up the delivery of the subsequent SDUs for the case where some outdated SDUs are being transmitted. On the other hand, since the SDUs are still transmitted by the lower layers, the application could still take benefit of them, even though delivered late. Applying the proposed mechanism would make them fall out of the Rx window, so they wouldn‘t be forwarded to upper layers, even though received successfully. |
| Samsung | No | There is no SN gap when the SDUs are being (re-)transmitted by RLC AM. Then the proposal seems an over optimization and also complicates SN gap reporting procedure |
| OPPO | Tend to No | The RLC AM will keep retransmitting a PDCP SDU until the PDCP SDU is successfully received, thus there is no SN gap issue to be resolved. We prefer to avoid this optimization at the late stage of Rel-18. |
| Ericsson | No | Similar understanding as HW, Samsung and OPPO. |
| III | No | Agree with LGE. |

##### Rapporteur Summary:

Out of the 10 companies that responded, 7 companies said ‘No’ or leaned towards ‘No’, while 2 companies did not provide a preference but provided comments and one company said ‘Yes’ to the proposal. Some of the concerns relate to the statement about “but is not ACKed” and whether this relates to ARQ ACK. In which case, this is only applicable to the RLC AM mode. Further, companies point out that the RLC AM mode is lossless i.e., will continue to retransmit the PDCP SDU until successfully received by the receiver. Furthermore, companies also think this is related to the Rel-19 RLC AM enhancements. But one company explains that this is equally applicable to the RLC UM case.

One company also points out that such PDUs while in-flight are always useful to be received and the application could still take benefit of them, even if delivered late. They mention that applying the proposed mechanism renders the PDU to fall outside the Rx window and prevent them from being forwarded to the upper layers even though received successfully.

While others also feel this is an over optimization and complicates the SN gap reporting procedure. Based on the above comments and the majority *not* in favour, it is recommended to not introduce a new trigger for the PDCP SN gap report.

**Proposal 1                 PDCP SN gap report is *not* triggered when the discard timer expires for the most recent PDCP SDU after it has been submitted to the lower layers but is not ACKed.**

# 4 Conclusion

Based on the comments from the companies, the following proposal is made:

**Proposal 1                 PDCP SN gap report is *not* triggered when the discard timer expires for the most recent PDCP SDU after it has been submitted to the lower layers but is not ACKed.**

# 5 References

1. Chair notes, RAN2#125bis, Changsha, China, April 2024.
2. R2-2403361, Triggering of PDCP SN gap report, RAN2#125bis, Changsha, China, April 2024.