3GPP TSG-RAN WG2 Meeting #109-e R2-200xxxx

Elbonia, Online, 24 February – 6 March 2020

**Agenda item: 7.3.2.3**

**Source: LG Electronics Inc. (summary rapporteur)**

**Title: Closing UP issues (PDCP/RLC/MAC) and discussing remaining open items for DAPS**

**WID/SID: NR\_Mob\_enh-Core/** **LTE\_feMob-Core - Release 16**

**Document for: Discussion and Decision**

# 1 Brief scope

The scope of this document is as follows.

* Agreeing on the proposals as per R2-2001532 and R2-2002099.
* Discuss open items as per R2-2001532 and R2-2002099 to seek companies feedback on open issues of UP for DAPS.

# 2 Summary

## 2.1 Is PDCP status report for UM DRB needed?

As stated in [1], it was indicated whether the PDCP status report for UM DRB should be introduced to minimize the number of the duplicated PDCP PDU. For this issue, we would like to ask the RAN2 companies to answer the following question:

Q1. Do you think the PDCP status report for UM DRBs is needed for DAPS HO?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| LG | Yes | Considering that the purpose of the PDCP status report is to minimize the number of duplicated PDCP PDUs, PDCP status report UM DRBs should be considered for DAPS HO. |
| Samsung | Yes | For UM DRBs, the PDCP status report can avoid unnecessary retransmission from the target. |
| MediaTek | No | In UM case, only PDCP PDUs not sent by source gNB are forwarded to target gNB. PDCP status report simply causes delay in sending/receiving new data, and this has negative effect for real-time application, which is the main use case of UM. |
| OPPO | No | UM DRBs are usually configured for real-time services and do not work with feedback/acknowledgement and we think PDCP status report will cause additional delay for target node to send packets, |
| Ericsson | Yes | Agree with comments from LG and Samsung. |
| Intel | No | Agree with comments from MediaTek and OPPO. |
| Nokia | Yes | It can help to reduce unnecessary transmissions from target cell. However, one thing to confirm is: we consider only UE to NW status reporting (and not the other way round)? Just checking as based on the description and some of the answers this may not be so clear. We should not specify anything for network side here as we have not done that in other cases. |
| Apple | No | Agree with comments from MediaTek and OPPO. |
| NEC | Yes | The PDCP status report can be used to avoid duplicated transmission. |
| ZTE | Yes | Yes, but no strong view. The PDCP status report for downlink transmission (status report from UE to NW) is beneficial to avoid unnecessary transmission of duplicated PDCP PDUs. However, since the NW may initiate the transmission for UM DRB without waiting for the PDCP status report, and there is no RLC retransmission in source link for the UM DRB, the status report for UM DRB seems not so necessary as PDCP status report for AM DRB. |
| Huawei, HiSilicon | No | Agree with comments from MediaTek and OPPO. |
| Sharp | No | Agree with MediaTek and OPPO.  However, as long as supporting PDCP status reporting for UM DRB is optional, i.e., PDCP status reporting is configurable by the network, we don’t have strong objection for “supporting” PDCP status reporting for UM DRB. |
| CATT | Yes | We think it is useful to send PDCP status report for downlink data to avoid unnecessary retransmission from target node. |
| ETRI | No | In DAPS HO, PDCP status report is useful to prevent redundant transmissions, but there is a trade-off between redundancy and latency. In the latency point of view, the PDCP status report triggered upon UL data switching can cause delay to begin sending data to the UE in the target and it can negatively affect application layers and interruption at radio level. In our view, the latency is a more important factor than the redundancy in this WI.  Furthermore, an intermediate SN status transfer can help to avoid redundant DL data transmission. By the introduction of indication of handover execution to the source (e.g., the “Bye” message) in DAPS HO, the source can send an intermediate SN status transfer upon receiving the “Bye”. It is a good compromise between the redundancy and the latency in DAPS HO as analyzed in our contribution. Therefore, we proposed that RAN2 consider the need of indication of DAPS handover execution to the source. |
| vivo | No | We think that the PDCP status report for the DL data transmission of the UM DRB is used to reduce the DL duplicated data while releasing the source link. However as the source node knows the transmission status of the DL packet via the HARQ feedback of the UE, the source node can send the DL PDCP SN status to the target node. There is no need for the UE to report such DL PDCN SN status. Furthermore, as the handover duration is expected to be very short, the number of the duplicated DL packets would not be a lot. |
| China Unicom | No | Agree with comments from MediaTek and OPPO. |
| China Telecom | Yes | If not, the target cell has to transmit all PDCP SDUs stored in its buffer regardless the PDCP SDUs already received by the UE in the source cell. That is a waste of radio resources for network. |
| CMCC | Yes | PDCP status report can be used to avoid unnecessary retransmission from the target cell for UM DRB data as well. |
| QC | Yes | Same view as LG and Samsung.  Once source send HO command to UE, same PDCP SNs will be sent over source cell and to target cell via Xn/X2. To avoid any DL duplication, UE need to send UL PDCP Status Report . |
| Futurewei | No | Share the similar view as MediaTek and OPPO. Sending status report in UM seems defeating the purpose of UM. |

**Conclusion 1:** Based on companies’ inputs, there is no clear consensus on whether PDCP status report for UM DRBs is needed or not. Thus, we propose that RAN2 discuss whether the PDCP status report for UM DRBs is needed.

* Summary of the companies view
  + - The PDCP status report for UM DRBs is needed: LG, Samsung, Ericsson, Nokia, NEC, ZTE, Qualcomm, CATT, China Telecom, CMCC (10)
    - The PDCP status report for UM DRB is not needed: MediaTek, OPPO, Intel, Apple, Huawei, Sharp, ETRI, vivo, China Unicom, Futurewei (10)

**Proposal 1. Discuss whether the PDCP status report for UM DRBs is needed.**

For proposal 1, from rapporteur point of view, the benefit of introducing the PDCP status report for UM DRBs is that the number of the duplicated PDCP PDUs can be minimized. In addition, if the target cell does not receive the PDCP status report, the PDCP PDUs are transmitted regardless of whether the transmitted PDCP PDUs are already successfully received to the UE. In this case, from UE point of view, the UE may receive the PDCP PDUs which were already successfully received, and it causes the transmission delay for the PDCP PDUs which are not received yet. Thus, the benefit of introducing the PDCP status report is the reducing the transmission delay of the PDCP PDUs which are not received yet in UE as well as the minimizing the number of the duplicated PDCP PDUs.

On the other hand, the drawback is the transmission of the PDCP PDUs in the uplink may be delayed due to transmission of the PDCP status report for UM DRBs. However, the size of the PDCP status report for UM DRBs may be small because the service requiring the low throughput, e.g., voice call, is usually carried on UM DRBs, and thus, it is not a big problem.

Considering above, from rapporteur point of view, it would be good to introduce the PDCP status report for UM DRBs. However, other companies may have a concern about the rapporteur’s view. Thus, the rapporteur would like to ask whether the rapporteur’s view is agreed or not. If not, please present the reason.

|  |  |  |
| --- | --- | --- |
| Company | Agree/Disagree? | Comments |
| Ericsson | Agree | I’m not sure there is any point in asking this question again since I assume companies haven’t changed their minds. |
| Futurewei | No | Since there is no consensus. We just simply follow the normal practice not to make the change. |
| QC | Agree | As per rapporteur summary, there is benefit of adding this. |
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## 2.2 Is the PDCP status report triggered when releasing the source link?

As stated in [1], it was addressed whether the PDCP status report is triggered when releasing the source link (let’s call it the second PDCP status report). For this issue, we would like to ask the RAN2 companies to answer the following question:

Q2. Do you think the second PDCP status report is needed?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| LG | No | Since the time between the first PDCP status report (i.e. at the UL data switching) and the second PDCP status report (i.e. at the source cell release) may be very short, there will only be a few DL packets sent from the source cell to the UE and therefore there is no strong need for the second PDCP status report. |
| Samsung | Yes | No strong opinion. However, the time scale depends on network implementation. From UE side, the PDCP status report would be a small byte of payload and thus the second PDCP status report could be beneficial without a big overhead. |
| MediaTek | Yes | A final status report needs to be sent to the target node. It is used to trigger retransmission of the DL PDCP SDUs which are not successfully delivered by the source Node. |
| OPPO | No | We also think the time interval between UL switching and source release is short and not many DL packets are received in the source. We don’t think optimization through second PDCP status report is needed. |
| Ericsson | No | Agree with comments from LG and Oppo. |
| Intel | Yes | Same view as Samsung and Mediatek. |
| Nokia | No | In our opinion PDCP status report sent at source link release makes more sense than the status report at UL switching. However, if the latter is already agreed then we are OK not to have the second reporting in addition. |
| Apple | No | Since the period between the UL switching and source link release is short, and the target node is possible to receive the final SN status transfer from the source Node upon the source link release to understand the next missing DL/UL PDCP SDU, UE does not need to trigger PDCP status report. |
| NEC | Yes | As there are still data transmitted by the source node, a final PDCP status report should be supported. |
| ZTE | No | Since no new PDCP PDU can be generated in source side after the transmission of “SNStatusTransfer” over X2/Xn, the PDCP PDU transmitted in the source link after the first PDCP status report will be quite limited. Also considering the NW will not wait for the second PDCP status PDU before the transmission of PDCP PDU on the target link, it is very much likely the concerned duplicated PDCP PDU will be transmitted before the reception of the second PDCP status report, thus it seems not so useful. |
| Huawei, HiSilicon | Yes | Same view as Samsung and Mediatek. |
| Sharp | Yes | Agree with Samsung and MediaTek |
| CATT | Yes | Same view as Samsung and Mediatek. |
| ETRI | Yes | The final PDCP status report is needed to be sent to the target to prevent retransmission redundancy and help to retransmit DL packets that are not successfully received at the source. In addition, if RAN2 consider that the time between the first PDCP status report and the second PDCP status report is very short, we prefer the second one to the first one because as the comment in Q1, in the latency point of view, the first PDCP status report can negatively affect application layers and interruption at radio level. |
| vivo | Yes | Agree with MTK. |
| China Unicom | Yes | Same view as Samsung and Mediatek. |
| China Telecom | Yes | Since DL protocol stack is still maintained after UL switching, there are some in-flight PDCP SDUs before the source protocol release. It is necessary to reflect the final status for selective retransmission. |
| CMCC | YES | The second PDCP status report can be used to trigger retransmission of the DL PDCP SDUs which are not successfully delivered by the source Node with small overhead. |
| QC | may be | It is not essential to have 2nd PDCP report from UE if the time delay between successful DAPS HO and source release is short. But it is upto NW implementation how soon source gets released. It may be helpful only when there is delay and a number of packets exchanged. Even if supported, this should be optional. |
| Futurewei | Yes | Same view as Samsung and Mediatek. |

**Conclusion 2:** Based on companies’ inputs, there is no clear consensus on whether the second PDCP status report is needed. Thus, we propose that RAN2 discuss whether the second PDCP status report is needed.

* Summary of the companies view
  + - Second PDCP status report is needed: Samsung, MediaTek, Intel, NEC, Huawei, Sharp, CATT, ETRI, vivo, Qualcomm, China Unicom, China Telecom, CMCC, Futurewei (12)
    - Second PDCP status report is not needed: LG, OPPO, Ericsson, Nokia, Apple, ZTE (6)

If the answer for Q2 is yes, we would like to ask company view on that the second PDCP status report is applied to only AM DRBs or AM and UM DRBs.

Q3. Do you think the second PDCP status report is triggered only for AM DRB or AM and UM DRBs?

|  |  |  |
| --- | --- | --- |
| Company | AM DRBs/ AM and UM DRBs | Comments |
| LG |  | The second PDCP status report should not be introduced. |
| Samsung | Both | If the second PDCP status report is agreed, then there seems no need to have different behaviour for UM DRBs and AM DRBs. |
| MediaTek | AM DRB only | For UM DRBs, it may be too late to retransmit them. |
| Intel | AM DRB only. | Retransmission is not supported for UM DRB. |
| NEC | Both | The purpose of the two PDCP status report are the same, if the first PDCP status report are supported for both RLC AM and RLC UM, then the second should also be supported for both cases. |
| ZTE | AM DRB only | If the second PDCP status report is adopted, based on the comments to Q2, we think it is sufficient to support the second PDCP status report for AM DRB only. |
| Huawei, HiSilicon | AM DRB only. | Same comments as for Q1. |
| Sharp | AM DRB only | Same comments as for Q1. |
| CATT | AM DRB only | The PDCP status report is triggered when releasing the source link is used to tell target node which packets have not been received successfully. And the target performs retransmission according to the status report. But for UM mode, there is no retransmission, which means such status report is not that useful. |
| ETRI | AM DRB only | RAN2 agreed that there is no retransmission for UM DRBs. Therefore, the second PDCP status report will be of no help to UM DRBs. |
| vivo | AM DRB only | Same answer as for Q1. |
| China Unicom | AM DRB only. | Same comments as for Q1. |
| China Telecom | Both |  |
| CMCC | Both | Be alignment with the intention of Q1. |
| QC | AM DRB mainly if supported | For UM DRBs, for latency sensitive data it is unnecessary. |
| Futurewei | AM DRB only. | We do not support status report for UM, |

**Conclusion 3:** Based on companies’ inputs, the majority view is the second PDCP status report should be applied only for the AM DRBs. Thus, we propose that the second PDCP status report is introduced only for AM DRBs, and the text proposal in Annex A is used as baseline.

**Proposal 2. The second PDCP status report is introduced only for AM DRBs, and the text proposal in Annex A is used as baseline.**

The rapporteur would like to ask the concern on proposal 2. Please do not present the same concern as stated above.

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| --- | --- |
| Company | Concern |
| Ericsson | The results for Q3 are a bit misleading since it was only the companies answering yes to Q2 that were supposed to answer Q3 (at least this is how I interpreted the formulation of Q3). This means that we don’t know what all the companies that answered no in Q2 thinks. |
| Futurewei | Agree with rapporteur’s proposal. |
|  |  |
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## 2.3 How to handle the stored PDCP PDUs received from the source cell when releasing the source cell

As stated in [1], it is addressed how to handle the stored PDCP PDUs received from the source cell when releasing the source cell. However, in the 108#66 email discussion, many companies thought that this issue can be resolved by UE implementation. For this issue, we would like to ask the RAN2 companies to answer the following question:

Q4: Do you think the stored PDCP PDUs received from the source cell can be handled by the UE implementation?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| LG | No | According to the current specification, the PDCP entity decompresses the stored PDCP PDU at PDCP re-establishment. In other words, how to handle the stored PDCP PDU is already defined in the specification. Considering this, we think that how to handle the stored PDCP PDUs received from the source cell when releasing the source cell should be specified in the spec. |
| Samsung | No | In Rel-15, we already have similar behaviour for AM DRBs at PDCP re-establishment due to RLC out-of-order delivery as follows:  - for AM DRBs, perform header decompression for all stored PDCP SDUs if *drb-ContinueROHC* is not configured in TS 38.331 [3];  We have some concern about whether UE implementation can catch this issue easily. At least, NOTE would be needed if the majority don’t want to have this in normative text. |
| MediaTek | Yes | The PDCP PDUs should be decompressed using source RoHC and security functions, instead of being discarded. This can be handled by UE implementation, e.g., UE keeps the RoHC profile for a while until all PDUs received from the source cell are decompressed, before releasing the RoHC and security functions associated with source gNB.  However, If companies think this is unclear, we are fine to have a NOTE. |
| OPPO | Yes | As a compromise, we are also ok to have a NOTE saying that UE should decompress those stored PDCP PDUs before releasing source cell. |
| Ericsson | No | Agree with comments from LG and Samsung. We don’t see why we should leave the decompression of stored PDCP SDUs at source cell release to UE implementation when we define it for e.g. PDPC re-establishment. We also recall that there were some text proposals submitted to this meeting showing how this can be specified, |
| Intel | Yes | Ok to clarify in the Note. |
| Nokia | No | Agree with LG and Samsung. That shall be a specified behaviour, especially when it has been already described for other cases. |
| Apple | No | We are fine to make the UE behaviour clear in the spec. |
| NEC | Yes | Same view as MediaTek |
| ZTE | Yes | We think it can be left to UE implementation. |
| Huawei, HiSilicon | Yes | It doesn’t impact NW side, so it can be implemented by UE itself. |
| Sharp | Yes |  |
| CATT | Yes | This can be left to UE implementation. |
| ETRI | Yes | Same view as MediaTek. |
| vivo | No | Agree with Samsung, Ericsson and LG. This is already captured for the legacy handover. |
| China Unicom | Yes | This can be left to UE implementation. |
| China Telecom | Yes | We think it can be left to UE implementation. |
| CMCC | Yes | It will be left to the UE implementation. |
| QC | Yes | Same view as MediaTek. |
| Futurewei | Yes | This can be left to UE implementation. |

**Conclusion 4:** Based on companies’ inputs, the majority view is that it can be handled by UE implementation, but they think it is ok with NOTE. Thus, we propose the adding a NOTE in the PDCP specification to handle the stored PDCP PDUs received from the source cell when releasing the source cell, and the text proposal in Annex B is used as baseline.

* Summary of the companies view
  + - It should be handled by UE implementation:
      * MediaTek, OPPO, Intel, NEC, ZTE, Huawei, Sharp, CATT, ETRI, Qualcomm, China Unicom, China Telecom, CMCC, Futurewei (14)
    - It should not be handled by UE implementation:
      * LG, Samsung, Ericsson, Nokia, Apple, vivo (6)

**Proposal 3. How to handle the stored PDCP PDUs received from the source cell when releasing the source cell is specified using NOTE in the PDCP specification, and the text proposal in Annex B is used as baseline.**

The rapporteur would like to ask the concern on proposal 3. Please do not present the same concern as stated above.

|  |  |
| --- | --- |
| Company | Concern |
| Ericsson | I think it would have been easier to discuss if the actual text proposals were included. Leaving the handling to UE implementation or describing it in an informative note means that the PDCP spec will be inconsistent: for normal handover we specify the behaviour but for DAPS handover we don’t. We are willing to accept the proposal though for the sake of progress. |
| Futurewei | If we agree it will be left for UE implementation. Not sure what should be in the note. |
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## 2.4 Should the consecutive ROHC decompression failure be resolved?

As stated in [1], it is addressed how to prevent the consecutive ROHC decompression failure. However, in the 108#66 email discussion, companies thought that this issue can be resolved by UE/NW implementation. For this issue, we would like to ask the RAN2 companies to answer the following question:

Q5. Which option do you prefer to solve this issue?

* Option 1. The target cell always transmits the PDCP PDUs containing IR packet until releasing the source cell.
* Option 2. The PDCP entity in UE decompresses the PDCP PDUs received from the target cell even if the PDCP PDUs are discarded due to duplication detection and out-of-window.
* Option 3. It is leave up to UE implementation.

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments |
| LG | Option 2 | In LTE, in order to prevent the consecutive ROHC decompression, the PDCP entity for none split bearer decompresses a PDCP PDU even if the PDCP PDU will be discarded due to out-of-window and duplication reception. We think that the same principle can be applied to the NR and LTE. |
| Samsung | Option 2. | Both Option 1 and Option 2 will work to resolve this issue. If the majority want to specify anything in PDCP specification, then Option 2 would be better. |
| MediaTek | Option 3 | The DL duplication is performed by network implementation. From UE aspect, UE doesn’t know whether DL duplication is enabled or not beforehand. Therefore, UE can only perform duplication discarding as usual. If DL duplication is enabled by network implementation, the target node can generate/transmit IR packets the PDCP status report is received from the UE. This can be realized by network implementation and nothing needs to be specified in for the air interface.  Note: We would support Option 1 if this cannot be left for NW/UE implementation. |
| OPPO | Option 3 | We think both option 1 and 2 can work and we prefer not to mandate NW and UE behaviour and prefer to leave it to UE implementation. |
| Ericsson | Option 1 | We prefer to address this issue by network implementation. Note that the same problem exist also for the source link. If the source ROHC compressor sends important context updates and the UE ROHC decompressor misses these, the decompression may fail.  Don’t really see how Option 2 will work since the discarded packets must be decompressed in order. For example, say that packet N+1 is received from target before packet N is received from target. If packet N+1 has already been received from the source, packet N+1 received from target will be discarded, and according to option 2 it will be sent for decompression. But since packet N has not yet been received from the target the decompression of packet N+1 may fail since it is decompressed out of order. To properly address this issue we may need two PDCP reordering functions, one for decompression and one for re-ordering, as discussed in Q6. |
| Intel | Option 1/3 | Option 1 is network implementation, option 3 is UE implementation. So option 1 and 3 are aligned with proposal in 108#66  Proposal 15. Leave it to UE/network implementation (without specification impact) on the issue caused by duplicate discarding if duplication is enabled. |
| Nokia | Option 1 or Option 3 | We believe it can be handled by the IR packets sent from source and target during DAPS HO. But leaving that to the UE without specified actions is also acceptable. |
| Apple | Option 1 | It can be up to NW implementation. |
| NEC | Option 1 or 3 | Agree with MediaTek. |
| ZTE | Option 2 or 3 | Considering option 1 will increase the packet size and may lead to negative impact on the performance, especially in HO case which usually happen on the edge of cell, we think option 1 should be excluded. For option 2 and option 3, which are both acceptable to us, considering the limited time budget, we have slight preference on the option 3 and leave this to UE implementation. |
| Huawei, HiSilicon | Option 1 | We hope to specify a deterministic behaviour to avoid ROHC failure in downlink transmission. And option 1 is an easy way without changing UE behaviour and with only minor impact on NW. |
| Sharp | Option 1 and/or 3 | Agree with MediaTek and Intel |
| CATT | Option 1 | Option 1 is preferred. We do not see how this adds extra complexity to UE implementation. This is handled by network implementation. |
| ETRI | Option 2 | Same view as LG. |
| vivo | Option 1 |  |
| China Unicom | Option 1 | Since most NW vendors support option1 and no UE change is needed, we think option 1 is an agreeable solution. |
| China Telecom | Option 1 | It can be up to NW implementation. |
| CMCC | Option 1 | Option 1 is preferred to avoid the decompress failure issue resulting from the lack of IR packet. |
| QC | Option 1 | In DL, due to duplicate discarding it is possible to have ROHC decompression failures. Number of IR packets is typically implementation specific (hard coded in implementation) for UE and NW side. In case of DAPS DL, it is not clear how many DL packets will be duplicated and how many packets will be discarded. This can lead to different number of ROHC IR packets implementation will have different decompression failures. To have more deterministic behaviour, one simple way is target node using IR packets until source cell is released. |
| Futurewei | Option 1 | We have similar view as Ericsson and Huawei. |

**Conclusion 5:** Based on companies’ inputs, the majority view is preferred to go Option 1. Thus, we propose the target cell always transmits the PDCP PDUs containing IR packet until releasing the source cell, and the text proposal in Annex C is used as baseline.

* Summary of the companies view
  + - Option 1: Ericsson, Intel, Nokia, Apple, NEC, Huawei, Sharp, CATT, vivo, Qualcomm, China Telecom, China Unicom, CMCC, Futurewei (14)
    - Option 2: LG, Samsung, ZTE, ETRI (4)
    - Option 3: MediaTek, OPPO, Intel, Nokia, NEC, ZTE, Sharp (7)

**Proposal 4. The target cell always transmits the PDCP PDUs containing IR packet until releasing the source cell, and the text proposal in Annex C is used as baseline.**

The rapporteur would like to ask the concern on proposal 4. Please do not present the same concern as stated above.

|  |  |
| --- | --- |
| Company | Concern |
| Ericsson | As we mentioned in our comment to Q5, the same problem applies to DL packets received on the source link. If we address the issue for the target link in 38.323 we should also address it for the source link for consistency/completeness.  In our understanding the problem is only relevant for NR since in LTE the DL packets are delivered in order from RLC to PDCP and PDCP decompresses the DL packets before they are put in the common re-ordering buffer. This should be clarified in the proposal. |
| Futurewei | Agree with the rapporteur’s proposal. |
| QC | We think it is applicable for both LTE and NR. In LTE, even though RLC delivers PDCP PDUs in sequence to PDCP entity, actual PDCP duplicate detection/discard is based on PDCP SN and any duplicates can still be discarded before Decompression. We think it is applicable for both LTE and NR. |
| Huawei, HiSilicon | 1. P4 can be applicable for LTE.   We agree with QC that it is applicable for both LTE and NR. Since in LTE this issue also exists, we prefer to have the same solution.   1. Unnecessary for source link.   If P4 can be agreed, from UE point of view it is able to decompress the mixed data stream of compressed PDUs from source and IR PDUs from target. And from NW perspective, it is easy to extend IR state at the beginning in target. But if we introduce this restriction to source, it will impact current ROHC implementation in state transition. Considering it is not actually needed in UE side, we don’t think it is necessary to apply for source. |

## 2.5 Are two PDCP reordering functions needed?

As stated in [1], it was addressed whether the two reordering functions should be specified or not, i.e., one is for decompression and another is for in-order delivery. For this issue, we would like to ask the RAN2 companies to answer the following question:

Q6: Do you think two PDCP reordering functions are needed, i.e., one is for decompression and another is for in-order delivery?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| LG | No | In the current specification, when the PDCP entity receives the PDCP PDUs from the lower layers, the PDCP entity performs the security, i.e., deciphering and integrity verification to the received PDCP PDUs. After that, the PDCP entity decompresses the received PDCP PDUs when the received PDCP PDUs are delivered to the upper layer. Considering this, even if the one ordering function is used, i.e., current specification for LTE and NR, there is no problem to support in-order delivery and decompression. Thus, we do not think two reordering functions are needed. |
| Samsung | No | Our understanding is that having two PDCP reordering is just for clarification. We think that there would be no ambiguity only with one PDCP reordering. |
| MediaTek | Yes? | We need to clearly describe the re-ordering behaviour in the spec, either modelled as a single re-ordering function or two re-ordering functions. |
| OPPO | Yes | We think two PDCP re-ordering functions would be clearer. |
| Ericsson | No | See our response to Q5. If other companies don’t agree that the decompression issue can be handled by sending IR packets (i.e. option 1 in Q5) then two PDCP re-ordering functions may be needed. |
| Intel | Yes? | The proposal in 108#66 is  there are two purposes for reordering, one for decompression, another for in order delivery. .  We agree, we do not need to have two reordering functions, but we should make it clear in spec, before decompression/in order delivery, reordering should be performed. |
| Nokia | No | One PDCP reordering should serve both purposes. |
| Apple | No | Agree with Samsung. There is no ambiguity with one PDCP ordering functionality. |
| NEC | No | If there are two reordering functions, the reordering window of the first re-ordering function can only be pushed forward by timer due to SN gap, which introduced additional latency. Single re-ordering function is enough support in-order delivery. |
| ZTE | No | Share the same view with LG and Samsung that one reordering function is sufficient. |
| Huawei, HiSilicon | No | Current spec is already clear enough. |
| CATT | No | Not needed. Complexity is high. |
| ETRI | Yes with Option 2 in Q5 | We share the view with Ericsson in Q5. If RAN2 agree with Option 2 in Q5, two PDCP reordering functions may be needed. With Option 1, we think that there would be no ambiguity with one PDCP reordering function, but the decompression may fail in the source as commented by Ericsson. |
| vivo | No | According to the Rel-15 PDCP specification, the decompression is performed at the same time when the PDCP SDU is submitted to the upper layer. This means that the in-order delivery and the in-order decompression are performed at the same time. We can simply reuse the current procedural text. |
| China Unicom | No | One PDCP reordering should serve both purposes. |
| China Telecom | No | There is no ambiguity with one PDCP ordering functionality. |
| CMCC | No | The benefit is uncleare. |
| QC | No | Same view as LG. There is no need to have 2 separate re-ordering functions. Based on UE implementation, single re-ordering function can be used for duplicate detection and in order delivery to upper layer. |

**Conclusion 6:** Based on companies’ inputs, the majority view is that two reordering functions are not needed. Thus, we propose that RAN2 do not specify two reordering functions in PDCP.

* Summary of the companies view
  + - Two PDCP reordering functions are not needed: LG, Samsung, Ericsson, Nokia, Apple, NEC, ZTE, Huawei, CATT, vivo, Qualcomm, China Unicom, China Telecom, CMCC (14)
    - Two PDCP reordering functions are needed: MediaTek, OPPO, Intel, ETRI (4)

**Proposal 5. RAN2 do not specify two reordering functions in PDCP.**

The rapporteur would like to ask the concern on proposal 5. Please do not present the same concern as stated above.

|  |  |
| --- | --- |
| Company | Concern |
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## 2.6 How to support the UDC for DAPS HO (only for LTE)?

As stated in [1], it was addressed whether and what will specify UDC for DAPS HO. However, RAN2 did not spend much time to discuss how to specify the UDC for DAPS HO. For this issue, we would like to ask the RAN2 companies to answer the following question:

Q7: What should be considered to support the UDC for DAPS?

|  |  |
| --- | --- |
| Company | Comments |
| LG | In our view, RAN2 should discuss many things to support the UDC for DAPS HO, e.g., are two UDC function needed, when the UDC function should be reset and so on. However, we think that RAN2 may not have enough time to discuss them. Thus, even if there is an agreement “support UDC”, we suggest that the UDC should not be considered for DAPS HO in Rel-16. |
| Samsung | In LTE, the features of UDC have been well-specified, e.g. it can be configured only for AM DRB, cannot be configured with ROHC and so on. Hence, for now, we don’t see a critical problem to apply UDC during DAPS handover. However, to consolidate the UP handling of DAPS handover, it would be better to avoid possible issues from UDC considering the meeting time. |
| MediaTek | UDC may be applied in DAPS. However, considering limited meeting time, we prefer to avoid UDC topics this time. |
| OPPO | We suggest not to support UDC for DAPS due to lack of time. |
| Ericsson | Is the question for LTE only or also for NR?  For LTE the changes required to support UDC seems quite small so we are fine with adding it. |
| Intel | The question is only for LTE since UDC is not supported in NR. We are afraid that we do not have time on this. |
| Nokia | We believe UDC is not necessary for DAPS. Thus, we suggest not to address it in Rel-16. |
| Apple | We suggest not to support UDC for DAPS due to lack of time. |
| NEC | Due to time limit, we prefer to not considering UDC in Rel-16. |
| ZTE | Considering the limited time budget, we think the support of UDC in DAPS can be postponed to later release. |
| Huawei, HiSilicon | Considering it is not an essential function and limited time, we suggest not to consider UDC for DAPS. |
| CATT | First of all from system point of view there is no doubt that it would be meaningful to achieve service continuity and transmission efficiency at the same time. Also we do not see any proof that the advantages of DAPS and UDC should be mutually exclusive. Then a logical way is to strive for support of DAPS+UDC in this WI.  Secondly, we don’t think ‘not having sufficient time’ a valid argument here to drop UDC+DAPS. In the previous ran2 meeting the way forward seems to check whether it could be that complex, by looking at company proposals. Now they are available so we can discuss. In our view the specification effort in PDCP as well as RRC to support this is marginal. We can just adopt a similar behaviour as ROHC UL. We observe similar comments from some companies. Another point to note is even if UDC is not supported with DAPS, it does require some discussions and some specified UE behaviours regarding how the DRB configured UDC is handled, or for the case when UE fallbacks to the source due to DAPS failure. It is also questionable if not supporting this combination actually leads to more implementation complexity at the UE side. Depending on the discussions, these could take even more time than specifying DAPS+UDC!  In short we prefer to follow the previous way forward and discuss on the introduction of UDC+DAPS based on the proposed changes to specification. If there is no time online we are OK to put such checking to email. Once the specification impact is clear we can easily get this done in perhaps the next meeting. |
| ETRI | Same view as Intel. |
| vivo | No strong preference. If companies consider that UDC is a very useful function, maybe we should avoid introducing too much specification impacts for the DAPS+UDC case. More discussion is probably needed to understand all potential impacts. If UDC is included in DAPS, maybe we could include EHC as well. |
| China Unicom | We suggest not to support UDC for DAPS due to lack of time. |
| China Telecom | No strong preference |
| CMCC | No strong perference |
| QC | We are OK to have UDC support. We have same view as Samsung.  If time permits, we can consider support in R16 DAPS. |
| Futurewei | Given the time limit, we suggest not to discuss UDC in this release. |

**Conclusion 7:** Based on companies’ inputs, the majority view is that the UDC should not be considered in Rel-16 due to lack of time. Thus, we propose that the UDC should not be supported for DAPS HO in Rel-16, and the DRBs configured with UDC is not supported for DAPS HO in Rel-16.

**Proposal 6. The UDC should not be supported for DAPS HO in Rel-16, and the DRBs configured with UDC is not supported for DAPS HO in Rel-16.**

The rapporteur would like to ask the concern on proposal 6. Please do not present the same concern as stated above.

|  |  |
| --- | --- |
| Company | Concern |
| Futurewei | Agree with rapporteur’s proposal. |
|  |  |
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## 2.7 How to prevent the transmission of the packet generated by the non-DAPS DRBs?

As stated in [3], it was addressed that the LCHs corresponding to non-DAPS DRBs should not be considered for LCP procedure of the source MAC entity during DAPS handover, not to allow the uplink resource to LCHs corresponding to non-DAPS DRBs, which should not perform data transmission. Thus, it is proposed that during DAPS handover, the source MAC entity selects only the logical channels corresponding to DAPS DRBs when the LCP procedure is applied.

For this issue, the summary rapporteur supposes that current running RRC CR [4] implies that the previous *LogicalChannelConfig* of non-DAPS DRBs from the source MAC entity has been already replaced. With this understanding, the summary rapporteur suggests that RAN2 confirm the understanding that whether the *LogicalChannelConfig* of non-DAPS DRBs from the source MAC entity should be released during DAPS HO. For this issue, we would like to ask the RAN2 companies to answer the following question:

Q8. Do you think the *LogicalChannelConfig* of non-DAPS DRBs from the source MAC entity should be released during DAPS HO?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| LG | No | If the UE performs the DAPS HO, the RLC entity associated with non-DAPS HO performs the re-establishment procedure. In other words, there is no stored RLC PDUs in the transmission buffer. Thus, even if the previous LCH config is applied, the RLC PDUs associated with non-DAPS HO are not transmitted to the source cell. Thus, we do not need to specify anything to prevent the transmission of the packet generated by non-DAPS DRBs. |
| Samsung | No (Yes if possible) | Regardless of RLC re-establishment and stored data, in principle, the source MAC entity performs LCP procedure for the LCHs of non-DAPS DRBs during DAPS handover, which would not be the intention. That’s the problem. The source MAC entity doesn’t have to apply LCP procedure to the LCHs of non-DAPS DRBs. |
| MediaTek | No | Agree with LG. |
| OPPO | No | We share the same view as LG. RLC entity has been re-established during HO and therefore the RLC PDUs generated by this RLC entity would be transmitted only to the target cell. |
| Ericsson | No (?) | Agree with the Samsung’s comment that it’s not the intention to consider the LCH of non-DAPS DRBs in the LCP procedure. But if we understand LG’s comment correctly, the non-DAPS LCGs will anyway not affect the outcome of the LCP (since the RLC transmission buffer is empty). If this is true then we are fine with not releasing the non-DAPS LCHs from the source MAC entity. |
| Intel | No | Agree with LG. RLC and PDCP for non-DAPS DRB have been reestablished, and no data can be delivered to MAC even if LogicalChannelConfig is still there for source. |
| Nokia | No | We agree LCHs for non-DAPS shall not be served during DAPS by not considering those in LCP. We share what LG pointed out – due to no RLC PDUs for non-DAPS bearers, there should be no issue at MAC level. |
| Apple | No | Agree with LG. There will be no data from non-DAPS LCHs for data transmission/reception during the DAPS HO, so it’s unnecessary to release it. |
| NEC | No | We understand there are three options. The first is to release the *LogicalChannelConfig*, the second is to keep the *LogicalChannelConfig* but do not perform LCP for LCH of non-DAPS DRB, the third is to do nothing. As LG commented, even we do nothing, there is no impact to the outcome of the LCP. We are ok to keep the LC configuration as most companies prefers. |
| ZTE | No | Considering the UE may need to revert back to old configuration in some failure case, we think the LCH for non-DAPS DRB shall be kept and suspended during the DAPS, and will be released when the source link is released. Otherwise, we may need to establish a new LCH in case the UE need to revert back to old configuration, and it is not clear how to align he RLC state variables between UE and source gNB in that case. |
| Huawei, HiSilicon | No | As non DAPS DRB follows legacy procedures, i.e. RLC re-establishment, so there is no PDU to be transmit. No need to specify specific behaviour for LCP. |
| CATT | No | Agree with LG’s comments. |
| ETRI | No | Same view as LG. |
| vivo | ? | Even though we have the RLC re-establishment for the non-DAPS DRB, if the RLC entity of the non-DAPS DRB is still associated with the source MAC entity, the LCP procedure would still indicate the PDCP of the non-DAPS DRB to send packets to the source MAC entity. Maybe we could clarify that the RLC entity of non-DAPS DRB is not associated with source MAC entity anymore while receiving the DAPS handover command. |
| China Unicom | No | No need to specify this. |
| China Telecom | No | Same view as LG. |
| CMCC | No | Agree with LG’s comments. |
| QC | No | Agree with Samsung comment. |
| Futurewei | No | Agree with LG. |

Q9. If the answer for Q8 is yes, do you think that the further clarification in RRC is needed?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| LG |  | We do not need to specify anything for this issue. |
| Samsung | No (Yes if possible) | Clarification is needed but, as mentioned in [3], we think it may not be easy to clarify this in RRC. |
| Intel |  | Same view as LG. |
| QC |  | Clarification is better to have in MAC |

Q10. If the answer for Q8 is no, do you agree that “the source MAC entity selects only the logical channels corresponding to DAPS DRBs when the LCP procedure is applied, and the LCHs corresponding to non-DAPS DRBs should not be considered for LCP procedure of the source MAC entity during DAPS HO”

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| LG |  | We do not need to specify anything for this issue. |
| Samsung | Yes | The source MAC entity doesn’t have to apply LCP procedure to the LCHs of non-DAPS DRBs. |
| OPPO | No | No need to specify anything. |
| Ericsson | Yes | This is the intention. Whether we need to make any specification changes to ensure this we don’t know. |
| Intel | No | Anyway, there is no data available in MAC for non DAPS DRB, we do not see the need to specify anything. |
| Nokia | Yes | That shall be the desired behaviour, but we agree nothing needs to be specified. |
| Apple | No | It has no spec impact. |
| NEC |  | We do not have to specify, this can be based on UE implementation, |
| ZTE | Yes | We agree the intention, and it seems we can simply capture in MAC that the MAC entity shall not transmit data for a suspended logical channel, and capture in RRC the LCH for non-DAPS DRB in source link shall be suspended. |
| Huawei, HiSilicon | No | No need to specify as there is no data for transmission in non DAPS DRB. |
| CATT | No | We do not see a need to specify anything here. |
| vivo | ? | We consider that the current running CR seems already implying that the logicalChannelConfiguration of the non-DAPS DRB has been changed when the DAPS handover command is received. |
| China Unicom | No | No need to specify this. |
| China Telecom | No | No need to specify this. |
| CMCC | No | We prefer to not specify anything for this. |
| QC | Yes | Same view as Samsung |
| Futurewei | No | No need to specify as the scenario does not occur. |

**Conclusion 8:** Based on companies’ inputs, the majority view is that RAN2 do not need to specify anything. Since even if the *LogicalChannelConfig* of non-DAPS DRBs for source cell is maintained during DAPS HO, the data associated with source cell is not transmitted to the source cell.

However, in the 109e#210 offline discussion, i.e., RRC procedural issues, it is discussed how to handle the non-DAPS DRBs in Q13 as follows.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| We need to further discuss the stage-3 details of how to ensure UE reverts back source cell keys for non-DAPS DRBs. Based on companies’ online comments and offline feedback, we gather the following options for further consideration.  Option 1: PDCP re-establishment twice. Upon reception of handover command, the first PDCP re-establishment should be performed to apply target keys. Then if DAPS HO fails, the second PDCP re-establishment should be performed to revert back source keys.  Option 2: non DAPS DRB suspend. UE suspends non-DAPS DRBs upon the reception of DAPS HO command, UE resumes non-DAPS DRBs at DAPS HO fallback, and UE only performs PDCP re-establishment for non-DAPS DRBs only when random access is successfully completed to the target.  Option 3: leave it to UE implementation. We only specify “For non DAPS DRB, upon DAPS handover failure, UE reverts back to the original source configuration”, UE can choose their own implementation.  Option 4: Add the clarification in 5.3.5.8.3, highlighted in yellow as below.  3> for each DRB without a DAPS PDCP entity:  4> revert back to the UE configuration used for the DRB in the source, includes PDCP, ~~and~~ RLC states and the keys used in the source;  4> resume DRB;  3> revert back to the UE RRM configuration used in the source;  Option 5other options?   |  |  |  | | --- | --- | --- | | **Question 13: which option do you prefer?** | | | | **Company** | **Option** | **Comments** | |

If above Option 2 is agreed, the RLC entity configured for the non-DAPS may not be re-established upon receiving the HO command. This is because the target configuration for the non-DAPS is applied only when random access is successfully completed to the target cell. In other words, the RLC entity configured for the non-DAPS may have the RLC SDUs and PDUs in the transmission buffer. In this case, the source MAC entity should not apply LCP procedure to the LCHs of non-DAPS DRBs.

Considering that, we propose that the *LogicalChannelConfig* of non-DAPS DRBs is maintained in the source MAC entity during DAPS HO if the RLC entity configured with non-DAPS performs the re-establishment upon receiving the HO command.

**Proposal 7. The LogicalChannelConfig of non-DAPS DRBs is maintained in the source MAC entity during DAPS HO if the RLC entity configured with non-DAPS performs the re-establishment upon receiving the HO command.**

The rapporteur would like to ask the concern on proposal 7. Please do not present the same concern as stated above.

|  |  |
| --- | --- |
| Company | Concern |
| Futurewei | Fine with proposal 7. |
| QC | There is difference in above yellow highlighted sentences. When DAPS HO command is received. if option2 is agreed then PDCP/RLC re-establishment happens upon successful RACH. Reason for UE to maintain non-DAPS DRB logical channel in source MAC is to handle fallback scenario without any RLC re-establishment for fallback case.  We think proposal 7 need to be modified as below.  **Proposal 7. The LogicalChannelConfig of non-DAPS DRBs is maintained in the source MAC entity during DAPS HO if the RLC entity configured with non-DAPS does not performs the re-establishment upon receiving the HO command.** |
|  |  |
|  |  |

# 3 Conclusions

Based on the above discussion, we propose the followings.

**Proposal 1. Discuss whether the PDCP status report for UM DRBs is needed.**

**Proposal 2. The second PDCP status report is introduced only for AM DRBs, and the text proposal in Annex A is used as baseline.**

**Proposal 3. How to handle the stored PDCP PDUs received from the source cell when releasing the source cell is specified using NOTE in the PDCP specification, and the text proposal in Annex B is used as baseline.**

**Proposal 4. The target cell always transmits the PDCP PDUs containing IR packet until releasing the source cell, and the text proposal in Annex C is used as baseline.**

**Proposal 5. RAN2 do not specify two reordering functions in PDCP.**

**Proposal 6. The UDC should not be supported for DAPS HO in Rel-16, and the DRBs configured with UDC is not supported for DAPS HO in Rel-16.**

**Proposal 7. The LogicalChannelConfig of non-DAPS DRBs is maintained in the source MAC entity during DAPS HO if the RLC entity configured with non-DAPS performs the re-establishment upon receiving the HO command.**

# 4 List of referenced documents

[1] R2-2001532 “Summary on PDCP/RLC aspects of DAPS HO in AI 7.3.2.1.1” LG Electronics Inc.

[2] R2-2000461 “Report of [108#66][LTE NR Mob] Open issues for LTE and NR mobility” Intel.

[3] R2-2002099 “Summary of DAPS MAC” vivo.

[4] R2-2000462 “RRC running CR for introduction of NR mobility enhancement [108#34]” Intel.

# Annex A (Text proposal for 38.323 on second PDCP status report)

## 5.4 Status reporting

### 5.4.1 Transmit operation

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

- upper layer requests a PDCP entity re-establishment;

- upper layer requests a PDCP data recovery;

- for DAPS bearers, upper layer requests a uplink data switching;

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

If a PDCP status report is triggered, the receiving PDCP entity shall:

- compile a PDCP status report as indicated below by:

- setting the FMC field to RX\_DELIV;

- if RX\_DELIV < RX\_NEXT:

- allocating a Bitmap field of length in bits equal to the number of COUNTs from and not including the first missing PDCP SDU up to and including the last out-of-sequence PDCP SDUs, rounded up to the next multiple of 8, or up to and including a PDCP SDU for which the resulting PDCP Control PDU size is equal to 9000 bytes, whichever comes first;

- setting in the bitmap field as '0' for all PDCP SDUs that have not been received, and optionally PDCP SDUs for which decompression have failed;

- setting in the bitmap field as '1' for all PDCP SDUs that have been received;

- submit the PDCP status report to lower layers as the first PDCP PDU for transmission via the transmitting PDCP entity as specified in clause 5.2.1.

*FFS: whether PDCP status reporting for DAPS bearers is needed for UL or DL for RLC UM.*

# Annex B (Text proposal for 38.323 on handling of stored PDCP PDUs)

## 5.1 PDCP entity handling

### 5.1.X PDCP entity reconfiguration

When upper layers request a PDCP entity reconfiguration and DAPS is configured for a data radio bearer, UE shall:

- establish a ciphering function for the radio bearer and apply the ciphering algorithm and key provided by upper layers for the ciphering function;

- establish an integrity protection function for the radio bearer and apply the integrity protection algorithm and key provided by upper layers for the integrity protection function;

- establish a header compression protocol for the radio bearer and apply the header compression configuration provided by upper layers for the header compression protocol.

When upper layers request a PDCP entity reconfiguration and the associated RLC entity is released for a radio bearer, UE shall:

- release the ciphering function associated to the released RLC entity for the radio bearer;

- release the integrity protection function associated to the released RLC entity for the radio bearer;

- release the header compression protocol associated to the released RLC entity for the radio bearer.

NOTE 1: The state variables which control the transmission and reception operation should not be reset, and the timers including *t-Reordering* and *discardTimer* keep running during PDCP entity reconfiguration procedure.

NOTE 2: Before releasing the header compression protocol associated to the released RLC entity, all stored PDCP SDUs received from the released RLC entity should be decompressed and stored in the reception buffer.

# Annex C (Text proposal for 38.323 on consecutive ROHC decompression failure)

### 5.7.4 Header compression

If header compression is configured, the header compression protocol generates two types of output packets:

- compressed packets, each associated with one PDCP SDU;

- standalone packets not associated with a PDCP SDU, i.e. interspersed ROHC feedback.

A compressed packet is associated with the same PDCP SN and COUNT value as the related PDCP SDU. The header compression is not applicable to the SDAP header and the SDAP Control PDU if included in the PDCP SDU.

For DAPS bearers, the PDCP entity shall perform the header compression for the PDCP SDU using the header compression protocol either configured for the source cell or configured for the target cell, based on to which cell the PDCP SDU is transmitted. For downlink, the header compression protocol of the target cell shall maintain the IR state in U-mode during DAPS handover. Interspersed ROHC feedback are not associated with a PDCP SDU. They are not associated with a PDCP SN and are not ciphered.

NOTE: If the MAX\_CID number of ROHC contexts are already established for the compressed flows and a new IP flow does not match any established ROHC context, the compressor should associate the new IP flow with one of the ROHC CIDs allocated for the existing compressed flows or send PDCP SDUs belonging to the IP flow as uncompressed packet.