**3GPP TSG RAN WG1 #104-e R1-210xxxx**

**e-Meeting, January 25th - February 5th, 2021**

Source: Moderator (vivo)

Title: Email discussion on [104-e-NR-L1enh-URLLC-06] for intra-UE prioritization

Agenda Item: 7.2.5

Document for: Discussion and Decision

1. Introduction

This document is used to discuss the following:

[104-e-NR-L1enh-URLLC-06] Email discussion/approval on remaining issues on intra-UE prioritization – Lihui (Vivo) by Feb 3

* Issue 1: PHY behavior for collision between CG and DG with same/different PHY-priority index
* Reply LS to [R1-2100026](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_104\Docs\R1-2100026.zip) on overlapped data and SR with equal L1 priority for Rel-16 URLLC

Note that the 1st deadline for the views input is set to be 26th Jan. 11:59pm UTC.

1. Discussions

* 1. Discussion on overlapped data and SR of equal L1 priority

Following LS is received from RAN2 [14]:

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| RAN2 confirms the intended UE behavior: For the case of overlapping PUSCH and SR with equal L1 priority and MAC has not yet delivered MAC PDU for the PUSCH to PHY, if SR is prioritized in MAC, MAC shall not deliver the MAC PDU for the PUSCH and shall instruct PHY for SR transmission.  RAN2 respectfully asks RAN1 to confirm if the intended UE behavior mentioned above can be supported. |

Precondition on above LS should be that the LCH based prioritization is configured.

Before detailed discussion, it may be good to make some clarifications on the following agreed CR in R1-2009687:

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| **38.214 6.1           UE procedure for transmitting the physical uplink shared channel**  <unchanged part omitted>  A UE shall upon detection of a DCI format scheduling a PUSCH transmit the corresponding PUSCH unless the UE does not generate a transport block as described in [10, TS38.321]. Upon detection of a DCI format 0\_1 or 0\_2 with "UL-SCH indicator" set to "0" and with a non-zero "CSI request" where the associated "reportQuantity" in *CSI-ReportConfig* set to "none" for all CSI report(s) triggered by "CSI request" in this DCI format 0\_1 or 0\_2, the UE ignores all fields in this DCI except the "CSI request" and the UE shall not transmit the corresponding PUSCH as indicated by this DCI format 0\_1 or 0\_2.  <unchanged part omitted> |

The initial intention for this CR is mainly for the UL skipping agreement. However, from the agreement made in RAN1#103 meeting, it should be understood by the group that the CR can also cover the intended behavior for some collision scenarios in PHY layer when *lch-basedPrioritization* is configured.

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| **Agreement**  Send an LS to RAN2 to convey the following:   * For the collision scenario between CG and DG with same/different PHY-priority index, if there is no collision between PUCCH and the CG and there is no collision between PUCCH and the DG, the behavior mentioned in the LS is consistent with RAN1’s understanding if taking into account the TP to Rel-16 TS 38.214, i.e., revision CR in R1-2008655. * When the MAC entity is configured with *lch-basedPrioritization*, for the collision scenario between CG and DG with same/different PHY-priority index, and when there is collision between PUCCH and the CG with the same priority and/or there is collision between PUCCH and the DG with the same priority, RAN1 is still discussing the related PHY layer behavior. |

Therefore, it is more constructive to first discuss the preferred PHY layer behavior for the collision case that overlapped data and SR of equal L1 priority as asked by RAN2; then we can check whether the CR in R1-2009687 covers the intended behavior and/or any modification need to be made for the current specification.

Based on the submitted contributions, following cases should be considered:

* + 1. Case 1 of overlapping only between SR and PUSCH of equal L1 priority
* **Case 1: overlapping is only between the SR and PUSCH with equal L1 priority**



Figure 1: overlapping UL-SCH resource(s) and SR of equal L1 priority only (borrow from R1-2100318)

For Case 1, companies’ views are summarized as below:

* Option 1: RAN1 support the intended behavior as asked by RAN2 that if SR is prioritized in MAC, MAC shall not deliver the MAC PDU for the PUSCH to PHY and MAC shall instruct PHY for SR transmission.
  + Reasons:
    - Consistency can be kept between RAN1 and RAN2.
    - With LCH based prioritization, the SR associated with the logical channels having high priority should be prioritized over the PUSCH associated with the logical channels having low priority. Although SR and PUSCH are of equal L1 priority.
* Option 2: RAN1 do not support the intended behavior as asked by RAN2, the PUSCH should be transmitted and SR should be dropped.
  + Reasons:
    - Workload at Network side for blind detection between SR and PUSCH.
    - In current RAN1 specification TS 38.213 section 9.2.5, if SR and PUSCH with the same priority overlaps in the time domain, the UE does not transmit SR when performing UCI multiplexing in the PUSCH.

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| For each PUCCH resource in the set  that satisfies the aforementioned timing conditions, when applicable,  - the UE transmits a PUCCH using the PUCCH resource if the PUCCH resource does not overlap in time with a PUSCH transmission after multiplexing UCI following the procedures described in Clauses 9.2.5.1 and 9.2.5.2  - the UE multiplexes HARQ-ACK information and/or CSI reports in a PUSCH if the PUCCH resource overlaps in time with a PUSCH transmission, as described in Clause 9.3, and does not transmit SR. In case the PUCCH resource overlaps in time with multiple PUSCH transmissions, the PUSCH for multiplexing HARQ-ACK information and/or CSI is selected as described in Clause 9. If the PUSCH transmission by the UE is not in response to a DCI format detection and the UE multiplexes only CSI reports, the timing conditions are not applicable  - the UE does not expect the resource to overlap with a second resource of a PUCCH transmission over multiple slots if the resource is obtained from a group of resources that do not overlap with the second resource. |

* Option 3: RAN1 should discuss and define if and how the processing time in the PHY layer is affected by the LCH-based prioritization in the MAC layer.
  + - Reasons: For the overlapping of SR and DG PUSCH with the same L1 priority in R16, the DG PUSCH may be de-prioritized in the MAC layer and hence the PHY layer needs to wait for a decision from MAC to continue the processing of DG PUSCH, which may result in an increased processing time for DG PUSCH in some cases.

**Q-a: What is your preferred option and your views for other options?**

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| Company | Comments |
| Nokia, NSB | Support Option 1  Reasons:  Option 2 basically would remove the LCH prioritization overall for this case. The quoted RAN1 specs assumes here that a PDU has been delivered.  Option 3: with UL skipping, PHY anyhow cannot react until getting a PDU delivered (this should be the understanding since Rel-15). So unclear need for discussion on processing time-line here. |
| ZTE | We support Option 2.  The collision between SR and PUSCH with the same PHY priority is similar as the collision between PUSCH and PUCCH in case of UL skipping, for which the PUSCH cannot be skipped. The reasoning is similar as UL skipping that we need to avoid blind detection between SR and PUSCH at gNB side. |
| FL’s reply to ZTE: As can be seen from below, the “UCI” in UL skipping agreements intend to include only HARQ-ACK and CSI feedback, and not SR. The complexity for blind detection for SR and PUSCH is not same as the “HARQ-ACK/CSI” on PUSCH or on PUCCH, since for SR and PUSCH, either SR is transmitted or PUSCH is transmitted; but for “HARQ-ACK/CSI” on PUSCH or on PUCCH in case of CA, it is not sure which PUSCH on which CC may carry the HARQ-ACK/CSI, which is complicated for gNB’s BD.  Agreements from RAN1 #102-e:  **Agreement**  Send an LS to RAN2 to inform them of the latest RAN1 agreement on uplink skipping. LS is endorsed in [~~R1-2007336~~](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2007336.zip)[R1-2007338](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_102\Docs\R1-2007338.zip)   |  |  | | --- | --- | | In Rel-15, for dynamic UL skipping, RAN1 discussed the LS R1-2000015 from RAN2 and provided replies in R1-2001376 for Case 1 of dynamic PUSCH skipping without overlapping CSI/HARQ-ACK on PUCCH.  Case 2 of dynamic PUSCH skipping with overlapping CSI/HARQ-ACK on PUCCH was further discussed in RAN1. In RAN1#101-e meeting, it was concluded that in Rel-15, the UE behavior is undefined for case 2 and case 2 can be addressed for Rel-16. Endorsed CR R1-2005044 (TS38.214, Rel-15, CR#0105, Cat. F) for Case 1 and Case 2 can be found in the attachment.  In Rel-16, RAN1 continued the discussion for Case 2 and made following agreements in RAN1#102-e meeting:   |  | | --- | | **Agreement**  For UL skipping of dynamic UL grant in non-CA and CA case, when there is PUCCH carrying UCI overlapping with a set of PUSCHs, the PUSCH with UCI multiplexing from the set cannot be skipped. MAC generates MAC PDU for the PUSCH and the UCI is multiplexed on the PUSCH. |   Based on above agreements, RAN1 in principle agreed the corrections for Rel-16 TS 38.214 (R1-200xxxx), assuming that RAN2 will update the Rel-16 sepcification TS 38.321 corresponding to the above agreement so that UE generates the MAC PDU for the PUSCH with UCI multiplexing.  In addition, RAN1 noticed that in Rel-15, dynamic UL skipping is an optional feature with capability signaling (*skipUplinkTxDynamic*). It is RAN1’s understanding the dynamic UL skipping cannot be implemented based on the Rel-15 specification. For Rel-16 with the defined UE behavior for dynamic UL skipping, RAN1 has discussed  following two options for the capability signaling handling. However, the final decision on the capability design for Rel-16 dynamic UL skipping should be decided by RAN2.   * Option 1: introduce a new UE capability for Rel-16 dynamic UL skipping * Option 2: Reuse Rel-15 UE capability with the understanding that Rel-15 dynamic UL skipping is not implementable therefore UEs indicating this capability should implement Rel-16 behavior. | | |
| DOCOMO | We prefer Option 1.  For Option 2, as MAC does not deliver the MAC PDU for the PUSCH to PHY, PUSCH does not exist in PHY and the overlapping does not happen.  For Option 3, as the PHY behaviour does not change from Rel.15, no additional processing time is necessary. |
| HW/HiSi | Before formally answering the LS, RAN1 should discuss the time-line for the UE behavior that is intended by the new LS from RAN2.  In Rel-15, when PHY detects the DCI that results in an overlap between DG PUSCH and SR, PHY can expect a MAC PDU to be delivered and PHY can prepare the PUSCH transmission without an interruption of UE PHY pipeline processing.  As a response to Nokia’s comment above, we described this potential time-line issue in R1-2101277 (“*PHY delivers the DCI to MAC and at the same time stops the processing of the SR transmission (if the SR is on processing at the PHY or already on transmission). The stopping operation does not incur any extra processing time for the PUSCH preparation since at the same time, the MAC layer is assembling the MAC PDU in parallel. Therefore, in Rel-15, PHY can decide independently from MAC to drop the SR and it can always expect MAC to deliver the MAC PDU. Hence, the preparation of the PUSCH in PHY is not interrupted*”)  However the requested behavior in the LS is different. The SR and PUSCH may have different L2 priorities and MAC may prioritize the SR according to the LCH-based prioritization. As a result, the PHY layer cannot judge if the PUSCH shall be transmitted and it must wait for the MAC decision, i.e. PHY has to wait whether the MAC PDU is delivered or not. Hence, the processing timeline of DG PUSCH may be affected. |
| FL’s question to HW/HiSi: thanks a lot for the detailed explanation. As you mentioned, “the stopping operation does not incur any extra processing time for the PUSCH preparation since at the same time, the MAC layer is assembling the MAC PDU in parallel.” If MAC PDU can be prepared in parallel with SR, then why decide to transmit or stop SR would affect DG processing timeline?  [HW/HiSi] What we mean is that originally in Rel-15, the SR can be stopped in PHY parallel with MAC is preparing the PDU. Therefore, no time is wasted. For the UE behaviour according to the LS, however, PHY has to stop the SR once it has received the MAC PDU. In that situation, PHY needs more time.  In addition, do you have any option on how to define the processing timeline in Rel-16? I feel it is difficult at Rel-16 maintenance stage.  [HW/HiSi] We think that time-line should be relaxed and hope to discuss the details within the group. Starting point could be the same rules that are applied for intra-UE prioritization, i.e. if the PUSCH is transmitted; the processing timeline is extended by d2 symbols.  From RAN1#99:   |  | | --- | | Agreement  When a high-priority UL transmission overlaps with a low-priority UL transmission in a slot,   * The UE is expected to cancel the low-priority UL transmission starting from *T*proc,2 + *d*1 after the end of PDCCH scheduling the high-priority transmission, where * *T*proc,2 is correponding to UE processing time capability for the carrier. * Value *d*1 is the time duration corresponding to 0,1,2 symbols reported by UE capability * Note: *d*2,1=0 is for cancellation * The minimum processing time of the high priority channel is extended by *d*2 symbols * Value *d*2 is the time duration corresponding to 0,1,2 symbols reported by UE capability   The overlapping condition is per repetition of the uplink transmission | | |
| OPPO | We support option1 to align with RAN2.  Option 2 is not preferred due to it makes LCH prioritization not work. |
| Qualcomm | We are fine with Option 1. |
| LG | We support Option 1. If MAC doesn’t not instruct MAC PDU to PHY, UE cannot handle PUSCH scheduling in PHY so the PUSCH scheduling should be treated as non-existent. |
| Intel | We are fine with Option 1. However, with this option, we would need to address the case when UE is NOT configured with UL skipping (e.g., if NOT configuring UL skipping can work in this case). |
| FL’s question to Intel: my understanding is for only SR overlapping with the PUSCH, regardless whether UL skipping is configured or not, if MAC does not deliver the MAC PDU, and MAC instruct PHY to transmit the SR, then UE should transmit SR. May I miss your intention? | |
| Samsung | It needs to do clarification further on RAN 2 LS. If PUSCH includes UL-SCH with HARQ and/or CSI, option 2 should be applied since it is aligned with current specification. Otherwise (that is, PUSCH includes only UL-SCH without HARQ and CSI, we think that this is not covered by current specification. So, option 1 could be applied. Regarding option 2, we think that LCH-prioritization mechanism itself needs more blind detection to gNB side. If gNB blind detection is real problem, gNB should not enable/configure LCH-prioritization. Regarding option 3, it is not expected that processing time is real burden to UE side. |
| FL’s question to Samsung: if the UL-SCH with HARQ and/or CSI, you mean the case 2 and case 3 in section 2.1.2 and 2.1.3, right? | |
| CATT | We prefer Option 1 |

Second round

* + - 1. Summary for Case 1

For the case that there is resource overlapping only between the SR and PUSCH with equal L1 priority as shown in Figure 1,

* Option 1 is supported by Nokia, NSB, DCM, OPPO, QC, LG, Intel, Samsung, vivo, CATT
* Option 2 is supported by ZTE
* Option 3 is supported by HW/HiSi

Therefore, following is proposed:

**Proposal 1:**

* For the case that there is resource overlapping only between the SR and PUSCH with equal L1 priority as shown in Figure 1 and the PUSCH does not include HARQ and/or CSI, RAN1 confirms that the intended UE behavior of overlapped data and SR of equal L1 priority is aligned with RAN2, i.e. for the case of overlapping PUSCH and SR with equal L1 priority and MAC has not yet delivered MAC PDU for the PUSCH to PHY, if SR is prioritized in MAC, MAC shall not deliver the MAC PDU for the PUSCH and shall instruct PHY for SR transmission.

Any comments?

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| --- | --- |
| Company | Comments |
| DOCOMO | Agree with the proposal |
| Nokia, NSB | Agree |
| Ericsson | Support the proposal |
| CATT | Add CATT to Option 1.  Support the proposal |
| HW/HiSi | We do not intend to oppose to the LS at this stage. Eventually we could be fine. But the intended behavior has impact on the time-line as we described above especially for UE processing capability 2. We hope to hear more views from other companies on this issue and would like to discuss this before drafting the LS response.  And we also would like to discuss how MAC knows whether PUSCH would include HARQ-ACK/CSI or not when MAC does LCH-prioritization. As commented before, if PHY needs to deliver the multiplexing result to the MAC layer and then MAC would deliver the MAC PDU or SR based on the result from the physical layer, there would be also an impact on the processing time-lines in PHY. |
| ZTE | For the discussion of the UL skipping in case of overlapping between PUCCH and PUSCH, the UCI does not include SR. The reason is RAN1 believe this case cannot happen at least for Rel-15. In other words, if the SR overlaps with PUSCH, RAN1 believe the MAC does not instruct PHY to transmit SR at all. In Rel-16, when the two channels with the same L1 priority overlaps, the Rel-15 behavior is reused.  For the UCI other than SR overlaps with PUSCH, RAN1 seeks for some methods to avoid the network blind detection. We do not know why network blind detection is not an issue in case of overlapping between SR and PUSCH with the same L1 priority.  Considering there are many cases as discussed below, a unified solution is preferred since it has less spec impact and is also beneficial for the UE implementation. MAC layer also does not need to consider such many and complex scenarios. The only unified solution is that the MAC generates the MAC PDU for the PUSCH and does not instruct PHY for SR transmission. |

* + 1. Case 2 of overlapping between other UCIs and SR and between SR and PUSCH of equal L1 priority
* **Case 2: other UCI(s) i.e., HARQ-ACK and/or CSI overlap with SR of equal L1 priority and the SR overlaps with the PUSCH of equal L1 priority**



Figure 2: other UCI(s) overlaps with SR and PUSCH of equal L1 priority (borrow from R1-2100318)

* **Case 2-1: PUCCH resource after UCI multiplexing among different PUCCHs does not overlap with PUSCH(s)**



Figure 3: PUCCH resource after UCI multiplexing among different PUCCHs does not overlap with PUSCH(s) (borrow from R1-2100318)

For case 2-1, following can be proposed:

* **Proposal 1: For the case of overlapping between PUSCH and SR with equal L1 priority, if there are other UCI(s) i.e., HARQ-ACK and/or CSI of the same L1 priority overlapping with SR and the PUCCH resource after UCI multiplexing among different PUCCHs does not overlap with the PUSCH, MAC can deliver MAC PDU for the PUSCH and instruct PHY for SR transmission.**

**Q-b: Do you agree above proposal 1? If not, what is your views and proposal for the case 2-1?**

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| Company | Comments |
| Nokia, NSB | We are a bit wondering, if for both cases here actually the MAC could deliver the SR & the PUSCH in the first place. As from MAC perspective for both cases 2a and 2b, SR and PUSCH are overlapping (as any other UCI multiplexing is not considered in MAC) 🡪 with higher SR LCH priority the SR (and no PUSCH TB) would be delivered, with the same LCH priority the PUSCH TB would be delivered to PHY (but not the SR) |
| ZTE | Fine with the proposal.  We prefer not to change the PHY multiplexing behavior. The MAC behavior (whether generate MAC PDU for PUSCH or instruct PHY for SR transmission) could be based on the intermediate decision of multiplexing from PHY. |
| DOCOMO | Agree |
| HW/HiSi | According to our understanding it should be clarified firstly if and how MAC is made aware of the multiplexing in the PHY layer. According to Rel-15 the multiplexing between HARQ-A/N and SR is transparent to MAC. MAC does not need to know whether the PUCCH after multiplexing overlaps with PUSCH or not.  If PHY needs to deliver the multiplexing result to the MAC layer and then MAC would deliver the MAC PDU based on the result from the physical layer, there would be an impact on the processing time-lines in PHY. Is there something that we are missing? |
| OPPO | Agree. |
| Qualcomm | Agree with the comment from HW/HiSi. The MAC layer is not aware of the presence of the other channels and cannot based its decision on that. Hence, we do not agree with the proposal. |
| LG | We have similar view to Huawei/HiSilicon. At least it seems difficult to generate MAC PDU according to a result of UL multiplexing and PHY processing. Based on the specification, multiplexing timeline should be guaranteed in any cases so PHY layer would know whether MAC PDU is instructed with sufficient time. If MAC PDU is not instructed, UE should multiplex UL channel as if PUSCH does not exist. |
| Intel | Agree with Nokia, HW, and others on transparency to MAC regarding UCI mux on PUCCH, which contradicts the proposal. |
| Samsung | In RAN2 perspective, it is not clear on whether SR resource means the resource before multiplexing or the resource after multiplexing in MAC specification. If former one is correct, proposal 1 is not valid. Otherwise, proposal 1 is valid. Actually, we tend to think that former one is more reasonable since MAC does not which PUCCH resource is for CSI and/or HARQ-ACK. |
| CATT | We support FL proposal 1. |

Second round

* + - 1. Summary for Case 2-1

For the case of overlapping between PUSCH and SR with equal L1 priority, if there are other UCI(s) i.e., HARQ-ACK and/or CSI of the same L1 priority overlapping with SR and the PUCCH resource after UCI multiplexing among different PUCCHs does not overlap with the PUSCH,

* Some companies think MAC can deliver MAC PDU for the PUSCH and instruct PHY for SR transmission; Some companies think that the MAC may not be aware of the UCI multiplexing procedure in PHY and MAC does not know whether the PUCCH after multiplexing overlaps with PUSCH or not. Therefore, following can be considered to include to the reply LS

**Proposal 2: include following in the reply LS to RAN2:**

For the case of overlapping between PUSCH and SR with equal L1 priority, if there are other UCI(s) i.e., HARQ-ACK and/or CSI of the same L1 priority overlapping with SR and the final PUCCH resource after UCI multiplexing among different PUCCHs does not overlap with the PUSCH as shown in Figure 3, it is not clear to RAN1 whether MAC is aware of the UCI multiplexing procedure in PHY layer and whether MAC is aware of the final PUCCH after multiplexing may not overlap with PUSCH.

* ~~If MAC is aware of the above, then MAC can deliver MAC PDU for the PUSCH and instruct PHY for SR transmission;~~
* ~~If MAC is not aware of the above and~~ 
  + ~~if MAC delivers the SR without delivering the PUSCH, then the PUCCH including SR and HARQ-ACK/CSI is transmitted, but the PUSCH is dropped unnecessarily;~~
  + ~~if MAC delivers the PUSCH without delivering the SR, PHY can handle this case same as in Rel-15.~~

Any comments?

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| --- | --- |
| Company | Comments |
| DOCOMO | Agree with the proposal as it’s better to clarify MAC behavior. |
| Nokia/NSB | It clearly is better to clarify the MAC behavior, but I guess the two bullets below should not show up in the LS to RAN2 (as this is PHY handling depending if SR or PUCCH are delivered).  Or is the suggestions, that we in RAN1 defined the operation as given by the 2 bullets? |
| Ericsson | Do not agree with the proposal.  First, we agree with several companies’ understanding that MAC is not aware (and should not be required to be aware) of potential multiplexing of SR + other UCI. There is no MAC spec indicating that MAC should check PUCCH multiplexing before making decision about sending SR or PDU to PHY.  Second, the two sub-bullets under “If MAC is not aware of the above” does not make sense in light of LS question from RAN2.   * For first sub-bullet, MAC made the decision not to send MAC PDU to PUSCH. Then it’s perfectly fine to drop the empty PUSCH. Why the negative statement “PUSCH is dropped unnecessarily”? * For the second sub-bullet, it’s asking something not in RAN2 LS, namely, “SR is prioritized in MAC” according to RAN2 LS.   Third, RAN1 discussion should avoid circular procedure between MAC and PHY. It does not work if MAC decision is based on PHY procedure (e.g., PUCCH resource overlapping after HARQ-ACK/CSI/SR multiplexing), PHY procedure is based on MAC decision (e.g., if MAC sends SR, PUCCH mux uses one PUCCH resource; if MAC does not send SR, PUCCH mux uses another PUCCH resource). |
| FL replies | Thanks for the comments! My intention is to inform RAN2 what the possible PHY layer behavior if MAC layer delivers SR or delivers PUSCH so that they can make the final decision on which one to deliver when SR and PUSCH has equal L1 priority.  If not necessary, I am fine to delete the two bullets. |
| CATT | Agree with the modified proposal |
| HW/HiSI | In our view, MAC layer is not aware of if HARQ-ACK and/or CSI is multiplexed. Even if MAC would be made aware of this, then MAC only knows this info from PHY, i.e. PHY needs to deliver the multiplexing result to MAC by UE implementation.  For not making discussions under wrong assumptions we agree it should be clarified firstly and quickly. Maybe companies can check internally with their RAN2 colleagues?  I would like to share our thought on the original proposal for this second round  Based on our current understanding, we should only discuss the second bullet and delete the first bullet from the proposal. (In our view, if the situation described in the first bullet would happen (i.e. that PDU and SR are sent to PHY), then it should be up to UE implementation which one to transmit).  For the second bullet, we propose to delete “unnecessarily”. We understand it is meant for the performance reasons, but there are implementation related reasons that would make it necessary to drop the PUSCH. We think it is better to only describe the behavior. And in RAN1, we think the timeline issue can be discussed as commented before, which is is not related to RAN2. |
| ZTE | We are not sure if the MAC can be aware of the UCI multiplexing procedure. However, even though it can be aware of the UCI multiplexing procedure, e.g., informed by the PHY, there may be some problems.  In some cases, the multiplexing results (whether the final PUCCH overlaps with PUSCH) depends on whether the SR is transmitted. The MAC layer should generate SR or MAC PDU for PUSCH depending on the multiplexing results. It is an chicken-egg problem. For example, SR and HARQ-ACK with 1 or 2 bits are transmitted using both format 1. For the positive SR (i.e., MAC instructs PHY for SR transmission), the UE transmits HARQ-ACK on the PUCCH resource for SR. In this case, the PUCCH resource after multiplexing overlaps with PUSCH as shown in case 2-1b. According to the multiplexing result, the MAC shall generate MAC PDU for the PUSCH as discussed in case 2-2. It means the MAC shall deliver MAC PDU for the PUSCH and instruct PHY for SR transmission. But RAN1 does not expect the instruction for SR transmission as discussed in case 2-2.  For the negative SR (i.e., MAC does not instruct PHY for SR transmission), the UE transmits HARQ-ACK on the PUCCH resource for HARQ-ACK. In this case, the PUCCH resource after multiplexing does not overlap with PUSCH as shown in case 2-1b. Therefore, the MAC layer shall deliver MAC PDU for the PUSCH and instruct PHY for SR transmission. However, the hypothesis is MAC does not instruct PHY for SR transmission.  How to resolve the issue above?  If the MAC only delivers MAC PDU for the PUSCH and does not instruct PHY for SR transmission, there is no problem. |

* **Case 2-2: PUCCH resource after UCI multiplexing among different PUCCHs overlaps with PUSCH(s)**



Figure 4: PUCCH resource after UCI multiplexing among different PUCCHs overlaps with PUSCH(s) (borrow from R1-2100318)

For case 2-2, if the PUCCH resource after UCI multiplexing among different PUCCHs overlaps with the PUSCH, the multiplexed UCI excluding SR would be multiplexed in the PUSCH. In other words, the SR cannot be transmitted in PHY based on UL skipping agreement and the specification TS 38.213 section 9.2.5 as cited in section 2.1.1 that “the UE multiplexes HARQ-ACK information and/or CSI reports in a PUSCH if the PUCCH resource overlaps in time with a PUSCH transmission, as described in Clause 9.3, and does not transmit SR”. Therefore, MAC should not instruct PHY for SR transmission but should deliver MAC PDU for the PUSCH.

* **Proposal 2: For the case of overlapping PUSCH and SR with equal L1 priority, if there are other UCI(s) i.e., HARQ-ACK and/or CSI of the same L1 priority overlapping with SR and the PUCCH resource after UCI multiplexing among different PUCCHs overlaps with the PUSCH, MAC shall deliver the MAC PDU for the PUSCH and shall not instruct PHY for SR transmission.**

**Q-c: Do you agree above proposal 2? If not, what is your views and proposal for case 2-2?**

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| Company | Comments |
| Nokia, NSB | Same comment as for the above:  We are a bit wondering, if for both cases here actually the MAC could deliver the SR & the PUSCH in the first place. As from MAC perspective for both cases 2a and 2b, SR and PUSCH are overlapping (as any other UCI multiplexing is not considered in MAC) 🡪 with higher SR LCH priority the SR (and no PUSCH TB) would be delivered, with the same LCH priority the PUSCH TB would be delivered to PHY (but not the SR) |
| ZTE | Fine with the proposal.  As commented above, we prefer not to change the PHY multiplexing behavior. The MAC behavior (whether generate MAC PDU for PUSCH or instruct PHY for SR transmission) could be based on the intermediate decision of multiplexing from PHY. In this particular case, MAC can generate BSR in MAC PDU, and the data can still be triggered based on BSR. |
| DOCOMO | Agree |
| HW/HiSi | Same comment as for Q-b. |
| OPPO | Agree |
| Qualcomm | The same comment as we had above. |
| LG | In Rel-15, SR was not triggered if PUSCH overlaps. Thus, UE behavior in section 9.2.5 has no conflict with RAN2 operation. Current situation is bit changed, now MAC can trigger SR overlapping PUSCH based on LCH prioritization. We think it is not necessary to stick the current PHY specification which is based on old MAC operation. |
| Intel | In contrast to the previous case, in this example, the PUSCH is indeed the destination for UCI multiplexing, and this should now be conveyed to MAC. Otherwise, for instance, the recent decision on UL skipping and PUSCH with HARQ-ACK/CSI multiplexing is not implementable unless MAC knows about HARQ-ACK/CSI multiplexing in the PUSCH corresponding to the UL grant. Thus, we do not see the issue mentioned by Nokia and others in this case, and support the proposal. |
| Samsung | Agree |
| CATT | We support FL proposal 2. |

Second round

* + - 1. Summary for Case 2-2

For the case of overlapping PUSCH and SR with equal L1 priority, if there are other UCI(s) i.e., HARQ-ACK and/or CSI of the same L1 priority overlapping with SR and the PUCCH resource after UCI multiplexing among different PUCCHs overlaps with the PUSCH,

* Some companies think that the MAC may not be aware of the UCI multiplexing procedure in PHY and MAC does not know whether the PUCCH after multiplexing overlaps with PUSCH or not;
* Some companies think based on RAN1 agreements on UL skipping with UCI that MAC should generate MAC PDU for the PUSCH on which there is UCI to be multiplexed, MAC should know about HARQ-ACK/CSI multiplexing in the PUSCH corresponding to the UL grant, hence MAC shall deliver the MAC PDU for the PUSCH and shall not instruct PHY for SR transmission.

Therefore, following can be considered to include to the reply LS

**Proposal 3: include following in the reply LS to RAN2:**

* For the case of overlapping PUSCH and SR with equal L1 priority, if there are other UCI(s) i.e., HARQ-ACK and/or CSI of the same L1 priority overlapping with SR and the final PUCCH resource after UCI multiplexing among different PUCCHs overlaps with the PUSCH as shown in Figure 4, it is not clear to RAN1 that whether MAC knows about HARQ-ACK/CSI multiplexing in the PUSCH based on RAN1 agreements on UL skipping with UCI that MAC should generate MAC PDU for the PUSCH on which there is UCI to be multiplexed.
* ~~For this case, if SR is delivered without delivering the PUSCH, it has impacts on PHY layer UCI multiplexing procedure. Therefore, RAN1 prefers MAC shall deliver the MAC PDU for the PUSCH and shall not instruct PHY for SR transmission.~~

Any comments?

|  |  |
| --- | --- |
| Company | Comments |
| DOCOMO | Agree with the proposal as it’s better to clarify MAC behavior. |
| Nokia, NSB | Agree here on the first bullet.  But no on the second one, if the MAC is not aware – then how to distinguish case 1 from this one here (there SR can be triggered, here we say – no PUSCH to be delivered)!?? |
| Ericsson | Do not support.  We understand that MAC is not aware (and should not be required to be aware) of potential multiplexing of SR + other UCI.  RAN2 is aware of RAN1 agreements on UL skipping and would generate a TB for the PUSCH with UCI multiplexing. Hence this is a scenario NOT asked in RAN2 LS.  A clarification sentence can be included in response LS, but we do not see the need to repeat the RAN1 agreement on UL skipping. Example sentence: “RAN1 assumes that the scenario described in RAN2 LS does not belong to the cases described in RAN1 agreements on uplink skipping. That is, MAC is required to generate a MAC PDU for the PUSCH if the PUSCH is expected to have UCI multiplexing, and MAC should not prioritize the overlapping SR over such PUSCH.” |
| FL’ response | Delete the second bullet. Based on the companies input, indeed RAN1 is not sure whether the case 2 and case 3 is under RAN2’s consideration or not; and whether RAN2 notice about RAN1 UL skipping agreement since in RAN2 different sessions handles the UL skipping and intra-UE prioritization. So, I think first bullet is more objective and should be fine. |
| CATT | Agree with modified FL proposal. |
| HW/HiSI | In our view, the MAC layer is not aware of the multiplexing in PHY. Isn’t this question similar to the question in the above question?  Maybe we should clarify if and how MAC is aware of the situation in PHY? And, if we commented earlier, if NAC shall take this PHY information into account, then react and PHY will wait for the MAC decision, then the design would become complicated and there would definitely come up a time-line issue.  In our should determine the multiplexing independently from if a PDU is delivered or not |
| ZTE | We prefer the MAC shall deliver the MAC PDU for the PUSCH and shall not instruct PHY for SR transmission due to overlapping between UCI and PUSCH according to the previous agreements in RAN1. |

* + 1. Case 3 of overlapping between other UCIs and SR and between SR and PUSCH of equal L1 priority
* **Case 3: other UCI(s) i.e., HARQ-ACK and/or CSI overlap with a PUSCH of equal L1 priority and SR overlaps with the PUSCH, but other UCI(s) do not overlap with SR of equal L1 priority**



Figure 5: other UCI(s) overlap with a PUSCH and the PUSCH overlaps with the SR, but the SR does not overlap with other UCI(s), all UL channels are of the same L1 priority (borrow from R1-2100318)

In case 3, similar as case 2-2 that the SR cannot be transmitted in PHY based on based UL skipping agreement and the specification TS 38.213 section 9.2.5 as cited in section 2.1.1 that “the UE multiplexes HARQ-ACK information and/or CSI reports in a PUSCH if the PUCCH resource overlaps in time with a PUSCH transmission, as described in Clause 9.3, and does not transmit SR”. Therefore, MAC should always deliver MAC PDU for the PUSCH and shall not instruct PHY for SR transmission.

* **Proposal 3: For the case of overlapping PUSCH and SR with equal L1 priority, if there are other UCI(s) i.e., HARQ-ACK and/or CSI of the same L1 priority overlapping with PUSCH for UCI multiplexing but the other UCI(s) do not overlap with the SR, MAC shall deliver the MAC PDU for the PUSCH and shall not instruct PHY for SR transmission.**

**Q-d: Do you agree above proposal 3? If not, what is your views and proposal for above case 3?**

|  |  |
| --- | --- |
| Company | Comments |
| Nokia, NSB | Same comment as for cases 2 above:  We are a bit wondering, if for both cases here actually the MAC could deliver the SR & the PUSCH in the first place. As from MAC perspective for both cases 3a and 3b, SR and PUSCH are overlapping (as any other UCI multiplexing is not considered in MAC) 🡪 with higher SR LCH priority the SR (and no PUSCH TB) would be delivered, with the same LCH priority the PUSCH TB would be delivered to PHY (but not the SR)  So we think the two scenarios depicted above should not be applicable (as the initial SR PUCCH resource before other UCI multiplexing, there should not be SR overlapping with a PUSCH of the same PHY priority). The handling in 38.213 is based on the fact that due to other UCI multiplexing, the PUCCH resource would be changed based on our understanding. |
| ZTE | Fine with the proposal.  As commented above, we prefer not to change the PHY multiplexing behavior. The MAC behavior (whether generate MAC PDU for PUSCH or instruct PHY for SR transmission) could be based on the intermediate decision of multiplexing from PHY. |
| DOCOMO | Agree |
| HW/HiSi | Same comment as before. |
| OPPO | Agree |
| Qualcomm | This is basically the scenario that was agreed in the last meeting that a PUSCH with UCI multiplexed on it cannot be skipped. Do we need a new agreement for this case? |
| LG | If RAN2 consider our previous agreement, SR shouldn’t be triggered and MAC PDU should be instructed for the PUSCH. We think it is not necessary to consider case 3. For else, same comment on proposal 1. |
| Intel | In contrast to Proposal 1 (case 2-1), in this example, the PUSCH is indeed the destination for UCI multiplexing, and this should now be conveyed to MAC. Otherwise, for instance, the recent decision on UL skipping and PUSCH with HARQ-ACK/CSI multiplexing is not implementable unless MAC knows about HARQ-ACK/CSI multiplexing in the PUSCH corresponding to the UL grant.  Thus, we do not see the issue mentioned by Nokia and others in this case. |
| Samsung | Agree |
| CATT | We support Proposal 3. |

Second round

* + - 1. Summary for Case 3

For the case of overlapping PUSCH and SR with equal L1 priority, if there are other UCI(s) i.e., HARQ-ACK and/or CSI of the same L1 priority overlapping with PUSCH, but the other UCI(s) do not overlap with the SR,

* Some companies think that the MAC may not be aware of the UCI multiplexing procedure in PHY and MAC does not know whether the PUCCH after multiplexing overlaps with PUSCH or not;
* Some companies think based on RAN1 agreements on UL skipping with UCI that MAC should generate MAC PDU for the PUSCH on which there is UCI to be multiplexed, MAC should know about HARQ-ACK/CSI multiplexing in the PUSCH corresponding to the UL grant, hence MAC shall deliver the MAC PDU for the PUSCH and shall not instruct PHY for SR transmission.

Therefore, following can be considered to include to the reply LS

**Proposal 4: include following in the reply LS to RAN2:**

* For the case of overlapping PUSCH and SR with equal L1 priority, if there are other UCI(s) i.e., HARQ-ACK and/or CSI of the same L1 priority overlapping with PUSCH, but the other UCI(s) do not overlap with the SR as shown in Figure 5, it is not clear to RAN1 that whether MAC knows about HARQ-ACK/CSI multiplexing in the PUSCH based on RAN1 agreements on UL skipping with UCI that MAC should generate MAC PDU for the PUSCH on which there is UCI to be multiplexed.
* ~~For this case, if SR is delivered without delivering the PUSCH, it has impacts on PHY layer UCI multiplexing procedure. Therefore, RAN1 prefers MAC shall deliver the MAC PDU for the PUSCH and shall not instruct PHY for SR transmission.~~

Any comments?

|  |  |
| --- | --- |
| Company | Comments |
| DOCOMO | Agree with the proposal as it’s better to clarify MAC behavior. |
| Nokia, NSB | Same as for the above. If the MAC is not aware – how can we have the second bullet. Moreover, if the MAC does not know – how to distinguish the case 1 from all of these – and as a consequence, how can we define different MAC behavior if MAC may not be able to distinguish the cases. |
| Ericsson | Do not support.  We understand that MAC is not aware (and should not be required to be aware) of potential multiplexing of SR + other UCI.  RAN2 is aware of RAN1 agreements on UL skipping and would generate a TB for the PUSCH with UCI multiplexing. Hence this is a scenario NOT asked in RAN2 LS.  A clarification sentence can be included in response LS, but we do not see the need to repeat the RAN1 agreement on UL skipping. Example sentence: “RAN1 assumes that the scenario described in RAN2 LS does not belong to the cases described in RAN1 agreements on uplink skipping. That is, MAC is required to generate a MAC PDU for the PUSCH if the PUSCH is expected to have UCI multiplexing, and MAC should not prioritize the overlapping SR over such PUSCH.” |
| FL’ response | Delete the second bullet. Based on the companies input, indeed RAN1 is not sure whether the case 2 and case 3 is under RAN2’s consideration or not; and whether RAN2 notice about RAN1 UL skipping agreement since in RAN2 different sessions handles the UL skipping and intra-UE prioritization. So, I think first bullet is more objective and should be fine. |
| CATT | Agree with modified proposal |
| HW/HiSI | We don’t think that the delivery a PDU should have impact on the multiplexing. The multiplexing should be determined according to PHY rules independently from MAC. If then a PDU is delivered or not, depends om MAC. If it is not delivered, the PUSCH will be dropped including possible multiplexed. UCI |
| ZTE | We think MAC shall deliver the MAC PDU for the PUSCH according to the previous RAN1 agreements. |

* 1. UL skipping with LCH prioritization

RAN1 agreements related to Rel-16 uplink skipping for DG and CG PUSCH overlapping with a PUCCH with the same priority can be found in Appendix. In the following, the discussions mainly focus on the CG PUSCH and the DG PUSCH having different LCH priority.

* + 1. General views

Based on the submitted contributions, following high-level options can be summarized for handling overlapping between DG and CG PUSCH and overlapping between grant(s) with a PUCCH with the same PHY priority when LCH based prioritization is configured.

* **Option 1: Handled by gNB scheduling or configuration restrictions**

[R1-2100336] proposed following:

* **Option 1-1:**
  + gNB should avoid scheduling LP DG PUSCH overlapping with both LP PUCCH and HP CG PUSCH when scheduled LP DG PUSCH transmission is earlier than HP CG PUSCH transmission and LP PUCCH doesn’t overlap with HP CG PUSCH
  + When HP CG PUSCH transmission is earlier than scheduled LP DG PUSCH transmission and LP PUCCH doesn’t overlap with HP CG PUSCH, LP UCI is transmitted on the LP PUCCH if MAC delivers PDU to HP CG PUSCH and LP UCI is multiplexed in LP DG PUSCH if MAC delivers PDU to LP DG PUSCH.

[R1-2101264] proposed following:

* **Option 1-2:**
  + The UL skipping feature shall not be simultaneously configured with logical channel prioritization.
    - This is to avoid the situation that following one rule e.g. LCH based prioritization would violate another rule e.g. UL skipping rule
* **Option 2: PHY selects and indicates to MAC the PUSCH that cannot be skipped and the MAC layer can skip other PUSCHs except the one indicated by the PHY layer.**

[R1-2101440] proposed following steps to handle the CG and DG collisions with PUCCH overlap:

* + Step #1: Assume no uplink skipping. For each priority, a UE determines whether UCI will be multiplexed on a PUSCH or not.
  + Step#2: A UE selects one PUSCH that cannot be skipped by comparing the L1 priorities of the PUSCHs in case a 2-level priority is configured for a UE.
  + Step#3: The MAC layer can skip other PUSCHs except the one indicated by the PHY layer.
  + Step #4: The PHY layer performs prioritization/multiplexing as needed.
    - In case the PHY has indicated one PUSCH as non-droppable, and if there is another PUSCH overlapping with it on the same carrier, that PUSCH, including UCI that is expected to be multiplexed on it as part of step #1, are dropped.
* **Option 3: MAC layer decide which MAC PDU should be delivered (based on LCH based priority and data availability and the resource overlapping between the PUSCH and PUCCH of the same L1 priority).**
  + **For the MAC PDU delivered by MAC layer, if it overlaps with the PUCCH of the same PHY priority, then the UCI is multiplexed on the delivered MAC PDU;**
  + **For the MAC PDU not delivered by MAC layer, if it overlaps with the PUCCH of the same PHY priority,**
    - **Option 3-1: The PUCCH is transmitted** 
      * **E.g. possibly with condition that gNB needs to ensure the timing for deciding which MAC PDU will be delivered to PHY is always earlier than the timing for preparing the UCI multiplexing on PUSCH; Otherwise, error case.**
    - **Option 3-2: The PUCCH is dropped**
    - **Option 3-3: Depending on timeline, the PUCCH can be transmitted or dropped.**
      * **E.g. If the timing for deciding which MAC PDU will be delivered to PHY is earlier than the timing for preparing the UCI multiplexing on PUSCH, then the PUCCH is transmitted; Otherwise, the PUCCH is dropped.**

**Without discussing the details case-by-case, it is difficult to directly conclude which options above is the good way to go. Therefore, some detailed cases are present in the following sections to collect companies’ views.**

Second round

Based on received comments, common understanding should be achieved for the following points:

**In case LCH prioritization is configured, about the MAC PDU generation and delivery for a single PHY priority,**

* **Option 1: MAC layer shall decide which MAC PDU should be delivered at least based on following:**
  + **LCH based priority, data availability and the resource overlapping between the PUSCH and PUCCH of the same L1 priority.**
* **Option 2: PHY selects and indicates to MAC the PUSCH that cannot be skipped and the MAC layer can skip other PUSCHs except the one indicated by the PHY layer.**

If option 1 is selected, then next we can discuss PHY layer UCI multiplexing procedure when LCH-based prioritization is configured. Whether the PUSCH for UCI multiplexing is based on the hypothetical PUSCH transmission (MAC may not deliver the PUSCH), or is based on the actual PUSCH transmissions.

If option 2 is preferred, then there is no need to discuss PHY layer UCI multiplexing procedure. But large spec impacts are expected for MAC layer. Therefore,

Q-A: What is your preference on above options and what is your views on gNB blind detects which data is on transmission?

|  |  |
| --- | --- |
| Company | Comments |
| DOCOMO | We prefer Option 2 to avoid gNB blind decoding |
| Nokia, NSB | Bit puzzled if this now here applies to only Sec. 2.2.1 (only LCH prioritization, single PHY priority) or also to Sec. 2.2.1 (two PHY priorities). Clearly for two PHY priorites this is not sufficient, as Option 1 will create non-supported PUSCH collision cases.  If this is to include the case of two PHY priorities as well – then neither option. As stated earlier, delivering dummy PDUs will impact latency dramatically and will lead to unsupported PUSCH collision cases (e.g. CGs of different priorities). For simplicity, when operating with PHY priority it is suggested to support PUSCH skipping unconditionally.  So we propose  **Option 3: MAC layer shall decide which MAC PDU should be delivered at least based on following:**   * + **LCH based priority, data availability and the resource overlapping between the CG PUSCH and CG PUSCH of the different L1 priority.**   Further updates below (based FL changes) |
| Ericsson | We support the principle of Option 2 to avoid gNB blind decoding. But similar to Nokia/NSB, we see that Option 2 considers only single PHY priority. Thus, Option 2 should be revised slightly as shown below:  Option 2’: For a given PHY priority, PHY selects and indicates to MAC the PUSCH that cannot be skipped and the MAC layer can skip other PUSCHs except the one indicated by the PHY layer.  After that, existing MAC procedure applies in PDU generation, including MAC check that the “PUSCH can be transmitted by lower layers” (38.321 section 5.4.1), e.g., MAC PDU is possible if the PUSCH is not dropped due to collision with PHY-HP PUCCH or PHY-HP PUSCH. |
| APT | Option 1 is preferred, as it is hard for PHY to determine a PUSCH that cannot be skipped if multiple PUSCHs overlaps with the PUCCH. |
| FL’s reply | Thanks for the comments! I will update the question.  @Nokia, I think your intention on option 3 should also cover the DG and CG overlapping case, so option 3 should be **MAC layer shall decide which MAC PDU should be delivered at least based on following:**  **LCH based priority, data availability, the resource overlapping between PUSCH and PUSCH of the same/different L1 priorities** |
| CATT | We prefer option1 because compared with PHY layer, MAC can consider more factors such as LCH based priority, data availability and data arriving etc and then make decision on which PDU is delivered to PHY. |
| HW/HiSi | For option 1, it needs a clarification about the order between LCH based priority and resource overlapping and if PHY needs to transmit the PUSCH containing the PDU delivered by MAC or not. If yes, then there is a time-line issue for PHY since PHY needs to wait for the MAC decisions (as commented before).  For Option 2, we would like to know better what would be the situation for non-CA? Is it correctly understood, that if UCI is multiplexed on PUSCH and the PUSCH is overlapping with SR, the PUSCH is dropped? Also it should be clarified whether PHY would have to deliver the CG PUSCH to MAC? Our understanding is that this would not be needed, because the CG PUSCH is configured by RRC so MAC already knows about it, CG regardless of the PHY indication. If no UCI multiplexing into PUSCH would be done and PHY delivers this PUSCH to MAC, but MAC has no data, would MAC generate a padding PDU or skip?  For gNB the blind detection, we think that the LCH-prioritization mechanism itself would increase blind detections for gNB, because the priority of the logical channel is related to whether it has data or not and the gNB might not be aware of this. |
| ZTE | We prefer option 1.  In our understanding, it is always up to MAC make the decision to select which grant to be transmitted if two PUSCHs overlap in the time domain. For example, in case DG PUSCH and CG PUSCH overlap in Rel-15, the UE finally transmits DG PUSCH. It should be noted that there is no such behavior description in the PHY spec. In PHY spec, only the timeline is defined such that MAC has enough time to process MAC PDU only for DG PUSCH. In MAC spec, MAC only generates MAC PDU for DG PUSCH and PHY follows the decision to transmit DG PUSCH. Option 2 will change the principle since it means PHY asks MAC to generate MAC PDU for the certain PUSCH selected by PHY. In addition, in our understanding, option 2 has also violated the RAN1 response in LS R1-2009680 as shown below.  **Agreement**  For the collision scenario between CG and DG with same/different PHY-priority index, if there is no collision between PUCCH and the CG and there is no collision between PUCCH and the DG, the behaviour mentioned in the LS is consistent with RAN1’s understanding if taking into account the TP to Rel-16 TS 38.214, i.e., revision CR in R1-2008655.  For option 2, the information in PHY is only the overlapping between UCI and PUSCH. PHY can only makes decision based on this information. For case 2-2 that two PUSCHs is overlapping with PUCCH, respectively, which PUSCH should not be skipped? Even RAN1 can define some rules to select the unskipped PUSCH finally, the select PUSCH may have no data. From the perspective of resource efficiency, the mechanism defined by MAC is reasonable since it allow data transmission as far as possible, i.e., if HP PUSCH has data, HP PUSCH is transmitted and if HP PUSCH has no data and LP PUSCH has data, LP PUSCH is transmitted. Therefore, it would be better to study the solution based on the current MAC mechanism. Option 1 only adds another condition of overlapping resource between UCI and PUSCH on the top of the current mechanism. Thus, it is a better choice. |
| Nokia, NSB 2nd | Thanks Lihui for the update / taking our comments into account.  We prefer Option 1 here. |

If option 1 is the decision, then the next question is about what is PHY layer behavior on UCI multiplexing when LCH-based prioritization is configured?

Q-B: in PHY layer, the PUSCH for UCI multiplexing is based on the hypothetical PUSCHs (MAC may not deliver the PUSCH) or based on the actual PUSCHs delivered by MAC?

* If it is based on the hypothetical PUSCH, if MAC does not deliver the PUSCH, how to handle the UCI?
* If it is based on the actual PUSCH,
  + what is your view on gNB blind detection complexity?
  + Is there any timeline issue for UE preparing UCI multiplexing?

|  |  |
| --- | --- |
| Company | Comments |
| APT | In PHY, UCI multiplexing should be based on actual PUSCH. To lower gNB blind detection complexity, a PUSCH with the same PHY priority as the PUCCH should be determined from multiple PUSCHs by the logical channel prioritization procedure, even if there is no data for the multiple PUSCHs. Further enhancement on logical channel prioritization can be considered by RAN2 to lower the blind detection complexity. We don’t see any timeline issue if the UCI multiplexing in PHY is based on actual PUSCH. |
| CATT | We support handling UCI multiplexing should be based on the hypothetical PUSCH.  Case by case is analyzed and discussed.  For case 1-3 and case 1-4  Even if there is no available data for DG PUSCH, MAC should deliver padding PDU to DG PUSCH with UCI piggyback in order to avoid blind detection on UCI by gNB  For case 1-6,  Regardless of whether there is available data for CG PUSCH or not, UE should follow opt.3-handling method for case 1-6, UCI is transmitted on PUCCH and MAC doesn’t generate PDU for CG PUSCH in order to ensure that LP UCI is not dropped due to selection of MAC LCH priority.  For detailed analysis, please refer to the following section. |
| ZTE | If the MAC does not deliver the PUSCH, the UCI overlapping with such PUSCH should be transmitted on the PUCCH as possible as it can. A timeline should be defined for the PUCCH transmission.  For the gNB blind detection complexity, we think it is difficult to be avoided in the intra-UE multiplexing when two L1-priority are introduced. We are also fine if there are some solutions based on the current MAC mechanism that can avoid the gNB blind detection complexity.  For the multiplexing, we do not see any issue for the UCI multiplexing and the current timeline is enough. |

**In case LCH prioritization is configured, about the MAC PDU generation and delivery for a two PHY priorities,**

* **Option 1: MAC layer shall decide which MAC PDU should be delivered at least based on following:**
  + **LCH based priority, data availability and the resource overlapping between the PUSCH and PUCCH of the same/different L1 priorities.**
* **Option 2: PHY selects and indicates to MAC the PUSCH that cannot be skipped and the MAC layer can skip other PUSCHs except the one indicated by the PHY layer.**
* **Option 3: MAC layer shall decide which MAC PDU should be delivered at least based on following:**
  + **LCH based priority, data availability, ~~LCH based priority, data availability,~~ the resource overlapping between PUSCH and PUSCH of the same/different L1 priorities (intention is to support PUSCH skipping unconditionally if there is no available data for the grant)**

Q-C: What is your preference on above options and what is your views on gNB blind detects which data is on transmission?

|  |  |
| --- | --- |
| Company | Comments |
| CATT | we want to clarify what is difference between option 1 and option3/  For option 1, MAC have different behavior for PUSCH skipping and no PUSCH skipping  For option 3, MAC have unified behavior for PUSCH skipping and no PUSCH skipping.  Our understanding is correct or not? |
| FL’s reply | My understanding about the difference based on Nokia’s comments is:   * For option 1, if there is no data available for a grant, but the grant overlaps with the HARQ-ACK/CSI, then the PUSCH should be generated and carry UCI. * For option 2, if there is no data available for a grant, but the grant overlaps with the HARQ-ACK/CSI, then the PUSCH should be skipped, and the UCI is transmitted on PUCCH.   (Refer to Nokia’s views for Case 2-2 and Case 2-3) |
| Nokia, NSB | Support Option 3  As also explained in our input contribution, we this option as this will take a lot of burden from all of us considering having the MAC behavior defined for all Rel-16 cases with PHY priority and not even considering all the additional cases we get with Rel-17 Intra-UE multiplexing enhancements. |

* + 1. UL skipping with LCH prioritization and a single PHY priority

Following are the cases that there are resource overlapping between DG and CG from agreed LS R1- 2009772 “LS on PUSCH skipping with UCI in Rel-16, RAN1” @RAN1#103-e meeting, see appendix with the difference that the LCH prioritization is configured.

|  |  |  |
| --- | --- | --- |
|  |  |  |
| **Case 1-3** | **Case 1-4** | **Case 1-6** |

Based on the following MAC spec TS 38.321, the priority for the grant for which no data for related logical channels is lower than either priority of the grant for which there is data for related logical channels. Therefore, in addition to the logical channel priority, the data availability for the grant associated with the logical channels needs to be taken into account.

|  |
| --- |
| For the MAC entity configured with lch-basedPrioritization, priority of an uplink grant is determined by the highest priority among priorities of the logical channels that are multiplexed (i.e. the MAC PDU to transmit is already stored in the HARQ buffer) or have data available that can be multiplexed (i.e. the MAC PDU to transmit is not stored in the HARQ buffer) in the MAC PDU, according to the mapping restrictions as described in clause 5.4.3.1.2. The priority of an uplink grant for which no data for logical channels is multiplexed or can be multiplexed in the MAC PDU is lower than either the priority of an uplink grant for which data for any logical channels is multiplexed or can be multiplexed in the MAC PDU or the priority of the logical channel triggering an SR. |

For Case 1-3,

* 1-3-1: When only one grant (either DG or CG) has available data, it is expected that MAC should generate and deliver the MAC PDU for which there is data available.
* 1-3-2: When both grants have available data, it is expected that MAC should generate and deliver the MAC PDU for which the grant has higher priority of the associated LCH(s)
* 1-3-3: When there is no available data for either grant, (it is similar as Case 1-3 without LCH priority configured), it is expected that MAC should generate the MAC PDU for the DG PUSCH)

Q1-1: Do you agree with above expected MAC layer behavior for case 1-3-1, 1-3-2 and 1-3-3?

* If you do not agree, please elaborate the reason and the expected MAC layer behavior.

|  |  |
| --- | --- |
| Company | Comments |
| Apple | In our view, there are 3 stages involves in the UCI multiplexing:  Stage 1: PHY selects a PUSCH for UCI multiplexing from hypothetical PUSCHs (there is at least one or multiple at a single CC or multiple CCs overlapping with resource Z)  Stage 2: PHY indicates the selected PUSCH for UCI multiplexing if any to MAC, and MAC performs any processing deemed suitable from RAN2 point of view;  Stage 3: MAC may deliver a MAC PDU for the selected PUSCH for UCI multiplexing for one occasion (it may not as well at some other occasions), PHY transmits the PUSCH with UCI multiplexed if the selected PUSCH from Stage 1 actually materialized.  RAN1 can focus the discussion on Stage 1 and Stage 3, Stage 2 should be delegated to RAN2. The cases listed somehow mix RAN1 design and RAN2 design.  For example, for 1-3-1: RAN1 should discuss between DG PUSCH and CG PUSCH occasion (note at Stage 1 there is no MAC PDU from MAC yet, “CG PUSCH” in the illustration is just CG PUSCH occasion, not actual CG PUSCH, which one should be assumed for UCI multiplexing, and what indication will be generated, whether MAC deliver the MAC PDU is up to RAN2.  For 1-3-2: again RAN1 should discuss between CG PUSCH occasion and DG PUSCH (two hypothetical transmissions) , which one will be assumed for UCI multiplexing. To have a somewhat deterministic behavior at UE (so there is a reasonable chance gNB can guess correctly), DG PUSCH should be assumed for UCI multiplexing in Stage 1.  For 1-3-3: again RAN1 should discuss between CG PUSCH occasion and DG PUSCH (two hypothetical transmissions) , which one will be assumed for UCI multiplexing. From the choice given, then we can deduce between CG PUSCH occasion and DG PUSCH (two hypothetical transmissions), DG PUSCH is assumed for UCI multiplexing in Stage 1. |
| ZTE | Agree.  In our understanding, this is also in line with the current MAC spec for case 1-3-1 and case 1-3-2. For case 1-3-3, we think it is reasonable since DG has higher priority than CG in Rel-15. |
| DOCOMO | Different UE behavior due to data availability requires gNB blind decoding and should be avoided. Since gNB doesn’t know the LCH priority for PUCCH, intra-UE prioritization between different LCH priorities should be resolved before UCI multiplexing on PUSCH. Then we can follow the procedure for determining the PUSCH for UCI multiplexing and MAC PDU generation discussed in [104-e-NR-7.1CRs-01]. Note that if both PUSCHs have the same LCH priority, same handling as the case without LCH prioritization can be applied.  In summary, we assume the following procedure for the case of UL skipping with LCH prioritization and a single PHY priority   1. Determine the PUCCH resource for UCI multiplexing 2. [New] intra-UE prioritization for different LCH priorities among overlapped PUSCHs assuming all PUSCHs have available data    * UE assumes only the PUSCH which has the highest LCH priority exists in the following steps 3. Determine the PUSCH for UCI multiplexing, if any 4. MAC generates MAC PDU for the PUSCH and does not generate a TB for other PUSCH(s) overlapping with the PUSCH   Therefore, for Case 1-3, DG or CG PUSCH which has higher LCH priority is selected for UCI multiplexing, and MAC generates MAC PDU for the PUSCH and does not generate a TB for the other PUSCH overlapping with the PUSCH. |
| FL’s question to DCM: thanks for your views. I would like to ask one question:   * In step 2, what do you mean “[New] intra-UE prioritization for different LCH priorities”, do you intend to modify MAC LCH prioritization procedures? The data availability in MAC spec is one factor for prioritization, see below, do you intend to change this?  |  | | --- | | For the MAC entity configured with lch-basedPrioritization, priority of an uplink grant is determined by the highest priority among priorities of the logical channels that are multiplexed (i.e. the MAC PDU to transmit is already stored in the HARQ buffer) or have data available that can be multiplexed (i.e. the MAC PDU to transmit is not stored in the HARQ buffer) in the MAC PDU, according to the mapping restrictions as described in clause 5.4.3.1.2. The priority of an uplink grant for which no data for logical channels is multiplexed or can be multiplexed in the MAC PDU is lower than either the priority of an uplink grant for which data for any logical channels is multiplexed or can be multiplexed in the MAC PDU or the priority of the logical channel triggering an SR. |   [DOCOMO]  Thanks for the question. Yes, FL’s understanding is correct that we propose to modify MAC procedure to avoid gNB blind decoding. As FL listed as Cases 1-3-1 to 1-3-3, in the current MAC procedure, MAC PDU is generated based on the data availability, which cannot been seen from PHY. | |
| HW/HiSi | Our impression is that the described behavior about the PDU delivery is within RAN2, and we are not sure if this should be discussed and answered by RAN1.  For the physical layer aspect, we agree with Apple that RAN1 needs to decide which PUSCH (e.g. a PUSCH 1) will carry the multiplexed UCI from the PUCCH, this could be based on a pre-defined rule in RAN1. Then, it is our view that the physical layer will transmit this PUSCH 1 if the corresponding PDU is delivered, otherwise PHY will cancel PUSCH 1 including the UCI. If the UE would then need to transmit another PUSCH (e.g. PUSCH 2), the PHY layer has to wait for the MAC decision which PUSCH to skip and which PUSCH to transmit.  This general principle above can be applied to all cases (also to 1-4 and 1-6).  Another way is to not configure the UL skipping feature and channel prioritization simultaneously, this would help to avoid complicated cases. Considering that RAN2 is still working on how to support the UL skipping feature in case of a single priority, this would be simpler both for RAN1 and RAN2. |
| FL’s response to HW: The intention to describe the MAC PDU delivery is to understand what the consequence would be when considering there is collision with PUCCH, especially for case 2-2-4 and case 2-3-4.  If we select option 3 as listed in section 2.2.1 that it is still MAC layer to make decision on which MAC PDU should be delivered, it may be better for MAC layer to make decision on which MAC PDU to be delivered based on not only data availability, LCH based prioritization, but also take into account the UCI multiplexing into account.  Alternatively, after analyze all the cases, if it is found that when the MAC make the decision, which MAC PDU is delivered is still unknown, causing many BD at gNB side, there is also proposal from companies, proposing to let PHY to indicate MAC which MAC PDU should be generated, e.g., option 2 in section 2.2.1.  Therefore, all the listed cases here are to let us have better understanding. | |
| OPPO | Agree |
| Qualcomm | The entire discussion on UL skipping started with two objectives: (1) UCI is multiplexed on a deterministic carrier and (2) within that carrier, a gNB does not need to decode each PUSCH under two hypotheses, i.e., one with UCI and one without UCI. The final solution should satisfy these two constraints.  In RAN1, we do not need to discussion the MAC behaviors. To solve this issue, we need to come up with a solution for selecting a carrier/PUSCH that satisfies the abovementioned constraints. Before going into the details, it would be preferable if we agree on a set of principles as above (basically the same ones that the UL skipping discussion in Rel. 16 is based on.)  Having said that, Option 3 is clearly not a solution to this problem. Option 2, however, can address both issues.  Another solution that would have less impact on how MAC checks data availability and performs LCH prioritization is to remove every carrier that its outcome is ambiguous from the list of CCs for UCI multiplexing. More specifically, if on a given carrier, CGDG overlap, since it is not clear which of the two will be prioritized, that CC will not be considered for UCI multiplexing. Once the set of candidate CCs is determined, a UE picks one based on the same set of rules defined in Rel. 15 (i.e., A-CSI on PUSCH or not, which PUSCH starts earlier, DG vs. CG, CC index, etc.) |
| Nokia, NSB | Agree |
| LG | Agree |
| Intel | We can accept the proposal when UL skipping is configured for DG PUSCH. *Here, it should be noted that this would effectively change the previous RAN1 design of prioritizing the DG PUSCH for when MAC entity is not configured with R16 LCH prioritization.*  However, if UE is NOT configured with UL skipping, then, from PHY perspective, the DG PUSCH would be prioritized and the destination for the UCI (this would be the expectation at the gNB). Hence, this should be considered by MAC during prioritization. In this regard, we seem to have different understanding from Huawei on the effect of configuring UL skipping for DG PUSCH in this case. |
| Samsung | Agree |
| Ericsson | Do not agree.  We share QC view that the two objectives in UL skipping discussion should be kept, and gNB does not need to perform hypothesis testing on which PUSCH has UCI multiplexing.  Thus, for Case 1-3, DG is expected to have UCI multiplexing according to existing Rel-15 rule. Hence, MAC should always generate MAC PDU for the DG PUSCH, and discard the CG PUSCH.  Behavior described for 1-3-1, 1-3-2 and 1-3-3 requires gNB to check all these possibilities, where information unknown to gNB (i.e., LCH priority, data availability) changes PUSCH multiplexing with UCI. |
| APT | Agree |
| CATT | For case 1-3-1, case 1-3-2 and case 1-3-3, in our understanding whether LCH priority is configured or not, from the perspective of PHY layer, MAC should send PDU to DG, because DG is always considered to carry UCI in PHY.  Even if there is no available data for DG PUSCH, MAC should deliver padding PDU to DG PUSCH with UCI piggyback in order to avoid blind detection on UCI by gNB |

For case 1-3-1, 1-3-2, 1-3-3, the UCI should be multiplexed on the PUSCH delivered by MAC.

Q1-2: Do you agree with above on UCI handling for case 1-3-1, 1-3-2 and case 1-3-3?

* If you do not agree, please elaborate the reason and the preferred UCI handling solution.

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| Company | Comments |
| Apple | If MAC does not deliver MAC PDU for the hypothetical PUSCH in Stage 1, then UCI is dropped. |
| ZTE | Agree.  According to RAN1 spec, the UCI should be multiplexed in the PUSCH if the PUCCH and PUSCH overlaps in the time domain. The prerequisite is there is MAC PDU delivered from MAC layer for the PUSCH. |
| DOCOMO | We agree with the statement assuming that MAC generates MAC PDU for one of the PUSCHs where UCI is multiplexed. |
| HW/HiSi | We do not agree with this behavior and would prefer to let PHY independently decide on which PUSCH to multiplex the UCI. |
| OPPO | Agree |
| Qualcomm | We do not agree with this proposal as explained above. If UCI multiplexing is a function of the MAC outcome, multiplexing cannot be deterministic. |
| Nokia, NSB | Agree |
| LG | Agree. However we also see it would make multiple hypothesis issue in gNB. In that case, gNB may configure LCH and indicate PUSCH carefully so DG PDSCH should have higher LCH property. |
| Intel | Agree, under the assumption that inconsistency between PHY and MAC layers is avoided as explained in previous response.  Note that if UL skipping for DG is configured, the gNB needs to do BD anyway.  On the other hand, as explained in the previous response, if UL skipping for DG is NOT configured, the gNB would expect the UE to transmit DG PUSCH with the UCI, and thus, MAC should generate PDU accordingly to avoid mismatch. |
| Samsung | Agree |
| Ericsson | Do not agree, if PUSCH-UCI multiplexing is not deterministic.  If MAC procedure ensures that MAC PDU is given to the PUSCH expected to have UCI multiplexing, then it is true that “UCI should be multiplexed on the PUSCH delivered by MAC.” |
| CATT | See the same comment as Q 1-1. |

For Case 1-4,

* 1-4-1: When only one grant (either DG or CG) has available data, it is expected that MAC should generate and deliver the MAC PDU for which there is data available.
* 1-4-2: When both grants have available data, it is expected that MAC should generate and deliver the MAC PDU for which the grant has higher priority of the associated LCH(s)
* 1-4-3: When there is no available data for either grant, (it is similar as Case 1-1 without LCH priority configured), it is expected that MAC should generate the MAC PDU for the DG PUSCH.

Q1-3: Do you agree with above expected MAC layer behavior for case 1-4-1, 1-4-2 and 1-4-3?

* If you do not agree, please elaborate the reason and the expected MAC layer behavior.

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| Company | Comments |
| ZTE | Agree  In our understanding, this is also in line with the current MAC spec for case 1-4-1 and case 1-4-2. For case 1-4-3, we think it is reasonable since it allow UCI multiplexing, which is also aligned with UE behavior the case 1-1. |
| DOCOMO | Based on the comment in Q1-1,   * If DG PUSCH has higher LCH priority, it is selected for UCI multiplexing, and MAC generates MAC PDU for DG PUSCH and does not generate a TB for the CG PUSCH overlapping with the DG PUSCH. * If CG PUSCH has higher LCH priority, UCI is transmitted on PUCCH assuming the DG PUSCH does not exist. Whether MAC generates MAC PDU for CG PUSCH or not depends on the data availability for the grant. |
| HW/HiSi | Same comment as for Q1-1 |
| OPPO | Agree |
| Qualcomm | We do not agree. UCI should be multiplexed on a deterministic PUSCH without a need for a gNB to perform blind decoding. |
| Nokia, NSB | Agree |
| LG | We assume “available data” as a result of MAC PDU generation, not only MAC SDU. If RAN2 consider our previous agreement, MAC would generate MAC PDU due to PUCCH with certain rules on skipping behavior. |
| Intel | Like the previous case, the suggested behaviors could work if UE is configured with UL skipping for DG PUSCH. However, it is understood that this behavior would be different from the previous RAN1 agreement on UL skipping and PUCCH overlaps when UE is NOT configured with R16 LCH prioritization. *Also, as before, it should be noted that this would effectively change the previous RAN1 design of prioritizing the grant with HARQ-ACK/CSI overlap.*  However, if UL skipping is NOT configured, then again, we have the situation wherein the gNB would be expecting the UE to transmit the DG PUSCH. |
| Samsung | Agree |
| Ericsson | Do not agree.  We share QC/DOCOMO view that the PUSCH with UCI multiplexing should be deterministic. |
| CATT | From our point of view,  For case 1-4-1, 1-4-2,  if the MAC PDU is delivered for the DG PUSCH, PHY will multiplex the UCI on the DG PUSCH and transmit the DG PUSCH including the UCI  if the MAC PDU is delivered for the CG PUSCH, when the deciding time for PDU delivering of DG PUSCH is latter than the time point for deciding UCI piggyback on DG PUSCH, UCI and DG PUSCH are dropped together due to no PDU delivered by MAC for DG PUSCH.  if the MAC PDU is delivered for the CG PUSCH, when the deciding time for PDU delivering of DG PUSCH is earlier than the time point for deciding UCI piggyback on PUSCH, handling of UCI is similar with Option 3-1: UCI is transmitted on PUCCH.  In order to ensure that LP UCI isn’t dropped due to selection of MAC LCH priority, we prefer that for case 1-4, MAC always delivers PDU to DG PUSCH and UCI is multiplexed on the DG PUSCH.  In addition, for case 1-4, if transmission sequence between PUCCH and CG PUSCG is exchanged, selection MAC LCH priority may be allowed. |

For case 1-4-1, 1-4-2, handling of UCI,

* If the MAC PDU is delivered for the DG PUSCH, PHY will multiplex the UCI on the DG PUSCH and transmit the DG PUSCH including the UCI;
* If the MAC PDU is delivered for the CG PUSCH, this case will result in the similar situation as for Case 1-6 without LCH priority by interchanging CG and DG. The same handling (e.g, option 3-1: UCI is dropped or option 3-2: UCI is transmitted on PUCCH or option 3-3: depending on timeline, the PUCCH can be transmitted or dropped etc.) should be applied as for Case 1-6 without LCH priority.

Q1-4: Do you agree with above on UCI handling for case 1-4-1, case 1-4-2?

* If you do not agree, please elaborate the reason and the preferred UCI handling solution.

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| Company | Comments |
| Apple | To have a unified design as for Case 1-6 with LCH priority can be something nice to have as an outcome, but not a design goal.  For Stage 1, PUSCH selection for UCI multiplexing is applied to hypothetical PUSCHs (over a single CC or multiple CCs for CA) |
| ZTE | Agree  According to RAN1 spec, the UCI should be multiplexed in the PUSCH if the PUCCH and PUSCH with MAC PDU overlaps in the time domain. For case 1-4-2, the PUCCH should be transmitted as far as possible to avoid resource waste due to PUCCH dropping and accordingly PDSCH retransmission. Therefore, the PUCCH should be transmitted if the timeline is satisfied. |
| DOCOMO | We agree with the statement.  For the case when MAC PDU is delivered for the CG PUSCH, we support option 3-2: UCI is transmitted on PUCCH, as UE assumes only CG PUSCH exists. |
| HW(HiSi | Same comment as for Q1-1 |
| OPPO | Agree |
| Qualcomm | The same response as before. |
| Nokia, NSB | Agree |
| LG | As we mentioned above, it depends on whether PUSCH multiplexed with PUCCH cannot be skipped or not. |
| Intel | Agree, under assumption of UE being configured with UL skipping for DG PUSCH and effective change from previous RAN1 design on UL skipping and overlapping HARQ-ACK/CSI when R16 LCH prioritization is NOT configured. |
| Samsung | Agree |
| Ericsson | Do not agree. No need to consider 3 sub-scenarios.  Due to existing PUSCH-UCI multiplexing rule, DG PUSCH exists for Case 1-4 and multiplex with UCI. |
| CATT | See the same comment on Q 1-3 |

For case 1-4-3, the UCI should be multiplexed on the DG PUSCH.

Q1-5: Do you agree with above on UCI handling for case 1-4-3?

* If you do not agree, please elaborate the reason and the preferred UCI handling solution.

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| Company | Comments |
| ZTE | Agree. This is similar as case 1-4-1 |
| DOCOMO | No. Irrespective of the data availability, UE resolves the intra-UE prioritization for different LCH priorities and determines whether or not UCI is multiplexed on the resultant PUSCH.   * If DG PUSCH has higher LCH priority, it is selected for UCI multiplexing, and MAC generates MAC PDU for DG PUSCH and does not generate a TB for the CG PUSCH overlapping with the DG PUSCH. UCI is multiplexed on the DG PUSCH. * If CG PUSCH has higher LCH priority, UCI is transmitted on PUCCH assuming the DG PUSCH does not exist. Whether MAC generates MAC PDU for CG PUSCH or not depends on the data availability for the grant. |
| HW/HiSi | For our understanding, could you please clarify the intention with this question, are we missing something here? For example, PHY does not (need to) know if the PDU is a padding PDU or if it contains data. This should be transparent to PHY. PHY only multiplexes PUCCH and DG PUSCH and transmits according to which PDU is delivered? |
| OPPO | Agree |
| Qualcomm | A PDU is generated for the PUSCH that is identified as non-skipable by the PHY layer. This is based on Option 2 of Q1-1. If the alternative solution as presented in our response is adopted, a special treatment for these cases is not needed. |
| Nokia, NSB | Agree.   But have some sympathy for HW/HiSi question here. If we agreed above that there is a PUSCH (in this case DG PUSCH) for mux, it does not matter if it is due to case 1-4-1 with DG PUSCH having data or case 1-4-3. |
| LG | We are bit confused with “no available data”. Even if there is no MAC SDU, MAC could generate padding BSR for the PUSCH. As Huawei said, it seems not necessary to consider what MAC PDU includes. We only have to consider MAC PDU has been generated for which PUSCH. |
| Intel | Agree on the outcome (conditioned on previous responses above). However, no special consideration for this case seems necessary as pointed out by Huawei and others. |
| Samsung | Agree |
| Ericsson | Do not agree. No need to consider 3 sub-scenarios.  Due to existing PUSCH-UCI multiplexing rule, DG PUSCH exists for Case 1-4 and multiplex with UCI. |
| CATT | We agree with FL’s view |

For case 1-6:

* 1-6-1: When only one grant (either DG or CG) has available data, it is expected that MAC should generate and deliver the MAC PDU for which there is data available.
* 1-6-2: When both grants have available data, it is expected that MAC should generate and deliver the MAC PDU for which the grant has higher priority of the associated LCH(s)
* 1-6-3: When there is no available data for either grant, (it is the same case as Case 1-6 without LCH priority configured), it is expected that MAC should generate the MAC PDU for the CG PUSCH.

Q1-6: Do you agree with above expected MAC layer behavior for case 1-6-1, 1-6-2 and 1-6-3?

* If you do not agree, please elaborate the reason and the expected MAC layer behavior.

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| Company | Comments |
| Apple | Don’t agree with 1-6-3. Depending on PUSCH selection outcome, if CG PUSCH is not selected for UCI multiplexing in Stage 1, no MAC generation for CG PUSCH is necessary. |
| ZTE | Agree  In our understanding, this is also in line with the current MAC spec for case 1-6-1 and case 1-6-2. For case 1-6-3, we think it is reasonable since it allow UCI multiplexing, which is also aligned with UE behavior the case 1-2. |
| DOCOMO | Based on the comment in Q1-1,   * If CG PUSCH has higher LCH priority, it is selected for UCI multiplexing, and MAC generates MAC PDU for CG PUSCH and does not generate a TB for the DG PUSCH overlapping with the CG PUSCH. * If DG PUSCH has higher LCH priority, UCI is transmitted on PUCCH assuming the CG PUSCH does not exist. Whether MAC generates MAC PDU for DG PUSCH or not depends on the data availability for the grant. |
| HW/HiSi | Same comment as Q1-1 |
| OPPO | Do not agree with 1-6-3. PUCCH transmission only. |
| Qualcomm | The same as before, a PDU should be generated for a PUSCH on a CC that is identified by the PHY layer. |
| Nokia, NSB | Agree  (basically the same as cases 1-4 with CG & CG PUSCH switched) |
| LG | Same as case 1-4 |
| Intel | As before, if UL skipping for DG PUSCH is NOT configured, then the proposal does not work since gNB expects the UE to transmit the DG PUSCH.  However, with UL skipping for DG PUSCH configured, IF we assume that the CG-DG prioritization rule from Re1-15 is NOT applied if the DG PUSCH does not have a MAC PDU (and is allowed to be skipped by PHY), then the proposal can work, except 1-6-3. *Also, as before, it should be noted that this would effectively change the previous RAN1 design of prioritizing the grant with HARQ-ACK/CSI overlap.*  For 1-6-3, our understanding is that if the RAN1 #103-e options are to be followed (case 1-6 w/o LCH priorities), then MAC PDU for the DG PUSCH should be delivered. |
| Samsung | Agree |
| Ericsson | Do not agree. No need to consider 3 sub-scenarios.  Due to existing PUSCH-UCI multiplexing rule, CG PUSCH exists for Case 1-6 and multiplex with UCI. DG PUSCH is discarded. |
| APT | Do not agree with case 1-6-3. In this case, MAC will prioritize DG PUSCH and no MAC PDU is delivered for the DG PUSCH. Accordingly, PUCCH is transmitted. |
| CATT | For case 1-6,  If UE hopes to identify case 1-6, UL grant for DG PUSCH needs to be scheduled early enough by gNB, otherwise UE can’t identify case 1-6.  If UE can identify case 1-6, PHY transmission behaviors are the similar with case 1-4 as follows:  if the MAC PDU is delivered for the CG PUSCH, PHY will multiplex the UCI on the CG PUSCH and transmit the CG PUSCH including the UCI  if the MAC PDU is delivered for the DG PUSCH, when the latest time for PDU delivering of DG PUSCH is latter than the time point for deciding UCI piggyback on PUSCH, UCI and CG PUSCH are dropped together due to no PDU delivered by MAC for CG PUSCH.  if the MAC PDU is delivered for the DG PUSCH, when the latest time for PDU delivering of DG PUSCH is earlier than the time point for deciding UCI piggyback on PUSCH, handling of UCI is similar with Option 3-1: UCI is transmitted on PUCCH.  In order to ensure that LP UCI is not dropped due to selection of MAC LCH priority, we prefer that for case 1-6, UE should follow opt.3-handling method for case 1-6, UCI is transmitted on PUCCH and MAC doesn’t generate PDU for CG PUSCH. |

For case 1-6-1, 1-6-2, handling of UCI,

* If the MAC PDU is delivered for the CG PUSCH, PHY will multiplex the UCI on the CG PUSCH and transmit the CG PUSCH including the UCI;
* If the MAC PDU is delivered for the DG PUSCH, this case will result in the same situation as for Case 1-6 without LCH priority. The same handling should be applied as for Case 1-6 without LCH priority.

Q1-7: Do you agree with above on UCI handling for case 1-6-1 and 1-6-2?

* If you do not agree, please elaborate the reason and the preferred UCI handling solution.

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| Company | Comments |
| Apple | No. It all depends on the rule RAN1 is going to develop for selection among hypothetical PUSCHs for UCI multiplexing. Case 1-6 may not arise. |
| ZTE | Agree  According to RAN1 spec, the UCI should be multiplexed in the PUSCH if the PUCCH and PUSCH with MAC PDU overlaps in the time domain. For case 1-6-2, the PUCCH should be transmitted as far as possible to avoid resource waste due to PUCCH dropping and accordingly PDSCH retransmission. Therefore, the PUCCH should be transmitted if the timeline is satisfied. |
| DOCOMO | We agree with the statement.  For the case when MAC PDU is delivered for the DG PUSCH, we think UCI is transmitted on PUCCH, as UE assumes only DG PUSCH exists. |
| HW/HiSI | Same comment ad for Q1-1 |
| OPPO | Agree |
| Qualcomm | The same comment as before. |
| Nokia, NSB | Agree |
| LG | Same as case 1-4 |
| Intel | Agree, under assumption of UE configured with UL skipping for DG PUSCH. |
| Samsung | Agree |
| Ericsson | Do not agree. No need to consider 3 sub-scenarios.  Due to existing PUSCH-UCI multiplexing rule, CG PUSCH exists for Case 1-6 and multiplex with UCI. DG PUSCH is discarded. |
| CATT | See the same comment on Q1-6 |

For case 1-6-3, the UCI should be multiplexed on the CG PUSCH.

Q1-8: Do you agree with above on UCI handling for case 1-6-3?

* If you do not agree, please elaborate the reason and the preferred UCI handling solution.

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| Company | Comments |
| Apple | No. It all depends on the rule RAN1 is going to develop for selection among hypothetical PUSCHs for UCI multiplexing. Case 1-6 may not arise. |
| ZTE | Agree. This is similar as case 1-6-1 |
| DOCOMO | No. Irrespective of the data availability, UE resolves the intra-UE prioritization for different LCH priorities and determines whether or not UCI is multiplexed on the resultant PUSCH.   * If CG PUSCH has higher LCH priority, it is selected for UCI multiplexing, and MAC generates MAC PDU for CG PUSCH and does not generate a TB for the DG PUSCH overlapping with the CG PUSCH. UCI is multiplexed on the CG PUSCH. * If DG PUSCH has higher LCH priority, UCI is transmitted on PUCCH assuming the CG PUSCH does not exist. Whether MAC generates MAC PDU for DG PUSCH or not depends on the data availability for the grant. |
| HW/HiSI | Same comment as for Q1-1. |
| OPPO | PUCCH transmission only if MAC does not generate MAC PDU for any grant. |
| Qualcomm | The same comment as before. |
| Nokia, NSB | Agree |
| LG | Same as case 1-4 |
| Intel | Cannot agree. Please see response to Q 1-6 in this regard. |
| Samsung | Agree |
| Ericsson | Do not agree. No need to consider 3 sub-scenarios.  Due to existing PUSCH-UCI multiplexing rule, CG PUSCH exists for Case 1-6 and multiplex with UCI. DG PUSCH is discarded. |
| APT | Logical channel prioritization should be enhanced to prioritize a PUSCH overlapping with a PUCCH of the same PHY priority (CG PUSCH in this case). MAC PDU is delivered for the CG PUSCH and UCI is multiplexed in the CG PUSCH. |
| CATT | See the same comment on Q1-6 |

* + 1. UL skipping with LCH prioritization and two PHY priorities

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| Case 2-1a | Case 2-1b |

Case 2-1a and Case 2-1b is similar, the only difference is for Case 2-1a, the starting symbol of LP DG PUSCH is earlier than that of HP CG PUSCH. In the following, we will use the case 2-1a for discussion. The same discussion results are also applied to case 2-1b.

For case 2-1a:

* 2-1a-1: When only one grant (either DG or CG) has available data, it is expected that MAC should generate and deliver the MAC PDU for which there is data available.
* 2-1a-2: When both grants have available data, it is expected that MAC should generate and deliver the MAC PDU for which the grant has higher PHY priority.
* 2-1a-3: When there is no available data for either grant, (it is the same case as Case 1-6 without LCH priority configured), it is expected that MAC should generate the MAC PDU for the DG PUSCH.

Q2-1: Do you agree with above expected MAC layer behavior for case 2-1a-1, 2-1a-2 and 2-1a-3?

* If you do not agree, please elaborate the reason and the expected MAC layer behavior.

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| Company | Comments |
| ZTE | Agree.  In our understanding, this is also in line with the current MAC spec for case 2-1a-1 and case 2-1a-2. For case 2-1a-3, we think it is reasonable since PUCCH and PUSCH have the same PHY priority and it allow UCI multiplexing, which is also aligned with UE behavior the case 1-1. |
| DOCOMO | As commented in Section 2.2.2, Different UE behavior due to data availability requires gNB blind decoding and should be avoided. Since gNB doesn’t know the LCH priority for PUCCH, intra-UE prioritization between different LCH priorities should be resolved before UCI multiplexing on PUSCH as the case for single PHY priority. In addition, PHY-HP UL should be prioritized and the procedure for intra-UE multiplexing/prioritization for different PHY priorities should be kept from PHY perspective. Once the collision is resolved, we can follow the procedure for MAC PDU generation discussed in [104-e-NR-7.1CRs-01].  In summary, we assume the following procedure for the case of UL skipping with LCH prioritization and two PHY priorities   1. Intra-UE multiplexing for PHY LP    1. Determine the PUCCH resource for UCI multiplexing for PHY LP    2. [New] intra-UE prioritization for different LCH priorities among overlapped PUSCHs assuming all PUSCHs have available data for PHY LP       * UE assumes only the PUSCH which has the highest LCH priority exists in the following steps    3. Determine the PUSCH for UCI multiplexing, if any 2. Intra-UE prioritization between different PHY priorities 3. Intra-UE multiplexing for PHY HP    1. Determine the PUCCH resource for UCI multiplexing for PHY HP    2. [New] intra-UE prioritization for different LCH priorities among overlapped PUSCHs assuming all PUSCHs have available data for PHY HP       * UE assumes only the PUSCH which has the highest LCH priority exists in the following steps    3. Determine the PUSCH for UCI multiplexing, if any 4. Intra-UE prioritization between different PHY priorities 5. MAC generates MAC PDU for the resultant PUSCH where UCI is multiplexed and does not generate a TB for other DG PUSCH(s) overlapping with the PUSCH   Therefore, for Case 2-1a, PHY-LP DG PUSCH is selected for UCI multiplexing in Step 1, but cancelled by PHY-HP CG PUSCH in Step 4. Whether MAC generates MAC PDU for PHY-HP CG PUSCH or not depends on the data availability for the grant. |
| HW/HiSi | Same comment as for Q1-1 |
| OPPO | Agree |
| Qualcomm | We do not agree due to the same reasons mentioned before. |
| Nokia, NSB | Do not agree on case 2-1a-3: as discussed in our input contribution in R1-2100756, looking at the overall PHY priority operation (incl. Rel-17 enhancements) we prefer to not deliver any ‘dummy/filling’ PDUs for the operation with two PHY priorities. |
| LG | Do not agree. The data availability may not an issue in PHY layer. Similarly, PHY priority also doesn’t have conclusive impact on MAC operation. |
| Intel | Prefer to discuss the previous cases before getting into this and the following cases with different PHY priorities. |
| Samsung | We think that this issue should be refined/reformulated after stabilizing previous topics. |
| Ericsson | Do not agree. No need to consider 3 sub-scenarios for Case 2-1a.  Similar view as DCM on handling of Case 2-1a: for Case 2-1a, PHY-LP DG PUSCH is selected for UCI multiplexing, but cancelled by PHY-HP CG PUSCH. PHY-LP PUCCH is transmitted. Whether MAC generates MAC PDU for PHY-HP CG PUSCH or not depends on the data availability for the grant. |
| APT | Do not agree with case 2-1a-2. Although logical channel priorities associated with PUSCHs of high PHY priority is typically higher than logical channel priorities associated with PUSCHs of low PHY priority, whether HP PUSCH or LP PUSCH will be prioritized depends on the logical channel priorities of the logical channels with available data. |
| CATT | For case 2-1a, according to FL's view, MAC may send PDU to LP DG or HP CG. If MAC sends PDU to HP CG, UCI and DG will be dropped together because PHY doesn’t know no DG PDU delivered by MAC before UCI multiplexing is executed. So it seems that it is meaningless for gNB to schedule LP DG PUSCH because LP DG PUSCH can’t be transmitted and it also causes UCI dropping. If LP DG PUSCH isn’t scheduled, both LP PUCCH and HP CG PUSCH could be transmitted in TDM manner. So for case 2-1a, we prefer avoid this case by gNB scheduling so as to ensure that LP UCI is not dropped.  For Case 2-1b, when there is data for HP CG, the proper way is that MAC delivers PDU for HP CG. In such case, one assumption is that LP UCI can be transmitted on PUCCH because UE already knows there is no PDU for LP DG before deciding UCI piggyback on PUSCH. This needs new UE behavior to support UCI on LP PUCCH when LP PUCCH overlaps with LP DG without PDU. The other assumption is that UE always operates LP UCI piggyback on LP DG without considering whether there is PDU or not for DG PUSCH, which means LP UCI may be dropped together with LP DG due to no PDU for DG when MAC delivers PDU for CG.  All in all, we suggest that for Case 2-1b, LP UCI is transmitted on the LP PUCCH if MAC delivers PDU to HP CG PUSCH and LP UCI is multiplexed in LP DG PUSCH if MAC delivers PDU to LP DG PUSCH. |

For case 2-1a-1, 2-1a-2 and case 2-1a-3, handling of UCI,

* When both grants have available data or only CG has available data, it is expected the MAC PDU should be delivered for the CG PUSCH, this case will result in the same situation as for Case 1-4 with LCH priority and a single PHY priority. The same handling should be applied as for the Case 1-4 with LCH priority and a single PHY priority.
* When only DG has available data, it is expected the MAC PDU should be delivered for the DG PUSCH, and PHY will multiplex the UCI on the DG PUSCH and transmit the DG PUSCH including the UCI
* When neither grant has available data, it is expected the MAC PDU should be delivered for the DG PUSCH, so that PHY will multiplex the UCI on the DG PUSCH and transmit the DG PUSCH including the UCI.

Q2-2: Do you agree with above on UCI handling for Case 2-1a-1, 2-1a-2 and case 2-1a-3?

* If you do not agree, please elaborate the reason and the preferred UCI handling solution.

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| Company | Comments |
| ZTE | Agree  According to RAN1 spec, the UCI should be multiplexed in the PUSCH if the PUCCH and PUSCH with MAC PDU overlaps in the time domain. For the PUCCH overlapping with the PUSCH without MAC PDU (case 2-1a-1), it should be transmitted as far as possible to avoid resource waste due to PUCCH dropping and accordingly PDSCH retransmission. Therefore, the PUCCH should be transmitted if the timeline is satisfied. |
| DOCOMO | No. As commented in Q2-1, UCI multiplexed on PHY-LP DG PUSCH is cancelled irrespective of the availability of data for each grant, and hence, UCI is not transmitted. |
| OPPO | Agree |
| Qualcomm | We do not agree due to the same reasons mentioned before. |
| Nokia, NSB | Do not agree on case 2-1a-3: as discussed in our input contribution in R1-2100756, looking at the overall PHY priority operation (incl. Rel-17 enhancements) we prefer to not deliver any ‘dummy/filling’ PDUs for the operation with two PHY priorities. |
| LG | Do not agree. The data availability may not an issue in PHY layer. Similarly, PHY priority also doesn’t have conclusive impact on MAC operation. |
| Ericsson | Do not agree. No need to consider 3 sub-scenarios for Case 2-1a.  For a given PHY priority, the PUSCH (PUSCH#0) that can have UCI multiplexing should still be deterministic. Even if PUSCH#0 of PHY-LP is cancelled by a PHY-HP PUSCH, the LP PUCCH cannot be multiplexed with another PHY-LP PUSCH different from PHSCH#0.  Similar view as DCM on handling of Case 2-1a: for Case 2-1a, PHY-LP DG PUSCH is selected for UCI multiplexing, but cancelled by PHY-HP CG PUSCH. PHY-LP PUCCH is transmitted. Whether MAC generates MAC PDU for PHY-HP CG PUSCH or not depends on the data availability for the grant. |
| CATT | The same comment as for Q2-1 |

Below are Case 2-2 and Case 2-3. The difference between Case 2-2 and Case 2-3 is for Case 2-2, the PUSCH collision is between DG and CG PUSCH; while for Case 2-3, the PUSCH collision is between CG and CG PUSCH. It is noted that for Case 2-2, PHY expects MAC only deliver one MAC PDU. But for Case 2-3, MAC can deliver two CG PUSCHs, it is up to UE implementation to make sure that the low priority CG PUSCH transmission can be cancelled before the start of the high priority CG PUSCH.

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| Case 2-2 | Case 2-3 |

For Case 2-2,

* 2-2-1: When only HP CG has available data, it is expected that MAC should generate and deliver the HP CG PUSCH.
* 2-2-2: When only LP DG has available data, it is expected that MAC should generate and deliver the LP DG PUSCH.
* 2-2-3: When both grants have available data, it is expected that MAC should generate and deliver the HP CG PUSCH.
* 2-2-4: When there is no available data for either grant, discuss what the expected behavior is in MAC.

Q2-2: Do you agree with above expected MAC layer behavior for case 2-2-1, 2-2-2 and 2-2-3?

* If you do not agree, please elaborate the reason and the expected MAC layer behavior.

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| Company | Comments |
| ZTE | Agree  In our understanding, this is also in line with the current MAC spec for these three cases. |
| DOCOMO | No. Based on the comment in Q2-1, PHY-LP DG PUSCH is selected for LP UCI multiplexing in Step 1, but cancelled by PHY-HP CG PUSCH where HP UCI is multiplexed in Step 4. MAC generates MAC PDU for the PHY-HP CG PUSCH where HP UCI is multiplexed and does not generate a TB for other DG PUSCH(s) overlapping with the PUSCH. |
| OPPO | Agree  For 2-2-4, MAC should generate and deliver the LP DG PUSCH. |
| Qualcomm | We do not agree due to the same reasons mentioned before. |
| Nokia, NSB | Agree |
| LG | It depends on how MAC handle PUSCH overlapping PUCCH for multiplexing. (Such as order between lch prioritization and PUCCH handling). |
| Ericsson | Do not agree. No need to consider 4 sub-scenarios.  We share the similar view as DOCOMO on the handling of Case 2-2. MAC generates MAC PDU for the PHY-HP CG PUSCH where HP UCI is multiplexed and does not generate a TB for the overlapping PHY-LP DG PUSCH. |
| APT | Do not agree with case 2-2-3. Although logical channel priorities associated with PUSCHs of high PHY priority is typically higher than logical channel priorities associated with PUSCHs of low PHY priority, whether HP PUSCH or LP PUSCH will be prioritized depends on the logical channel priorities of the logical channels with available data. |
| CATT | For case 2-2-1, case2-2-2 and case 2-2-3, MAC always generates PDU for HP HG PUSCH with HP UCI piggyback and LP UCI is always dropped.  In order to solve the above issues of LP UCI dropping, we suggest gNB should avoid scheduling LP DG PUSCH overlapping with both LP PUCCH and HP CG PUSCH for case 2-2. |

Q2-3: for Case 2-2-4,

* Q2-3-a: What is the expected MAC layer behavior from PHY perspective and why?
* Q2-3-b: based on your replies to Q2-3-a, what is the preferred PHY layer on handling of the HP PUCCH and LP PUCCH?

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| Company | Comments |
| ZTE | We prefer the MAC layer should generate MAC PDU for the HP CG PUSCH to align with the UE behavior in case 2-2-1 and case 2-2-3 since the latter two cases are normal cases. |
| DOCOMO | Q2-3-a: Irrespective of the data availability, the PUSCH where HP UCI is multiplexed is determined as commented in Q2-1. MAC generates MAC PDU for the PHY-HP CG PUSCH where HP UCI is multiplexed and does not generate a TB for other DG PUSCH(s) overlapping with the PUSCH.  Q2-3-b: As commented in Q2-1, different UE behavior due to data availability requires gNB blind decoding and should be avoided. Deterministic procedure for intra-UE multiplexing/prioritization is preferred. |
| OPPO | For 2-2-4, MAC should generate and deliver the LP DG PUSCH. LP PUCCH is multiplexed in LP PUSCH. And HP PUCCH is transmitted. |
| Qualcomm | We do not agree due to the same reasons mentioned before. |
| Nokia, NSB | Q2-3-a: MAC should not generate any PDU. As discussed in our input contribution in R1-2100756, looking at the overall PHY priority operation (incl. Rel-17 enhancements) we prefer to not deliver any ‘dummy/filling’ PDUs for the operation with two PHY priorities.  Q2-3-b: both PUCCH (as non-overlapping) transmitted |
| LG | If PUCCH is considered a part of lch prioritization in advance to obtaining MAC PDU, it would be up to UE implementation since those seems have same priority in MAC perspective.  For PHY, it is preferred to transmit both PUCCH. |
| Ericsson | We share DOCOMO view on the handling.  Deterministic handling of PUSCH-UCI multiplexing should be ensured for a given PHY priority, and this does not change due to data availability. |
| APT | MAC will prioritize LP DG PUSCH and deliver MAC PDU to PHY, and LP PUCCH will be multiplexed in the LP DG PUSCH. HP PUCCH will be transmitted alone. |
| CATT | For case 2-2-4, MAC always generates PDU for HP HG PUSCH with HP UCI piggyback. |

For case 2-2-1, 2-2-2 and case 2-2-3, handling of UCI,

* For case 2-2-1 and case 2-2-3, HP CG is delivered and PHY will multiplex the HP-UCI on the HP-CG PUSCH; for LP-PUCCH, the same handling (e.g, UCI is dropped or UCI is transmitted on PUCCH or whether to drop or transmit the UCI depends on the timeline, etc.) should be applied as for the Case 2-1a with LCH priority and two PHY priorities.
* For case 2-2-2, LP DG is delivered and PHY will multiplex the LP-UCI on the LP-DG PUSCH; for HP-PUCCH, the same handling (e.g, UCI is dropped or UCI is transmitted on PUCCH, or whether to drop or transmit the UCI depends on the timeline etc.) can be considered to apply as for the Case 2-2-1.

Q2-4: Do you agree with above on UCI handling for Case 2-2-1, 2-2-3 and case 2-2-2?

* If you do not agree, please elaborate the reason and the preferred UCI handling solution.

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| Company | Comments |
| ZTE | Agree  According to RAN1 spec, the UCI should be multiplexed in the PUSCH if the PUCCH and PUSCH with MAC PDU overlaps in the time domain. For the PUCCH overlapping with the PUSCH without MAC PDU, it should be transmitted as far as possible to avoid resource waste due to PUCCH dropping and accordingly PDSCH retransmission. Therefore, the PUCCH should be transmitted if the timeline is satisfied. |
| DOCOMO | No. Based on the comment in Q2-1, PHY-LP DG PUSCH is selected for LP UCI multiplexing in Step 1, but cancelled by PHY-HP CG PUSCH where HP UCI is multiplexed in Step 4. MAC generates MAC PDU for the PHY-HP CG PUSCH where HP UCI is multiplexed and does not generate a TB for other DG PUSCH(s) overlapping with the PUSCH. |
| OPPO | Agree |
| Qualcomm | We do not agree due to the same reasons mentioned before. |
| Nokia, NSB | No  The PUCCHs can be transmitted (as non-overlapping with the delivered PUSCH of other priority) |
| Ericsson | Do not agree. No need to consider the sub-scenarios.  We share the similar view as DOCOMO on the handling of Case 2-2. MAC generates MAC PDU for the PHY-HP CG PUSCH where HP UCI is multiplexed and does not generate a TB for the overlapping PHY-LP DG PUSCH. |
| CATT | The same comment on Q2-2 |

For Case 2-3,

* 2-3-1: When only HP CG has available data, it is expected that MAC should generate and deliver the HP CG PUSCH.
* 2-3-2: When only LP CG has available data, it is expected that MAC should generate and deliver the LP CG PUSCH.
* 2-3-3: When both grants have available data, it is possible that MAC generates and delivers both HP CG PUSCH and LP CG PUSCH, then it is up to UE implementation to make sure that the low priority CG PUSCH transmission can be cancelled before the start of the high priority CG PUSCH.
* 2-3-4: When there is no available data for either grant, it is similar as Case 2-2, we can discuss what the expected behavior is in MAC.

Q2-5: Do you agree with above expected MAC layer behavior for case 2-3-1, 2-3-2 and Case 2-3-3?

* If you do not agree, please elaborate the reason and the expected MAC layer behavior.

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| Company | Comments |
| ZTE | Agree  In our understanding, this is also in line with the current MAC spec for case 2-3-1 and case 2-3-3. For 2-3-3, it is also possible that MAC layer only generates and delivers the HP CG PUSCH. For example, when the high priority data arrives before the MAC generates the MAC PDU for the LP CG PUSCH. |
| DOCOMO | No. Based on the comment in Q2-1, PHY-LP DG PUSCH is selected for LP UCI multiplexing in Step 1. PHY-HP CG PUSCH is selected for HP UCI multiplexing in Step 3. MAC generates MAC PDU for the PHY-HP CG PUSCH where HP UCI is multiplexed and can generate a MAC PDU for the PHY-LP CG PUSCH where LP UCI is multiplexed as long as it is cancelled before the start of PHY-HP CG PUSCH. |
| OPPO | Agree |
| Qualcomm | We do not agree due to the same reasons mentioned before. |
| Nokia, NSB | Agree |
| LG | Agree |
| Ericsson | Do not agree. No need to consider 4 sub-scenarios.  We share the similar view as DOCOMO on the handling of Case 2-3. MAC generates MAC PDU for the PHY-HP CG PUSCH where HP UCI is multiplexed. UE implementation ensures that the overlapping PHY-LP CG PUSCH is cancelled. PHY-LP PUCCH is transmitted. |
| APT | Do not agree with case 2-3-3. Although logical channel priorities associated with PUSCHs of high PHY priority is typically higher than logical channel priorities associated with PUSCHs of low PHY priority, whether HP PUSCH or LP PUSCH will be prioritized depends on the logical channel priorities of the logical channels with available data. |
| CATT | We agree with expected MAC layer behavior for case 2-3-1and Case 2-3-3  For case 2-3-2, MAC should generate and deliver the HP CG PUSCH due to HP UCI piggyback on HP CG PUSCH. |

Q2-6: for Case 2-3-4,

* Q2-6-a: What is the expected MAC layer behavior from PHY perspective and why?
* Q2-6-b: based on your replies to Q2-6-a, what is the preferred PHY layer on handling of the HP PUCCH and LP PUCCH?

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| Company | Comments |
| ZTE | We prefer the MAC layer should generate MAC PDU for the HP CG PUSCH to align with the UE behavior in case 2-3-1 and case 2-3-3 (only HP CG PUSCH delivered as mentioned in Q2-5) since the latter two cases are normal cases |
| DOCOMO | Q2-6-a: Irrespective of the data availability, the PUSCHs where LP/HP UCI is multiplexed are determined as commented in Q2-1. MAC generates MAC PDU for the PHY-HP CG PUSCH where HP UCI is multiplexed and can generate a MAC PDU for the PHY-LP CG PUSCH where LP UCI is multiplexed as long as it is cancelled before the start of PHY-HP CG PUSCH  Q2-6-b: As commented in Q2-1, different UE behavior due to data availability requires gNB blind decoding and should be avoided. Deterministic procedure for intra-UE multiplexing/prioritization is preferred. |
| OPPO | MAC should NOT generate and deliver any MAC PDU. HP PUCCH and LP PUCCH transmit |
| Qualcomm | For all the cases, either Option 2 from Q1-1 or the alternative solution as explained in our response can be used. Both of the solutions achieve the objectives. |
| Nokia, NSB | Q2-6-a: MAC should not generate any PDU. As discussed in our input contribution in R1-2100756, looking at the overall PHY priority operation (incl. Rel-17 enhancements) we prefer to not deliver any ‘dummy/filling’ PDUs for the operation with two PHY priorities.  Q2-6-b: both PUCCH (as non-overlapping) transmitted |
| LG | Same as Q2-3 |
| Ericsson | We share DOCOMO view on the handling.  Deterministic handling of PUSCH-UCI multiplexing should be ensured for a given PHY priority, and this does not change due to data availability. |
| APT | MAC will prioritize the LP CG PUSCH when the logical channel prioritization pseudo code is checked for the LP CG PUSCH, and LP PUCCH will be multiplexed in the LP CG PUSCH. MAC will prioritize the HP CG PUSCH when the logical channel prioritization pseudo code is checked for the HP CG PUSCH, and HP PUCCH will be multiplexed in the HP CG PUSCH. As such, the LP CG PUSCH and the multiplexed UCI of the LP PUCCH will be cancelled. |
| CATT | For Case 2-3-4, MAC always generates for HP HG PUSCH with HP UCI piggyback. In addition, MAC also generates UCI for LP PUCCH if the last point for PUCCH preparation is later than the last point of PDU delivering. |

Handling of UCI for case 2-3-1, 2-3-2 and case 2-3-3,

* For case 2-3-1, HP CG is delivered and PHY will multiplex the HP-UCI on the HP-CG PUSCH; for LP-PUCCH, FFS UCI can be dropped or UCI can be transmitted on PUCCH, etc.
* For case 2-3-2, LP CG is delivered and PHY will multiplex the LP-UCI on the LP-CG PUSCH; for HP-PUCCH, FFS UCI can be dropped or UCI can be transmitted on PUCCH, etc.
* For case 2-3-3,
  + if only HP CG is delivered, it becomes the same case as case 2-3-1;
  + if only LP CG is delivered, it becomes the same case as case 2-3-2;
  + if both CGs are delivered, it is up to UE implementation to make sure that the LP CG PUSCH with the LP UCI multiplexed on it can be cancelled before the start of the HP CG PUSCH, and the HP UCI is multiplexed on HP CG PUSCH.

Q2-7: Do you agree with above on UCI handling for Case 2-3-1, 2-3-2 and case 2-3-3?

* If you do not agree, please elaborate the reason and the preferred UCI handling solution.

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| Company | Comments |
| ZTE | Agree  According to RAN1 spec, the UCI should be multiplexed in the PUSCH if the PUCCH and PUSCH with MAC PDU overlaps in the time domain. For the PUCCH overlapping with the PUSCH without MAC PDU, it should be transmitted as far as possible to avoid resource waste due to PUCCH dropping and accordingly PDSCH retransmission. Therefore, the PUCCH should be transmitted if the timeline is satisfied.  For case 2-3-3, we do not think only LP CG PUSCH is delivered since the HP CG PUSCH has data for transmission. We think the other two behaviors are possible. |
| DOCOMO | No. Irrespective of the data availability, the PUSCHs where LP/HP UCI is multiplexed are determined as commented in Q2-1. MAC generates MAC PDU for the PHY-HP CG PUSCH where HP UCI is multiplexed and can generate a MAC PDU for the PHY-LP CG PUSCH where LP UCI is multiplexed as long as it is cancelled before the start of PHY-HP CG PUSCH |
| OPPO | Agree with FL’ suggestion.  For case 2-3-1, LP UCI can be transmitted on LP PUCCH.  For case 2-3-2, HP UCI can be transmitted on HP PUCCH. |
| Qualcomm | We do not agree due to the same reasons mentioned before. |
| Nokia, NSB | Agree  Preference to have the PUCCH transmitted (and no UCI dropping) |
| LG | Based on the current specification and our previous agreement, both PUSCH cannot be skipped but LP PUSCH should be cancelled by other PUSCH with sufficient timeline. |
| Ericsson | Do not agree. No need to consider the sub-scenarios.  We share similar view as DOCOMO on the handling of Case 2-3. MAC generates MAC PDU for the PHY-HP CG PUSCH where HP UCI is multiplexed. UE implementation ensures that the overlapping PHY-LP CG PUSCH is cancelled. PHY-LP PUCCH is transmitted. |
| CATT | For case 2-2-1, case2-2-2 and case 2-2-3, if the last point for LP PUCCH preparation is later than the last point of PDU delivering, LP PUCCH and HP CG PUSCH with HP UCI piggyback are transmitted.  If not, only HP CG PUSCH with HP UCI piggyback is transmitted and LP UCI is dropped.  In order to solve the above issues of LP UCI dropping, we suggest gNB should avoid LP CG PUSCH overlapping with both LP PUCCH and HP CG PUSCH for case 2-3 |

**Q2-8: Based on your views for section 2.1 and 2.2, which high-level option as provided in the section 2.2.1 General views do you prefer?**

* **Option 1: Handled by gNB scheduling or configuration restrictions**
* **Option 2: PHY selects and indicates to MAC the PUSCH that cannot be skipped and the MAC layer can skip other PUSCHs except the one indicated by the PHY layer.**
* **Option 3: MAC layer decide which MAC PDU should be delivered (based on LCH based priority and data availability and the resource overlapping between the PUSCH and PUCCH of the same L1 priority).**

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| Company | Comments |
| ZTE | Option 3  In our understanding, the MAC layer should decide which MAC PDU should be deliver based on  LCH based priority and data availability if there is available data for either grant, or  the resource overlapping between the PUSCH and PUCCH of the same L1 priority if there is no available data for the two grants. |
| DOCOMO | Option 2 |
| OPPO | Option 3 |
| Qualcomm | Either Option 2 or the alternative proposed in our response to Q1-1. |
| Nokia, NSB | Option 3 |
| LG | Option 3 |
| Ericsson | Option 2 with minor revision:  Option 2’: For a given PHY priority, PHY selects and indicates to MAC the PUSCH that cannot be skipped and the MAC layer can skip other PUSCHs except the one indicated by the PHY layer. |
| APT | Option 3 |
| CATT | We prefer Option1 and Option3.  For case 2-1a, case 2-2 and case 2-3, option 1 can be used and LP CG PUSCH overlapping with both LP PUCCH and HP CG PUSCH is avoided by gNB scheduling.  For case 2-1b, option 3 can be used.  LP UCI is transmitted on the LP PUCCH if MAC delivers PDU to HP CG PUSCH and LP UCI is multiplexed in LP DG PUSCH if MAC delivers PDU to LP DG PUSCH. |

**Q2-9: for the MAC PDU not delivered by MAC layer, if it overlaps with the PUCCH of the same PHY priority, do you prefer to have the same solution should be adopted as for the case 1-6 without LCH priority?**

* **If your answer is No, please share your reasons.**

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| Company | Comments |
| ZTE | Yes. We think the same solution should be used.  In general, the UCI should be multiplexed in the PUSCH if the PUCCH and PUSCH with MAC PDU overlaps in the time domain. For the PUCCH overlapping with the PUSCH without MAC PDU, it should be transmitted as far as possible to avoid resource waste due to PUCCH dropping and accordingly PDSCH retransmission. Therefore, the PUCCH should be transmitted if the timeline is satisfied. The timeline requirement is the time interval between the PUCCH and the PDCCH scheduling the PUSCH is not less than Tproc,1, where the PUSCH is transmitted finally. |
| OPPO | Yes |
| Nokia, NSB | No  As discussed in our input contribution in R1-2100756, looking at the overall PHY priority operation (incl. Rel-17 enhancements) we prefer to not deliver any ‘dummy/filling’ PDUs for the operation with two PHY priorities. And the PUCCH transmission should be possible for the UE. Otherwise, we will have some time domain scheduling limitations even for HP HARQ-ACK looking e.g. at Cases 2-2-2 & 2-2-3. |
| LG | We believed that “the PUSCH with UCI multiplexing from the set cannot be skipped” should mean that MAC generate dummy PDU for the PUSCH. In our view, there should be no such case. |
| DOCOMO | No. Unlike the case without LCH priority, there is ambiguity issue on MAC PDU generation with LCH prioritization. Deterministic procedure for intra-UE multiplexing/prioritization is preferred to avoid gNB blind decoding. |
| Ericsson | The question is unclear.   * If the PUSCH is HP, and expected to have UCI multiplexing, then: we share same view as LG that this shouldn’t happen. This PUSCH will have a MAC PDU. * If the PUSCH is HP, but not the one expected to have UCI multiplexing, then: this is possible and this PUSCH does not participate in PHY intra-UE multiplexing/prioritization. * If the PUSCH is LP, and expected to have UCI multiplexing, then: this PUSCH serves the purpose of giving the deterministic PUSCH that can have LP PUCCH multiplexing, i.e., the LP PUCCH cannot multiplex with another LP PUSCH. * If the PUSCH is LP, but not the one expected to have UCI multiplexing, then: this PUSCH does not affect PUCCH multiplexing; does not participate in PHY intra-UE multiplexing/prioritization. |
| CATT | For the PDU not delivered by MAC layer, if it overlaps with the PUCCH of the same PHY priority, we prefer to the same solution for the case 1-6 without LCH priority. |

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# Appendix

## RAN1 agreements related to Rel-16 uplink skipping

**Agreement (RAN1#102)**

For UL skipping of dynamic UL grant in non-CA and CA case, when there is PUCCH carrying UCI overlapping with a set of PUSCHs, the PUSCH with UCI multiplexing from the set cannot be skipped. MAC generates MAC PDU for the PUSCH and the UCI is multiplexed on the PUSCH.

**Agreement: (RAN1#103)**

For the case (Case 1-2) where only one or more CG PUSCHs overlapping with PUCCH

* In Rel.16, for CA and non-CA case, when Rel-16 LCH based prioritization is not configured and there is a single PHY priority for UL transmissions, and when PUSCH repetition is not applied, in case of one or more CG PUSCHs overlapping with UCI and there is no DG PUSCH overlapping with the UCI and there is no DG PUSCH overlapping with the one or more CG PUSCHs, the CG PUSCH with UCI multiplexing from the one or more CG PUSCHs cannot be skipped.  MAC generates MAC PDU for the CG PUSCH and delivers the MAC PDU to PHY and the UCI is multiplexed on the CG PUSCH.

**Conclusion (RAN1#103)**

For the following cases, for CA and non-CA, when DG PUSCH skipping is configured and Rel-16 LCH based prioritization is not configured and there is a single PHY priority for UL transmissions, MAC generates MAC PDU for the DG PUSCH and the UCI is multiplexed on the DG PUSCH. For the case 1-3 and 1-4, MAC does not generate a TB for the CG PUSCH(s) overlapping with the DG PUSCH on the same serving cell.  The ~~G~~CG PUSCH(s) is discarded and does not participate in subsequent physical layer procedure.

* (Case 1-3) DG PUSCH and CG PUSCH are overlapping and both DG/CG PUSCH are overlapping with PUCCH
* (Case 1-4) DG PUSCH and CG PUSCH are overlapping and DG PUSCH is overlapping with PUCCH, and CG PUSCH is non-overlapping with the PUCCH
* (Case 1-5) DG PUSCH and CG PUSCH are non-overlapping and both DG/CG PUSCH are overlapping with PUCCH

**Working Assumption: (RAN1#103)**

For the case (Case 1-6) when DG PUSCH and CG PUSCH are overlapping on a serving cell and CG PUSCH is overlapping with PUCCH, and DG PUSCH is non-overlapping with the PUCCH

* In Rel.16, for non-CA case, when DG PUSCH skipping is configured and Rel-16 LCH based prioritization is not configured and there is a single PHY priority for UL transmissions, and when PUSCH repetition is not applied, in case of one or more CG PUSCHs overlapping with UCI and there is DG PUSCH overlapping with the CG PUSCHs on a serving cell and not overlapping with the UCI
  + Opt-3:
    - If there is data for DG, MAC generates PDU for DG PUSCH
      * UCI is transmitted on PUCCH.
    - If there is no data for DG, MAC does not generate PDU for DG or CG PUSCH
      * UCI is transmitted on PUCCH.
  + Opt-4:
    - If there is data for DG, MAC generates PDU for DG PUSCH
      * UCI is dropped together with CG PUSCH.
    - If there is no data for DG, MAC does not generate PDU for DG or CG PUSCH.
      * UCI is dropped together with CG PUSCH.

Note: In RAN1#104-e, aim to resolve case 1-6 using above options as a starting point, other options are not precluded.

|  |  |
| --- | --- |
|  |  |
| **Case 1-2** | **Case 1-3** |
|  |  |
| **Case 1-4** | **Case 1-5** |
|  | |
| **Case 1-6** | |

## RAN1 agreements from Rel-16 URLLC

**Agreement (RAN1#103)**

* For the collision scenario between CG and DG with same/different PHY-priority index, if there is no collision between PUCCH and the CG and there is no collision between PUCCH and the DG, the behaviour mentioned in the LS is consistent with RAN1’s understanding if taking into account the TP to Rel-16 TS 38.214, i.e., revision CR in R1-2008655.
* When the MAC entity is configured with *lch-basedPrioritization*, for the collision scenario between CG and DG with same/different PHY-priority index, and when there is collision between PUCCH and the CG with the same priority and/or there is collision between PUCCH and the DG with the same priority, RAN1 is still discussing the related PHY layer behaviour.

## RAN1 agreements related to collision handling for PUSCH of different PHY priorities in Rel-16

1. Overlapping HP DG PUSCH and LP DG PUSCH is not supported
   * Related RAN1#99 Conclusion: In Rel. 16 URLLC, the UE is not expected to be scheduled with two DG-PUSCH overlap in the time domain on the same carrier.
2. HP CG PUSCH and LP CG PUSCH can be overlapping and MAC may deliver more than one PDU, it is up to UE implementation to make sure that the low priority CG PUSCH transmission can be cancelled before the start of the high priority CG PUSCH.
   * Related RAN1#101-e Agreement: For collision handling between CG and CG with different priorities - If MAC delivers two MAC PDUs, it is up to UE implementation to make sure that the low priority CG PUSCH transmission can be cancelled before the start of the high priority CG PUSCH
3. Overlapping of DG PUSCH and CG PUSCH of different PHY priority is supported, if the Rel-15 overriding timeline is satisfied (i.e. only a single MAC PDU will be delivered, no PHY cancelation)
   * Related RAN1#101-e Conclusion:There is no consensus in RAN1 for the support of the following
     + - high priority DG cancel the transmission of low priority CG in the physical layer
       - high priority CG cancel the transmission of low priority DG in the physical layer

No further discussion for Rel-16.

* + Related RAN1#102-e Conclusion: For the collision between DG PUSCH and CG PUSCH with different priorities, the DG PUSCH can be scheduled overlapping in time with CG PUSCH occasion if Rel-15 timeline satisfies.