**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. |
| 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. |
| 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). |
| 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. |

* + - 1. Summary for Case 1

[To be updated]

* + 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. |

* + - 1. Summary for Case 2-1

[To be updated]

* **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 |

* + - 1. Summary for Case 2-2

[To be updated]

* + 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?**

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| 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 |

* + - 1. Summary for Case 3

[To be updated]

* 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.**

* + 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.

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| **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.

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| 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.

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| 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. |
| 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. |
| 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 |

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 |

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 |

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 |

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 |

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 |

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 |

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 |

* + 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. |

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. |

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). |

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. |

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) |
|  |  |

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 |

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 |

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. |

**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 |

**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. |

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20. R1-2101166 Draft reply LS on overlapped data and SR are of equal L1 priority Samsung
21. R1-2101276 Draft reply LS on overlapped data and SR with equal L1 priority for Rel-16 URLLC Huawei, HiSilicon
22. R1-2101277 Discussion on overlapped data and SR with equal L1 priority for Rel-16 URLLC Huawei, HiSilicon
23. R1-2101502 Discussion of Response LS on Overlapped Data and SR of Equal L1 Priority Ericsson Inc.
24. R1-2101528 Discussion on LS on overlapping data and SR with same L1 priority Intel Corporation

# 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.

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| **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.