**3GPP TSG RAN WG1 #101e R1-** **20xxxxx**

**May 25th – June 5th, 2020**

**Agenda item:** 7.2.5.4

**Source:** Moderator (Qualcomm)

**Title:** Summary of [101-e-NR-L1enh-URLLC-HARQ&Scheduling-01]

**Document for:** Discussion and Decision

# 1 Introduction

This document summarizes the companies’ views and captures the agreements related to the following email discussion:

**Email Discussion #1 by 5/29 and corresponding TP (if any) by 6/5 – Kianoush (Qualcomm):**

* *Issue #1: Cancellation timeline for the case the high priority channel is dynamically scheduled*
  + *Potential modification for the previous agreement on when the UE can cancel the ongoing transmission*
  + *Determination of SCS and N2 for the case of non-CA UL and CA UL*
* *Issue #2: Intra-UE cancellation and multiplexing order*
* *Issue #3: Revision of existing RAN1 agreement*

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| --- |
| The agreement in RAN1#100bis-e is updated as follows:   * If a UE is scheduled with a first PDSCH and a second PDSCH which is starting later than the first PDSCH on a given serving cell, the corresponding PUCCHs carrying HARQ-ACK with different priorities can overlap in time.   + ~~FFS: For supporting this feature, a new FG, separate from FG 12-1, will be introduced.~~   + ~~FFS: The PUCCH associated with the second PDSCH cannot be scheduled for transmission at or earlier than PUCCH associated with the first PDSCH.~~ |

**Companies are encouraged to share their initial feedback by 05/26.**

The summary of the companies’ proposals is available in [1]

# 2 Issue#1: Intra-UE Cancellation Timeline Determination and Behaviour

### 2.1 Revisiting the Agreement on Intra-UE Cancellation Timeline

One of the issues brought up during RAN1 #100e-b was to clarify/modify the cancellation time according to the following agreement:

**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 Tproc,2 +d1 after the end of PDCCH scheduling the high-priority transmission, where*
  + *Tproc,2 is corresponding to UE processing time capability for the carrier.*
  + *Value d1 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 d2 symbols*
  + *Value d2 is the time duration corresponding to 0,1,2 symbols reported by UE capability*

*The overlapping condition is per repetition of the uplink transmission*

The main reason for clarifying/modifying the above agreement is that enforcing an exact cancellation time incurs additional UE implementation complexity.

The following options were discussed:

* **Option#1:** Tproc,2+d1 is the exact time for cancellation, i.e., the UE is not allowed to cancel the low priority channel earlier or later than the time pointed by Tproc,2+d1.
* **Option#2:** Tproc,2+d1 is the latest time for cancellation, i.e., the UE is allowed to cancel the low priority channel earlier than the time indicated by Tproc,2+d1, however, the deadline for cancellation is at the time indicated by Tproc,2+d1.
* **Option#3:** Tproc,2+d1 is the earliest time for cancellation, i.e., the UE could cancel the low priority channel at or after the time indicated by Tproc,2+d1, but not earlier. The deadline for cancellation is the start of the first symbol of the high priority channel.
* **Option#4:** A UE is expected to cancel the overlapping low priority channel by the first overlapping symbol at the latest. Further, the UE is expected the gap between the end of PDCCH carrying the grant for the high priority channel and the starting symbol of the high priority channel to be no smaller than Tproc,2+d1.

**Question #1: Which of the abovementioned options should be adopted? Please share your preferred option and additional comments in the table below.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Preferred Option** | **Comment** | **FL Comments** |
| MediaTek | Option#4 | Option#1 and Option#3 add complexity to the UE implementation of the feature.  We are fine with Option#2 as well. |  |
| OPPO | Option # 2,4 | The latest time for cancellation is required to avoid UL transmission overlapping. Timeline is also required to define to ensure there is enough processing time to cancel. So we prefer to option 2 plus timeline restriction in option 4. | The same timeline is included to Option 2 in the updated proposal. |
| HW/HiSi | Option #2 (in principle with a clarification in the comment section) or Option #4 | For option #2 some  We are in general supportive of Option 2 in addition to option #4, but would like to extend it a bit in order to resolve an ambiguity that arises from the case below. When the LP channel is scheduled with a later start than Tproc2+d1 as shown in the figure below, then it needs to be clarified if the cancellation shall start from the HP channel or from the LP channel. | Under Option 2, the assumption is that the LP PUSCH is cancelled already somewhere before the dashed line. |
| ZTE | Option#3 | Two reasons to support Option#3.   1. For the collision caused by SFI, the current spec in TS 38.213 handles such collision as below. It means a UE can cancel a number of symbols no smaller than *TProc,2*, which is equivalent to that *TProc,2* after the last symbol of a CORESET is the earliest time for cancellation. Similarly, this principle can also be used to solve the collision between UL transmissions with different priorities.  |  | | --- | | For operation on a single carrier in unpaired spectrum, if a UE is configured by higher layers to transmit SRS, or PUCCH, or PUSCH, or PRACH in a set of symbols of a slot and the UE detects a DCI format indicating to the UE to receive CSI-RS or PDSCH in a subset of symbols from the set of symbols, then  - the UE does not expect to cancel the transmission in symbols from the set of symbols that occur, relative to a last symbol of a CORESET where the UE detects the DCI format, after a number of symbols that is smaller than the PUSCH preparation time  for the corresponding UE processing capability [6, TS 38.214] assuming  and  corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format and the SCS configuration of the SRS, PUCCH, PUSCH or *r*, where *r* corresponds to the SCS configuration of the PRACH if it is 15kHz or higher; otherwise *r*=0  - the UE cancels the PUCCH, or PUSCH, or PRACH transmission in remaining symbols from the set of symbols and cancels the SRS transmission in remaining symbols from the subset of symbols |  1. For Option#3, at least the symbols between the last symbol of PDCCH scheduling the high priority transmission and the *T*proc,2+*d*1 after the end of PDCCH are available for gNB to decode. It is important to keep the low priority UL transmission as much as possible, especially for the PUSCH with UCI. Regarding Options#2 and Option#4, gNB can’t assume the valid reception symbols for low priority UL transmission as the cancellation depends on UE implementation, so Option#3 can provide more resource efficiency.   In addition, as for the latest time for cancellation of low priority transmission, we think a better way is to replace the deadline in Option#2, Option#3, even Option#4 by *d*2 symbol before high priority channel. If we do so, the issue in section 2.2 will not exist. |  |
| DOCOMO | Option #2 | Share similar view as MediaTek. As long as UE cancels low priority channel earlier than Tproc,2+d1, no problem. |  |
| vivo | Option #2 | The cancellation timeline here is similar as cancellation timeline for SFI in NR Rel-15, from our understanding, Tproc,2+d1is the latest time to make sure the low priority chancel is cancelled. |  |
| Nokia, NSB | Modified Option#4 | In principle, Option 4 is preferred. However, in Option 4, the gap is about scheduling restriction other than the cancellation timeline, and therefore it should be d2 instead of d1. So in Option 4 d2 should be used instead of d1!  Furthermore, such extension is not always necessary as discussed in our Tdoc. We propose to update Option 4 as following:  **Option#4:** A UE is expected to cancel the overlapping low priority channel by the first overlapping symbol at the latest. Further, the UE is expected the gap between the end of PDCCH carrying the grant for the high priority channel and the starting symbol of the high priority channel to be no smaller than Tproc,2+d~~1~~2 if the time from the end of the last symbol of the PDCCH carrying the grant for the high priority channel to the start of the first symbol of the low priority channel is shorter than Tproc,2. | The processing time for preparation of the HP channel is based on N1/N2 plus some additional offset denoted by d2. This has to be guaranteed.  The proposed change, however, ties the minimum processing timeline for HP channel to the timeline for cancellation. It is not clear how the dependency should work. In addition, if the gap is smaller than Tproc,2 by 5 symbols, given that the max value of d is 2 symbols, what the UE behavior should be? |
| Sony | Option#2 | We share’s OPPO’s view that we can also add the timeline restriction of Option 4, i.e. “*the gap between the end of PDCCH carrying the grant for the high priority channel and the starting symbol of the high priority channel to be no smaller than Tproc,2+d1*” | Added. |
| Ericsson | Option#4 | As we explained last meeting, as well as in our contribution [5], Tproc,2+d should be perceived as the minimum required time that the gNB has to provide to the UE reference to the DCI scheduling HP if expects the UE to cancel the low priority transmission.  If gNB fulfills this requirement, then gNB expects the UE to not transmit the low priority transmission over the HP transmission.  As shown below, the gNB scheduled HP such that it doesn’t provide enough time for the UE to cancel. Hence, LP Tx is not expected to be canceled.    In following cases, both left and right, enough time is provided. Then it is UP to UE when to cancel. What is important that there is no transmission by LP channel on the HP channel since UE has enough time to cancel the LP Tx by the time that the HP starts to be transmitted. When the UE cancels it is completely UE implementation. |  |
| Samsung | Option 3 | As ZTE explained, this is similar cancellation behavior of receiving SFI or UL CI.  For SFI cancelling CG PUSCH, UE does not expect to cancel the transmission before corresponding symbol right after Tproc,2 +d1 after the end of PDCCH scheduling the high-priority transmission, otherwise, UE can cancel the transmission at and after the corresponding symbol.  Moreover, main issue is that gNB make sure that UE cancels low priority channel and then transmit high priority channel properly. In this sense, option 3 can provide proper UE behavior since the deadline for cancellation is the start of the first symbol of the high priority channel, as same reason in option 4.  Regarding complexity mentioned by MTK, if option 3 provides similar sentence as in Rel-15 SFI or Rel-16 UL CI, current specification may also have similar complexity already in there. | If the time indicated by Tproc,2+d1 is exactly the same as where the transmission of the high priority channel starts, then the cancellation time becomes exact. Hence, this proposal does not seem to address the UE’s complexity issue. |
| Qualcomm | Option 4 | Option 1 and 3 increases UE complexity, and are not reasonable. Note that under Option 3, the point of time indicated by Tproc,2+d1 could be the beginning of the high priority transmission too; hence, effectively, the cancellation time becomes exact again.  On the suggestion from Nokia, we think the offset value should be d1. The other offset, i.e., d2, is added to N1 or N2 depending on whether the transmission is PUCCH or PUSCH. |  |
| Spreadtrum | Option 4 (1st )  Option 2 (2nd ) | Agree with MTK and Qualcomm, Option 1 and Option 3 will increase the complexity for UE cancelation. From our understanding, Tproc,2+d1 is the cancelation point that we have already agreed. So if UE is able to cancel LP UL channel earlier, it is reasonable to allow this procedure. This definition is benefit for both of gNB and UE sides. |  |
| Intel | Option 4 (with minor modification for improved readability) | Agree with MediaTek on the issues related to Options 1 and 3.  Our preference is Option 4 with some minor modifications, as follows:  A UE is expected to cancel the overlapping low priority channel by the first overlapping symbol at the latest. Further, ~~the UE is expected the gap between the end of PDCCH carrying the grant for the high priority channel and the starting symbol of the high priority channel to be no smaller than Tproc,2+d1~~. UE expects that the first symbol of the high priority channel is not earlier than Tproc,2+d1 after the last symbol of the PDCCH with the DCI format scheduling the high priority channel. | Addressed in the updated proposal. |
| Apple | Option 4 or 2 | We think the sentence **“the UE is expected the gap between the end of PDCCH carrying the grant for the high priority channel and the starting symbol of the high priority channel to be no smaller than Tproc,2+d1.” should be true for all the options**. Because this is the requirement on the UE cancellation timeline, the gNB should not schedule any HP transmission before this timeline. Therefore, we propose to make it a separate proposal, independent from which option we choose here.  Agree that Option #1 is too restrictive in UE implementation because it requires the UE to cancel at the exact time.  Option #3 leaves very limited flexibility in the cancellation time point. But it does not allow the UE to cancel earlier. Fundamentally it is not that much different from Option #1 from UE implementation point of view, because the UE would need to be able to handle the case where the HP transmission starts at Tproc,2+d1 for Option #3 (which becomes Option #1 in this case). |  |
| NEC | Option 3 | We share similar view with ZTE and Samsung. If the cancellation timeline requirement is such that HP transmission is not scheduled before Tproc,2+d1, in our understanding it is more resource efficient not to cancel LP transmission before this. The deadline for cancellation is still the start of the first symbol of the HP channel. |  |
| CATT | Option 4 | We prefer option 4 with the update from Intel.  In addition, we would like to further discuss the proposal from Nokia. Our understanding of Nokia’s proposal is to make sure that the scheduling delay of the high priority channel is similar as in the Rel-15 for cancellation timeline of DG overriding CG. In Rel-15, as long as the scheduling DCI for DG PUSCH ends N2 symbols before the start of CG PUSCH, CG PUSCH can be cancelled and there is no additional processing time added for DG PUSCH. |  |

**2.1.1 Summary of the Discussion and Next Steps**

Based on the comments, the companies’ positions are summarized in the table below:

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| --- | --- |
| **Option 1** | None |
| **Option 2** | MTK, OPPO, HW/HiSi, DOCOMO, vivo, Sony, Spreadtrum (2nd preference), Apple (8) |
| **Option 3** | ZTE, Samsung, NEC (3) |
| **Option 4** | MTK, OPPO, HW/HiSi, Nokia (with modification), Ericsson, Qualcomm, Spreadtrum (1st preference), Intel, Apple, CATT (FFS Nokia’s proposal) (10) |

**Proposal: In case of collision between a high priority channel and low priority channels, adopt one of the following options:**

* **Option#2:** Tproc,2+d1 is the latest time for cancellation, i.e., the UE is allowed to cancel the low priority channel earlier than the time indicated by Tproc,2+d1, however, the deadline for cancellation is at the time indicated by Tproc,2+d1. Further, a UE expects that the first symbol of the high priority channel is not earlier than Tproc,2+d1 after the last symbol of the PDCCH with the DCI format scheduling the high priority channel.
* **Option#3:** Tproc,2+d1 is the earliest time for cancellation, i.e., the UE could cancel the low priority channel at or after the time indicated by Tproc,2+d1, but not earlier. The deadline for cancellation is the start of the first symbol of the high priority channel. Further, a UE expects that the first symbol of the high priority channel is not earlier than Tproc,2+d1 after the last symbol of the PDCCH with the DCI format scheduling the high priority channel.
* **Option#4:** A UE is expected to cancel the overlapping low priority channel by the first overlapping symbol at the latest. ~~A UE is expected to cancel the overlapping low priority channel by the first overlapping symbol at the latest.~~ Further, a UE expects that the first symbol of the high priority channel is not earlier than Tproc,2+d1 after the last symbol of the PDCCH with the DCI format scheduling the high priority channel.

### 2.2 Minimum Processing Timeline Extension for a High Priority Channel

As agreed previously, in case of collision, the minimum processing timeline for a dynamically scheduled high priority channel should be extended by d2 symbols; d2 is reported as a UE capability. However, this agreement has not yet been captured in the specification.

The feature lead recommendation is to capture the agreement by adopting the following TP:

**Proposal#1: Adopt the following TP to capture the minimum processing timeline extension for scheduling a high priority channel in case of collision:**

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| **Modified clause (Section 5.3 of TS 38.214)** |

If the first uplink symbol of the PUCCH which carries the HARQ-ACK information, as defined by the assigned HARQ-ACK timing *K1* and the PUCCH resource to be used and including the effect of the timing advance, starts no earlier than at symbol *L1*, where *L1* is defined as the next uplink symbol with its CP starting after after the end of the last symbol of the PDSCH carrying the TB being acknowledged, then the UE shall provide a valid HARQ-ACK message.

*- N1* is based on *µ* of table 5.3-1 and table 5.3-2 for UE processing capability 1 and 2 respectively, where *µ* corresponds to the one of (*µPDCCH*, *µPDSCH*, *µUL*) resulting with the largest *Tproc,1*, where the *µPDCCH* corresponds to the subcarrier spacing of the PDCCH scheduling the PDSCH, the *µPDSCH* corresponds to the subcarrier spacing of the scheduled PDSCH, and *µUL* corresponds to the subcarrier spacing of the uplink channel with which the HARQ-ACK is to be transmitted, and κ is defined in clause 4.1 of [4, TS 38.211].

*-* If the PDSCH DM-RS position for the additional DM-RS in Table 7.4.1.1.2-3 in clause 7.4.1.1.2 of [4, TS 38.211] is then *N1,0=14* inTable 5.3-1*,* otherwise *N1,0=13.*

- If the UE is configured with multiple active component carriers, the first uplink symbol which carries the HARQ-ACK information further includes the effect of timing difference between the component carriers as given in [11, TS 38.133].

- For the PDSCH mapping type A as given in clause 7.4.1.1 of [4, TS 38.211]: if the last symbol of PDSCH is on the *i-*th symbol of the slot where *i* < 7, then *d1,1 = 7 - i*, otherwise *d1,1 = 0.*

* If the UE reports the capability of [intra-UE prioritization], and if a PUCCH of a larger priority index is overlapping with PUCCH/PUSCH of a smaller priority index, is determined by the reported UE capability [XXXXX].

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| **End** |

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| **Modified clause (Section 6.4 of TS 38.214)** |

If the first uplink symbol in the PUSCH allocation for a transport block, including the DM-RS, as defined by the slot offset *K2* and the start and length indicator *SLIV* of the scheduling DCI and including the effect of the timing advance, is no earlier than at symbol *L2*, where *L2* is defined as the next uplink symbol with its CP starting after the end of the reception of the last symbol of the PDCCH carrying the DCI scheduling the PUSCH, then the UE shall transmit the transport block.

*- N2* is based on *µ* of Table 6.4-1 and Table 6.4-2 for UE processing capability 1 and 2 respectively, where *µ* corresponds to the one of (*µDL*, *µUL*) resulting with the largest *Tproc,2*, where the *µDL* corresponds to the subcarrier spacing of the downlink with which the PDCCH carrying the DCI scheduling the PUSCH was transmitted and *µUL* corresponds to the subcarrier spacing of the uplink channel with which the PUSCH is to be transmitted, and *κ* is defined in clause 4.1 of [4, TS 38.211].

- If the first symbol of the PUSCH allocation consists of DM-RS only, then *d2,1* = 0*,* otherwise *d2,1* = 1.

- If the UE is configured with multiple active component carriers, the first uplink symbol in the PUSCH allocation further includes the effect of timing difference between component carriers as given in [11, TS 38.133].

- If the scheduling DCI triggered a switch of BWP, *d2,2* equals to the switching time as defined in [11, TS 38.133], otherwise *d2,2*=0.

* If the UE reports the capability of [intra-UE prioritization], and if a PUSCH of a larger priority index is overlapping with a PUCCH of a smaller priority index, is determined by the reported UE capability [XXXXX].

- For a UE that supports capability 2 on a given cell, the processing time according to UE processing capability 2 is applied if the high layer parameter *processingType2Enabled* in *PUSCH-ServingCellConfig* is configured for the cell and set to *enable*,

- If the PUSCH indicated by the DCI is overlapping with one or more PUCCH channels, then the transport block is multiplexed following the procedure in clause 9.2.5 of [6, TS 38.213], otherwise the transport block is transmitted on the PUSCH indicated by the DCI.

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| **End** |

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| **Company** | **Comment** | **FL comment** |
| MediaTek | Support.  The case where *d2* is not applicable (i.e. no collision between HP and LP channels) need to be added to the TP.  If the UE reports the capability of [intra-UE prioritization], and if a PUCCH of a larger priority index is overlapping with PUCCH/PUSCH of a smaller priority index, is determined by the reported UE capability [XXXXX], otherwise *d2*=0.  If the UE reports the capability of [intra-UE prioritization], and if a PUCCH of a larger priority index is overlapping with PUCCH/PUSCH of a smaller priority index, is determined by the reported UE capability [XXXXX] otherwise *d2*=0. | Updated. |
| OPPO | Support TP with MediaTek’s suggestion. |  |
| HW/HiSi | Support the TP from MTK.  One further question is on the d2. Currently there is only one and the same d2 value that is applied for Tproc1 and Tproc2. It could be discussed if only one value for d2 should be reported, or two separate values. What view have other companies on this? | Based on the current agreement, only a single value is reported by the UE regardless of whether the high priority channel is PUCCH or PUSCH. |
| ZTE | Not agree. If *d*2 is needed for a UE to stop the ongoing low priority transmission in order to ensure the high priority transmission, the latest cancellation time of low priority can be replaced from the first symbol of high priority transmission to *d*2 symbol before the first symbol of high priority transmission. For example, as shown in following figure, if we define the latest time for low priority PUSCH is point B which is the *d*2 symbol before the first symbol of high priority PUCCH, i.e. point C in this figure, then extra d2 is not needed for the UE to prepare the high priority PUCCH (non-existent of ongoing low priority transmission in point C), which is also benefit for high priority PUCCH in aspect of latency. | The proposal is to capture an earlier agreement in the specification. |
| DOCOMO | Support TP with MediaTek’s suggestion. |  |
| vivo | Agree with MediaTek to add the case where d2 is not applicable for both and . In addition, for , the case HP DG PUSCH overlaps with LP CG is being discussed. Maybe a note is needed whether this case should also be captured here. | Other scenarios can be discussed if any agreement is reached. |
| Nokia, NSB | We agree with the intention of the TP and the clarification by MTK on d2=0 (in blue), but similarly as for the first proposal, we think that d2 is only needed if the time from the end of the last symbol of the PDCCH carrying the grant for the high priority channel to the start of the first symbol of the low priority channel is shorter than Tproc,2. Therefore, we suggest the following additions in red font.  *If the UE reports the capability of [intra-UE prioritization], and if a PUCCH of a larger priority index is overlapping with PUCCH/PUSCH of a smaller priority index, and if the time from the end of the last symbol of the PDCCH carrying the grant for the high priority channel to the start of the first symbol of the low priority channel is shorter than Tproc,2, is determined by the reported UE capability [XXXXX], otherwise d2=0.*  *If the UE reports the capability of [intra-UE prioritization], and if a PUSCH of a larger priority index is overlapping with a PUCCH of a smaller priority index, and if the time from the end of the last symbol of the PDCCH carrying the grant for the high priority channel to the start of the first symbol of the low priority channel is shorter than Tproc,2, is determined by the reported UE capability [XXXXX], otherwise d2=0..* | Please refer to my earlier comment in the previous section. |
| Sony | Support the TP with MediaTek’s suggestion. |  |
| Ericsson | We agree with Nokia’s suggestion.  However, we have a comment (more general) that concerns all the proposed TP. In our view, it is not a proper practice from specification perspective to state in the core specifications, “If a UE supports capability Z…” unless it is necessary. We are aware there are few examples of that, but it would be preferred to be avoided.  When a procedure is defined and a respective capability, it is apparent that procedure is not applicable unless the capability is supported. There is no need to overly state this condition. Preferred approach, also recommended by RAN2, is to use the corresponding RRC parameter, if available. | The capability parts are removed. |
| Qualcomm | Agree. Also, we are fine with the suggestion from MTK and also Ericsson (to remove the capability from the sentence.)  On the response from ZTE, i.e., to not support the TP, it should be noted that this TP is merely aiming at capturing our earlier agreement in the specification, which is currently misssing. Since we already have an agreement to extend the minimum processing timeline of the HP channel, the timeline extension should be captured in the spec.  We think the suggestion from Nokia is not needed; it says that d2 is only applied if the gap between the HP PDCCH and HP channel is less than Tproc,2. Tproc,2 and d2 are defined to address two different challenges; the former is the time needed to stop the transmission of a low priority channel (over the air.) The latter one is introduced due to he delay incurred for managing the UE pipeline. |  |
| Spreadtrum | We support the revised version given by MTK. |  |
| Intel | Support the TP with MediaTek’s suggestion. |  |
| Apple | Support the TP in general, but would suggest some modification for consideration:  If the UE reports the capability of [intra-UE prioritization], and if the PUCCH has a larger priority index and would overlap with a PUCCH/PUSCH of a smaller priority index, is determined by the reported UE capability [XXXXX], otherwise *d2*=0.  If the UE reports the capability of [intra-UE prioritization], and if the PUSCH has a larger priority index and would overlap with a PUCCH of a smaller priority index, is determined by the reported UE capability [XXXXX] otherwise *d2*=0.  However, if companies prefer MTK’s version, we are fine as well. But the 2nd bulelt need to be fixed. |  |
| CATT | We prefer Apple’s update in principle since it is clearer that d2 is added to the PUCCH/PUSCH of a larger priority index only (not for a PUCCH/PUSCH of a smaller priority index).  For the capability, we also think we need further discuss. According to RAN2’s agreements that PHY based prioritization and LCH based prioritization can be separated configured, our understanding is that for a UE capable of [intra-UE prioritization], PHY based prioritization may or may not be configured. Then is it more appropriate to use the configuration as a condition although we are not clear whether we have such configuration explicitly or implicitly?  In addition, as commented for Q1, we would like to further discuss Nokia’s proposal. |  |

**2.2.1 Summary of the Discussion and Next Steps**

Two modifications, proposed by MTK and Ericsson, are addressed; The companies views are captured in the table below:

|  |  |
| --- | --- |
| Support | MTK, OPPO, HW/HiSi, DCM, vivo, Sony, Qualcomm, Spreadtrum, Intel, Apple (10) |
| Support with additional modifications | Nokia/NSB, Ericsson, CATT (3) |
| Not support | ZTE (1) |

The feature lead recommendation is to adopt the following updated proposal:

**Proposal: Adopt the TP in Section 2.2 of this document with the following changes for Section 5.3 and 6.4 of TS 38.214, respectively:**

* **If a PUCCH of a larger priority index would overlap with PUCCH/PUSCH of a smaller priority index, is as reported by the UE; otherwise *d2*=0.**
* **If a PUCCH of a larger priority index would overlap with PUCCH/PUSCH of a smaller priority index, is as reported by the UE; otherwise *d2*=0.**

### 2.3 SCS and N2 Determination for UL non-CA

In this section, the main assumption is that a UE is configured with a single UL carrier; however, multiple serving cells may have been configured for a UE. Hence, all collisions happen on a single serving cell even though the uplink channels, if dynamically scheduled, can be scheduled using PDCCHs received on different serving cells. In order to calculate Tproc,2, two inputs are needed: (1) SCS, and (2) N2.

To determine the input SCS, the following proposal can be considered (Note that the SCS of the low and high priority channels is identical since the UE is configured with a single UL serving cell; however, the proposal is written in a more generic manner.)

**Proposal#2: If a UE is configured with a single UL carrier and in case a dynamically scheduled high priority channel overlaps with a low priority channel, the SCS for Tproc,2 calculation is determined as the smallest SCS configuration of the PDCCH providing the DCI for the low priority channel (if any), the SCS configuration for the PDCCH providing the DCI for the high priority channel, the SCS configuration of the low priority channels to be cancelled and the SCS configuration of the high priority channel.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| MediaTek | Fine with the proposal |
| OPPO | Fine with the proposal |
| DOCOMO | Fine with the proposal |
| vivo | Fine with the proposal |
| Nokia, NSB | Fine with the proposal. |
| Sony | Fine with the proposal. |
| Ericsson | Fine with the proposal. |
| Samsung | Fine with the proposal. |
| Qualcomm | Support the proposal. |
| Spreadtrum | Fine with the proposal. |
| Intel | Support the proposal. |
| Apple | Support |
| OPPO | Support the proposal |
| NEC | Support the proposal |
| CATT | Fine with the proposal with the understanding that Tproc,2 in the proposal is for calculating the cancellation timeline. For Tproc,2 for HP PUSCH preparation, only the SCS configuration of the DCI associated with the HP PUSCH and the SCS configuration of the PUSCH are considered as in Rel-15. |

To determine N2, the following proposal can be considered (Note that timing capability #2 is only supported in case of self-carrier scheduling):

**Proposal #3:** **If a UE is configured with** **a single UL carrier and in case a dynamically scheduled high priority channel overlaps with a low priority channel, N2 for Tproc,2 calculation is determined as:**

* **If the overlapping group consists of a high priority PUCCH carrying HARQ-ACK and low priority PUCCHs and/or PUSCHs and if *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for the serving cell with the high priority DCI format and for all serving cells corresponding to the low priority HARQ-ACK information transmission in the overlapping group and if *processingType2Enabled* of *PUSCH-ServingCellConfig* is set to *enable* for the serving cell with the corresponding low priority PUSCHs in the overlapping group, is 5 for 5.5 for and 11 for otherwise, is 10 for 12 for , 23 for and 36 for**
* **If the overlapping group consists of a high priority PUSCH and low priority PUCCHs and/or PUSCHs and if *processingType2Enabled* of *PUSCH-ServingCellConfig* is set to *enable* for the serving cell with the high priority DCI format and for the serving cell with the corresponding low priority PUSCHs in the overlapping group and if *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for all serving cells corresponding to the low priority HARQ-ACK information transmission in the overlapping group, is 5 for 5.5 for and 11 for otherwise, is 10 for 12 for , 23 for and 36 for**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | Proposal 3 simplified as the following? Some quick attempt 😊   * **If *processingType2Enabled* of *PDSCH-ServingCellConfig* or of *PUSCH-ServingCellConfig, whichever applicable,* is set to enable for all serving cells corresponding to the low and high priority serving channels in the overlapping group, is 5 for 5.5 for and 11 for otherwise, is 10 for 12 for , 23 for and 36 for** |
| Samsung | In our views, proposal#3 looks like as follows.   * If *processingType2Enabled* of *PDSCH-ServingCellConfig* and of *PUSCH-ServingCellConfig, whichever applicable,* is set to enable for all serving cells corresponding to the low and high priority serving channels in the overlapping group, is 5 for 5.5 for and 11 for otherwise, is 10 for 12 for , 23 for and 36 for   For example, in case that PDSCH processing time is not configured to capability#2 while PUSCH preparation time is configured to capability#2, UE will apply capability#2 if PUSCH is not overlapping with low priority channels, while apply capability#1 if overlapping with low priority channels. Is it intention from proposal#3? |
| Qualcomm | We support the proposal.  Also, we do not think the proposal from Ericsson is accurate for the same reason explained by Samsung. |
| Spreadtrum | **We support the proposal from Samsung.** |
| Intel | Support the proposal from Samsung |
| Apple | We support the original proposal. There may be ways to simplify it. But it is not clear to us whether Samsung’s proposal means exactly the same, because “whichever applicable” is a bit ambiguous and it is not clear whether DL processing capability of the serving cell that carries UL grant is taken into account or not. |
| CATT | In Rel-15, an SFI can cancel a configured UL transmission and the timeline considers UE processing capability for PUSCH only (no PDSCH processing capability).   |  | | --- | | If a UE is configured by higher layers to transmit SRS, or PUCCH, or PUSCH, or PRACH in a set of symbols of a slot and the UE detects a DCI format 2\_0 with a slot format value other than 255 that indicates a slot format with a subset of symbols from the set of symbols as downlink or flexible, or the UE detects a DCI format 1\_0, DCI format 1\_1, or DCI format 0\_1 indicating to the UE to receive CSI-RS or PDSCH in a subset of symbols from the set of symbols, then  - the UE does not expect to cancel the transmission in symbols from the set of symbols that occur, relative to a last symbol of a CORESET where the UE detects the DCI format 2\_0 or the DCI format 1\_0 or the DCI format 1\_1 or the DCI format 0\_1, after a number of symbols that is smaller than the PUSCH preparation time  for the corresponding PUSCH processing capability [6, TS 38.214] assuming  and  corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format 2\_0, DCI format 1\_0, DCI format 1\_1 or DCI format 0\_1 and the SCS configuration of the SRS, PUCCH, PUSCH or *r*, where *r* corresponds to the SCS configuration of the PRACH if it is 15kHz or higher; otherwise *r*=0  - the UE cancels the PUCCH, or PUSCH, or PRACH transmission in remaining symbols from the set of symbols and cancels the SRS transmission in remaining symbols from the subset of symbols. |   Similarly in this case, we think it sufficient to consider PUSCH processing capability. In addition, given that we are considering the case with a single UL carrier, we can just determine the PUSCH processing capability based on the configured PUSCH processing capability on the UL carrier. |

**2.3.1 Summary of the Discussion and Next Steps**

All companies support Proposal 2.

For proposal 3, a simpler wording is proposed by Samsung; the feature lead proposal is to agree to the original proposal. If there are suggestions on how to make the specification concise, it can be discussed when preparing the TP.

### 2.4 SCS and N2 Determination for CA UL

**Feature lead comment: Based on the discussions amongst the feature leads, the SCS and N2 determination for UL CA will be discussed after the discussion in Section 2.3 is stable.**

# 3 Multiplexing versus Intra-UE Prioritization Order

During RAN1 #99, RAN1 reached the following two agreements:

During the last RAN 1 meeting, the following agreement was reached:

**Agreement:**

* *To resolve collision between UL transmissions, a UE performs the following:* 
  + *Step 1: Resolve collision between UL transmissions with same priority.*
  + *Step 2: Resolve collision between UL transmissions with different priorities.*

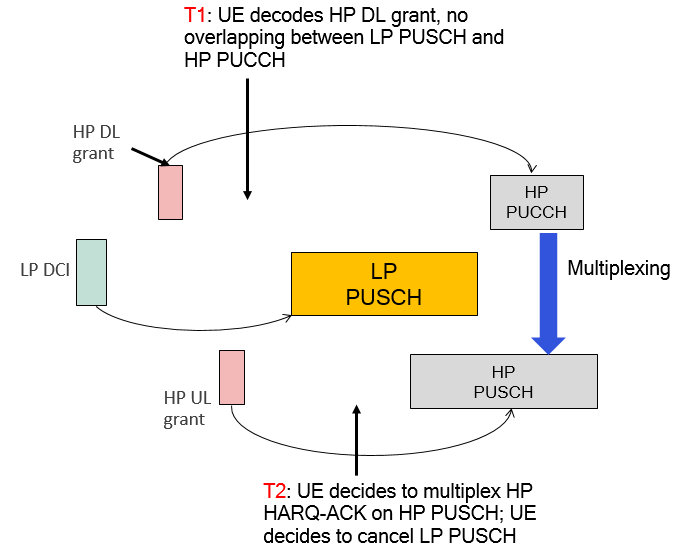
**Agreement:**

*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 Tproc,2 +d1 after the end of PDCCH scheduling the high-priority transmission, where*
  + *Tproc,2 is corresponding to UE processing time capability for the carrier.*
  + *Value d1 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 d2 symbols*
  + *Value d2 is the time duration corresponding to 0,1,2 symbols reported by UE capability*

*The overlapping condition is per repetition of the uplink transmission*

According to the first agreement, in an event of collision, before prioritization, the channels of the same priority should be multiplexed. However, based on the second agreement, the cancellation is triggered upon detection of “a” high priority grant. Hence, as shown in [2], in some cases (e.g., as illustrated in Figure (a)), multiplexing before cancellation is possible. However, in some other scenarios (e.g., as illustrated in Figure (b)), multiplexing before cancellation is not feasible. In particular, under (b), if the UE is enforced to wait and see if another high priority grant might be scheduled, its time for cancellation will be shorter than Tproc,2+d1.



(a)



(b)

To address the abovementioned issue, the following options are proposed:

* **Option#1:** No specification change is needed [3]
  + **FL comment: Some elaboration on how the issue should be avoided would be helpful.**
* **Option#2:** If the first symbol of the LP UL transmission is later than Tproc,2+d1 after the end of the second PDCCH scheduling the HP PUSCH, the UE transmits the LP PUCCH/PUSCH; otherwise, the LP PUCCH/PUSCH is cancelled [4].
* **Option#3:** When resolving collision between a high priority uplink transmission and one or more low priority uplink transmissions, the cancellation of the low priority channel(s) is triggered upon reception of the first PDCCH scheduling an overlapping high priority channel, i.e., no look-ahead for intra-UE cancellation determination is assumed [2].

**Question #2: Which of the abovementioned options should be adopted? Please share your preferred option and additional comments in the table below.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preferred Option** | **Comments** |
| MediaTek | Option#3 | The decision for canceling the LP channel will be executed by the UE once it finds there is a collision between LP & HP channels. |
| HW/HiSi | Option#2 | The UE does not need to initiate the cancelling of the LP PUSCH until Tproc2+d1 before its intended start. There is no need to initiate the cancelling earlier. IN our view, this would be in-line with the agreement to resolve collisions of the same priority firstly.    Figure 2 Cancellation order |
| ZTE | Option#1 | In Release 16, the UE can regard this conflicting scenario as an error case. UE is not expected the error case. We suggest this issue can be discussed in R17. |
| vivo | Option#1 | Option#2 will complex UE’s implementation. Either option#1 or option#3 can be considered. option#1 has no spec impact and is preferred. |
| Nokia, NSB | Option#1 | In our view, this issue can be solved with proper UE implementation as explained below.  Following the UE multiplexing/prioritization procedure specified in TS38.213, UE will first resolve the collision issue among the channels with the same priority, afterwards between the remaining channels with different priority. Taking the example as shown in Fig. 3.5 in our Tdoc [3], depending on the UE processing timeline, at the time instance of collision resolution, two different scenarios could happen:   * **Scenario 1:** The HP PUSCH scheduled by the second PDCCH is not known due to e.g. the second PDCCH scheduling HP PUSCH coming too late, then following the current specification, UE will resolve the collision between LP PUSCH and HP PUCCH. As the outcome of this process, LP PUSCH will be cancelled. Then at a bit later time, when the HP PUSCH is known to the UE, UE will handle the collision between HP PUCCH and HP PUSCH. This is the same outcome as proposed in R1-2002545. * **Scenario 2:** The HP PUSCH scheduled by the second PDCCH is known at the UE before the cancelation process for LP PUSCH has started. In this case, the UE will handle the collision between HP PUSCH and HP PUCCH for example making multiplexing decision (while not necessarily mean completing the entire multiplexing process), then checking whether there is overlapping channels with different priorities. In this example case, the remaining channels are the LP PUSCH and HP PUSCH which are not overlapping, and therefore no cancellation of the LP PUSCH is needed.   Based on this discussion, in our opinion with proper UE implementation, the UE can follow the current specification when making decision of cancellation/multiplexing according to the cancellation/multiplexing timeline and the current specification is sufficient to handle the considered scenario. Therefore, we prefer Option 1. |
| Ericsson | Option# 1 | We would like to elaborate in the following and describe our view of the procedures.   * First of all, the two agreements should not be considered out of context. It is clear that in case of overlapping between different priorities, first multiplexing per priority is considered, and then cancellation, if applicable. Each agreement has its purpose.   + 1) If there is only overlapping between same priority, clause 9.2.5 multiplexing procedures.   + 2) If there is overlapping between a high priority and a low priority, cancelation procedures is applied.   + If there is both 1&2, first 1, and then 2. * The cancelation timeline agreement describes the requirements on the cancelation time that must be fulfilled by gNB as we explained previously. It does not mean after the required time for cancelation has elapsed UE has to start cancelling. Similarly, with multiplexing timeline (described in clause 9.2.5 in 38.213). These timeline means that if UE is expected to multiplex, enough time should be provided. * Secondly, the way we considers examples as illustrated is that, as long as gNB is provided enough time for multiplexing and canceling with respect to corresponding reference time, since the order of procedures is clearly specified, UE is expected to multiplex first and then cancel. How the UE does it, it is really up to UE implementation. Maybe the UE has to wait with cancelation (usually takes less time) until it can be surely executed. * To summarize, the procedures and the order of them are clear. The requirement from gNB is to provide enough time for executing the expected procedures. If that is fulfilled, UE is expected to follow the order. How the UE does it, it is up to UE. |
| Samsung |  | Principle of option#3 if it is up to UE implementation. We are not sure whether specification impact is or not. In this sense, we are also a little bit preferable of option 1 with same reasons as mentioned by Nokia and Ericsson since gNB make sure UE behavior. |
| Qualcomm | Option 3 | The triggering time for cancellation, if needed, is upon decoding the high priority DCI. Enforcing the UE to wait longer and determine if the multiplexing situation changes incurs additional, significant, complexity at the UE.  Our understanding from Nokia’s response is that the decision can be left to the UE. However, the current specification states that the multiplexing across channels of the same priority should be done first. It would be great if additional explanation can be provided on how the operation can be left to the UE, while the above behavior is also guaranteed. |
| Spreadtrum | Option 3 | For this multiple PDCCHs for HP UL transmissions, we also agree that it can complex UE implementation if always requiring UE to wait for the next PDCCH, which is unknown whether there is or not.  Regarding our previous agreement, it mainly focus on the high level of HP and LP collision handle. So we support Option 3. It can simplify the multiplexing procedure and timeline definition. |
| Intel | Option 3 | We think this issue intends to make it more clear regarding when and how UE applies the two step process of handling UL transmissions of same and different priorities.  In particular, the following agreement only states about the condition of overlapping of UL channels.  **Agreement:**   * *To resolve collision between UL transmissions, a UE performs the following:*    + *Step 1: Resolve collision between UL transmissions with same priority.*   + *Step 2: Resolve collision between UL transmissions with different priorities.*   Preparation to multiplex or drop a transmission starts based on when information of such overlapping transmissions is available at the UE. In this regard, we support Option 3 as it simplifies UE implementation and no look-ahead procedure is used for intra-UE prioritization.  To this end, we think it is adequate to capture that the behavior only applies when UE determines there are overlapping transmissions of different priorities. First UE resolves overlapping UL transmissions of same priority if any, and subsequently moves onto handling UL transmissions of different priorities according to step 2 of agreement. We suggest following update which is general enough and seems to cover example mentioned by Qualcomm as well.  --------------------- **Text proposal starts for TS 38.213, Section 9** -------------------  **\*\*\*\* Unchanged text omitted  \*\*\*\*\***  When a UE determines overlapping for PUCCH and/or PUSCH transmissions of different priority indices, UE resolves if there is any overlapping for PUCCH and/or PUSCH transmissions of a same priority index first, and then, if the  ~~If, after resolving overlapping for PUCCH and/or PUSCH transmissions of a same priority index, a~~ UE determines to transmit  -    a first PUCCH of larger priority index, a PUSCH or a second PUCCH of smaller priority index, and a transmission of the first PUCCH would overlap in time with a transmission of the PUSCH or the second PUCCH, the UE does not transmit the PUSCH or the second PUCCH  -    a PUSCH of larger priority index, a PUCCH of smaller priority index, and a transmission of the PUSCH would overlap in time with a transmission of the PUCCH, the UE does not transmit the PUCCH  -    a first PUSCH of larger priority index on a serving cell, a second PUSCH of smaller priority index on the serving cell, and a transmission of the first PUSCH would overlap in time with a transmission of the second PUSCH, the UE does not transmit the second PUSCH, where at least one of the two PUSCH is not scheduled by a DCI format  In the remaining of this Clause, a UE multiplexes UCIs with same priority index in a PUCCH or a PUSCH. A PUCCH or a PUSCH is assumed to have a same priority index as a priority index of UCIs a UE multiplexes in the PUCCH or the PUSCH.  **\*\*\*\* Unchanged text omitted  \*\*\*\*\*** |
| Apple | Option 3 | This seems to be a very reasonable UE behavior, not having to wait for the possible DCI in the future. |
| OPPO | Option 1 | If the cancellation/multiplexing timeline is sufficient, UE follows current spec to handle the considered scenario.  Otherwise, it is an error case. |
| NEC | Option 3 | It is reasonable not to enforce a UE wait for a possible DCI in the future. |

**3.1 Summary of the Discussion and Next Steps**

Based on the comments, the companies’ views are summarized in the table below:

|  |  |
| --- | --- |
| Option 1 | ZTE, vivo, Nokia/NSB, Ericsson, Samsung, OPPO (6) |
| Option 2 | HW/HiSi (1) |
| Option 3 | MTK, vivo, Samsung(?), Spreadtrum, Intel, Apple, NEC, Qualcomm (8) |

Feature lead comment: The proposed TP by Intel seems reasonable and could address the views from different companies. As a next step, it is recommended to consider this TP for further discussion.

**Question: Is the following TP agreeable to address the order of operation between intra-UE prioritization and multiplexing?**

------------------ **Text proposal starts for TS 38.213, Section 9** -------------------

**\*\*\*\* Unchanged text omitted  \*\*\*\*\***

When a UE determines overlapping for PUCCH and/or PUSCH transmissions of different priority indices, UE resolves if there is any overlapping for PUCCH and/or PUSCH transmissions of a same priority index first, and then, if the

~~If, after resolving overlapping for PUCCH and/or PUSCH transmissions of a same priority index, a~~ UE determines to transmit

-    a first PUCCH of larger priority index, a PUSCH or a second PUCCH of smaller priority index, and a transmission of the first PUCCH would overlap in time with a transmission of the PUSCH or the second PUCCH, the UE does not transmit the PUSCH or the second PUCCH

-    a PUSCH of larger priority index, a PUCCH of smaller priority index, and a transmission of the PUSCH would overlap in time with a transmission of the PUCCH, the UE does not transmit the PUCCH

-    a first PUSCH of larger priority index on a serving cell, a second PUSCH of smaller priority index on the serving cell, and a transmission of the first PUSCH would overlap in time with a transmission of the second PUSCH, the UE does not transmit the second PUSCH, where at least one of the two PUSCH is not scheduled by a DCI format

In the remaining of this Clause, a UE multiplexes UCIs with same priority index in a PUCCH or a PUSCH. A PUCCH  
or a PUSCH is assumed to have a same priority index as a priority index of UCIs a UE multiplexes in the PUCCH or  
the PUSCH.

**\*\*\*\* Unchanged text omitted  \*\*\*\*\***

**Please share your views in the table low:**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **If the answer is No, please share your reasons** |
| CATT | Yes |  |
|  |  |  |

# 4 Issue #3: PUCCH/PUCCH Collision Handling

In RAN1 #100e-b, the following agreement was reached:

**Agreement:**

* If a UE is scheduled with a first PDSCH and a second PDSCH which is starting later than the first PDSCH on a given serving cell, the corresponding PUCCHs carrying HARQ-ACK with different priorities can overlap in time.
  + FFS: For supporting this feature, a new FG, separate from FG 12-1, will be introduced.
  + FFS: The PUCCH associated with the second PDSCH cannot be scheduled for transmission at or earlier than PUCCH associated with the first PDSCH.

For RAN1 #101e, it is proposed to revise the agreement as follows:

**Proposal #4: Revise the RAN1 agreement as follows:**

|  |
| --- |
| The agreement in RAN1#100bis-e is updated as follows:   * If a UE is scheduled with a first PDSCH and a second PDSCH which is starting later than the first PDSCH on a given serving cell, the corresponding PUCCHs carrying HARQ-ACK with different priorities can overlap in time.   + ~~FFS: For supporting this feature, a new FG, separate from FG 12-1, will be introduced.~~   + ~~FFS: The PUCCH associated with the second PDSCH cannot be scheduled for transmission at or earlier than PUCCH associated with the first PDSCH.~~ |

If there is an objection, please provide your comments in the table below:

|  |  |
| --- | --- |
| **Company** | **Comments** |
| MediaTek | Support the proposal |
| HW/HiSi | Support the proposal |
| ZTE | We support the revised the agreement (with deleting the two FFSs). |
| vivo | Support the proposal |
| Nokia, NSB | Support the proposal |
| Ericsson | Support the proposal |
| Samsung | Support the proposal |
| Spreadtrum | Support the proposal |
| Intel | Support the proposal |
| Apple | Support |
| OPPO | Support |
| NEC | Support the proposal |
| CATT | Support the proposal |

**4.1 Summary of the Discussion and Next Steps**

Based on the comments, the proposal is stable and can be agreed.

# 5 References

**[1] R1-2004674, “Summary#1 on UCI enhancements for R16 URLLC,” Moderator (OPPO)**

**[2] R1-2004458, “Remaining issues on UCI enhancements for URLLC,” Qualcomm**

**[3] R1-2003578, “Maintenance of Rel-16 URLLC UCI enhancements,” Nokia, NSB**

**[4] R1-2003528, “Corrections on UCI enhancements,” Huawei/HiSi**

**[5] R1-2003440, “Remaining Issue of UCI Enhancements for NR URLLC,” Ericsson**