**3GPP TSG RAN WG1 #104e-b R1-** **21xxxxx**

**April 12th – 20th, 2021**

**Agenda item:** 7.2.5

**Source:** Moderator (Qualcomm)

**Title:** Summary #1 of the Remaining Issues on HARQ and Scheduling Enhancements for URLLC

**Document for:** Discussion and Decision

# 1 Introduction

In this document, proposals and remaining issues related to URLLC HARQ and scheduling are summarized. The list of the proposals is as follows:

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| **Topic** | **Companies supporting the discussion in RAN1 #104b-e** | **FL Comment** |
| **Issue #1:** Intra-UE prioritization  | OPPO [1] | Proposal is unclear  |
| **Issue#2:** Clarification on cancellation of LP channels | CATT [2] | Discuss |
| **Issue #3:** Processing order of UL cancellation by SFI/DG and UL multiplexing  | CATT [2] | Discuss under PUSCH AI. Not related to HARQ and scheduling AI.  |
| **Issue #4:** Timeline requirement for cancellation | CATT [2] | Discuss |
| **Issue #5:** PDSCH and PUSCH processing time  | CATT [2] | This is largely a Rel. 15 issue. My suggestion is to discuss it under Rel. 15 CRs. If any change then is needed for intra-UE prioritization, it can be discussed.  |

# 2 Issue #1

The following example and proposal are presented in [1]:

*For LP PUCCH Y, any of PUCCH2, PUCCH 4 and PUCCH5 can be considered to cancel PUCCH Y.*

* *For PUCCH1, due to it has been overridden by PUCCH4 before PUCCH Y is determined, PUCCH Y is not impacted by PUCCH1. It seems contradict with “before performing overriding HP channels”. However, in our understanding, the intention of “before performing overriding HP channels” is to take PUCCH 1 into account to deprioritize PUCCH X, which can be determined before HP DCI 2, not for PUCCH Y.*
* *For PUCCH3, it is resulted from PUCCH 1 and PUCCH 2 multiplexing. However, PUCCH1 has been overridden by PUCCH4 before PUCCH Y is determined, PUCCH 3 does not exist either. So, it is unreasonable to take PUCCH 3 into account.*



***Proposal: Overridden HP channel(s) and corresponding HP channel(s), e.g. multiplexed channel(s) resulted from overridden channel(s), before LP channel is determined, are not considered for prioritization.***

# 3 Issue #2

As shown in Figure 1, multiplexing HP PUCCH-1 and HP PUCCH-2 result in HP PUCCH-3, which overlaps with HP PUSCH and would multiplex with HP PUSCH. It is not clear whether the intermediate HP PUCCH-3 would cancel LP PUCCH according the specification.



Since UE may not know the HP PUCCH-3 would multiplex with HP PUSCH when UE begins to cancel the LP PUCCH, the LP PUCCH should be cancelled by intermediate high priority PUCCH resource(s). Hence, the following TP is proposed:

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| **9 UE procedure for reporting control information**<Unchanged text omitted>When a UE determines overlapping for PUCCH and/or PUSCH transmissions of different priority indexes other than PUCCH transmissions with SL HARQ-ACK reports, including repetitions if any, the UE first resolves the overlapping for PUCCH and/or PUSCH transmissions of smaller priority index as described in Clauses 9.2.5 and 9.2.6. Then, - if a transmission of a first PUCCH of larger priority index scheduled by a DCI format in a PDCCH reception would overlap in time with a repetition of a transmission of a second PUSCH or a second PUCCH of smaller priority index, the UE cancels the repetition of a transmission of the second PUSCH or the second PUCCH before the first symbol that would overlap with the first PUCCH transmission- if a transmission of a first PUSCH of larger priority index scheduled by a DCI format in a PDCCH reception would overlap in time with a repetition of the transmission of a second PUCCH of smaller priority index, the UE cancels the repetition of the transmission of the second PUCCH before the first symbol that would overlap with the first PUSCH transmissionwhere - the overlapping is applicable before or after resolving overlapping among channels of larger priority index, and during the multiplexing among channels of larger priority index, if any, as described in Clauses 9.2.5 and 9.2.6; and the overlapping is applicable during PUCCH resource overriding procedure, if any, as described in Clauses 9.2.3- any remaining PUCCH and/or PUSCH transmission after overlapping resolution is subjected to the limitations for UE transmission as described in Clause 11.1- the UE expects that the transmission of the first PUCCH or the first PUSCH, respectively, would not start before $T\_{proc,2}+d\_{1}$ after a last symbol of the corresponding PDCCH reception- $T\_{proc,2} $is the PUSCH preparation time for a corresponding UE processing capability assuming $d\_{2,1}=0$ [6, TS 38.214], based on $μ$ and $N\_{2}$ as subsequently defined in this Clause, and $d\_{1}$ is determined by a reported UE capability----------------------------------------------------- End of text proposal ------------------------------------------------------ |

# 4 Issue #3

In [2], it is mentioned that when a UE is configured by higher layers with parameter *SlotFormatIndicator* and the UE does not detect a DCI format 2\_0 providing a slot format for the slot, the following agreement is not reflected in the specification:

**Agreement**

Confirm the following working assumption and remove the brackets as follows:

* A UE behavior of handling intra-UE prioritization/multiplexing for overlapping UL transmissions on semi-static flexible symbols is not affected by UL cancellation due to dynamic SFI or ~~[~~DL grant~~]~~

Note: The UE performs prioritization/multiplexing first and once done applies dynamic SFI

Based on above, the following TP is proposed:

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| -------------------------------------------------- Start of text proposal ------------------------------------------------------11.1.1      UE procedure for determining slot format<Unchanged text omitted>For a set of symbols of a slot that are indicated as flexible by *tdd-UL-DL-ConfigurationCommon*, and *tdd-UL-DL-ConfigurationDedicated* if provided, or when *tdd-UL-DL-ConfigurationCommon*, and *tdd-UL-DL-ConfigurationDedicated* are not provided to the UE, and if the UE does not detect a DCI format 2\_0 providing a slot format for the slot- the UE receives PDSCH or CSI-RS in the set of symbols of the slot if the UE receives a corresponding indication by a DCI format- the UE transmits PUSCH, PUCCH, PRACH, or SRS in the set of symbols of the slot if the UE receives a corresponding indication by a DCI format, a RAR UL grant, fallbackRAR UL grant, or successRAR- the UE receives PDCCH as described in Clause 10.1- if the UE is configured by higher layers to receive PDSCH in the set of symbols of the slot, the UE does not receive the PDSCH in the set of symbols of the slot- if the UE is configured by higher layers to receive CSI-RS in the set of symbols of the slot, the UE does not receive the CSI-RS in the set of symbols of the slot, except when UE is provided *CO-DurationsPerCell* and the set of symbols of the slot are within the remaining channel occupancy duration.- if the UE is configured by higher layers to receive DL PRS in the set of symbols of the slot, the UE receives the DL PRS- if the UE is configured by higher layers to transmit SRS, or PUCCH, or PUSCH, or PRACH in the set of symbols of the slot and the UE is not provided *enableConfiguredUL*, the UE - does not transmit the PUCCH, or the PUSCH, or an actual repetition of the PUSCH [6, TS 38.214], as determined in Clauses 9 and 9.2.5 or in Clause 6.1 of [6. TS 38.214], or the PRACH in the slot and does not transmit the SRS in symbols from the set of symbols in the slot, if any, starting from a symbol that is after PUSCH preparation time $T\_{proc,2}$ for the corresponding PUSCH timing capability [6, TS 38.214] assuming $d\_{2,1}=1$ after a last symbol of a CORESET where the UE is configured to monitor PDCCH for DCI format 2\_0 and $μ$ corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format 2\_0 and the SCS configuration of the SRS, PUCCH, PUSCH or $μ\_{r}$, where $μ\_{r}$ corresponds to the SCS configuration of the PRACH if it is 15kHz or higher; otherwise $μ\_{r}=0$- does not expect to cancel the transmission of the SRS, or the PUCCH, or the PUSCH, or the PRACH in symbols from the set of symbols in the slot, if any, starting before a symbol that is after the PUSCH preparation time $T\_{proc,2}$ for the corresponding PUSCH timing capability [6, TS 38.214] assuming $d\_{2,1}=1$ after a last symbol of a CORESET where the UE is configured to monitor PDCCH for DCI format 2\_0 and $μ$ corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format 2\_0 and the SCS configuration of the SRS, PUCCH, PUSCH or $μ\_{r}$, where $μ\_{r}$ corresponds to the SCS configuration of the PRACH if it is 15kHz or higher; otherwise $μ\_{r}=0$- if the UE is configured by higher layers to transmit SRS, or PUCCH, or PUSCH, or PRACH in the set of symbols of the slot and the UE is provided *enableConfiguredUL*, the UE can transmit the SRS, or PUCCH, or PUSCH, or PRACH, respectively.----------------------------------------------------- End of text proposal ------------------------------------------------------ |

# 5 Issue #4

In [4], it is proposed that:

***Proposal: The SCS configuration of the PDSCH corresponding to the overlapping PUCCH should be considered in cancellation time.***

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| -------------------------------------------------- Start of text proposal ------------------------------------------------------If a UE is scheduled by a DCI format in a first PDCCH reception to transmit a first PUCCH or a first PUSCH of larger priority index that overlaps with a second PUCCH or a second PUSCH transmission of smaller priority index that, if any, is scheduled by a DCI format in a second PDCCH- $T\_{proc,2}$ is based on a value of $μ$ corresponding to the smallest SCS configuration of the first PDCCH, the second PDCCHs, the PDSCHs corresponding to the first PUCCH, the PDSCHs corresponding to the second PUCCHs, the first PUCCH or the first PUSCH, and the second PUCCHs or the second PUSCHs - if the overlapping group includes the first PUCCH- if *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for the serving cell where the UE receives the first PDCCH and for all serving cells where the UE receives the PDSCHs corresponding to the second PUCCHs, and if *processingType2Enabled* of *PUSCH-ServingCellConfig* is set to *enable* for the serving cells with the second PUSCHs, $N\_{2} $is 5 for $μ=0$, 5.5 for $μ=1$ and 11 for $μ=2$ - else, $N\_{2} $is 10 for $μ$=0*,* 12 for $μ=1$, 23 for $μ=2$, and 36 for $μ=3$;- if the overlapping group includes the first PUSCH - if *processingType2Enabled* of *PUSCH-ServingCellConfig* is set to *enable* for the serving cells with the first PUSCH and the second PUSCHs and if *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for all serving cells where the UE receives the PDSCHs corresponding to the second PUCCHs, $N\_{2} $is 5 for $μ=0$, 5.5 for $μ=1$ and 11 for $μ=2$- else, $N\_{2} $is 10 for $μ$=0*,* 12 for $μ=1$, 23 for $μ=2$, and 36 for $μ=3$;----------------------------------------------------- End of text proposal ------------------------------------------------------ |

# 6 Issue #5

For determining the value of *N2* for Tproc,2, it is not clear whether PDSCH processing capability of a serving cell with a PDSCH transmission is the same as the PUSCH processing capability of a serving cell with a PUCCH transmission which carries HARQ-ACK for the PDSCH transmission.

***Proposal : It should be clarified which is the correct understanding below and the corresponding text proposal should be adopted:***

* ***Understanding 1: PDSCH processing capability of a serving cell with a PDSCH transmission should be the same as the PUSCH processing capability of a serving cell with a PUCCH transmission corresponding to the PDSCH transmission***
* ***Understanding 2: PDSCH processing capability of a serving cell with a PDSCH transmission can be different with the PUSCH processing capability of a PUCCH transmission corresponding to the PDSCH transmission***

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| -------------------------------------------------- Start of text proposal ------------------------------------------------------If a UE is scheduled by a DCI format in a first PDCCH reception to transmit a first PUCCH or a first PUSCH of larger priority index that overlaps with a second PUCCH or a second PUSCH transmission of smaller priority index that, if any, is scheduled by a DCI format in a second PDCCH- $T\_{proc,2}$ is based on a value of $μ$ corresponding to the smallest SCS configuration of the first PDCCH, the second PDCCHs, the first PUCCH or the first PUSCH, and the second PUCCHs or the second PUSCHs - if the overlapping group includes the first PUCCH- if *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for the serving cell where the UE receives the first PDCCH, and if *processingType2Enabled* of *PUSCH-ServingCellConfig* is set to *enable* for the serving cells with the second PUSCHs, $N\_{2} $is 5 for $μ=0$, 5.5 for $μ=1$ and 11 for $μ=2$ - else, $N\_{2} $is 10 for $μ$=0*,* 12 for $μ=1$, 23 for $μ=2$, and 36 for $μ=3$;- if the overlapping group includes the first PUSCH - if *processingType2Enabled* of *PUSCH-ServingCellConfig* is set to *enable* for the serving cells with the first PUSCH and the second PUSCHs and if *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for all serving cells where the UE receives the PDSCHs corresponding to the second PUCCHs, $N\_{2} $is 5 for $μ=0$, 5.5 for $μ=1$ and 11 for $μ=2$- else, $N\_{2} $is 10 for $μ$=0*,* 12 for $μ=1$, 23 for $μ=2$, and 36 for $μ=3$;----------------------------------------------------- End of text proposal ------------------------------------------------------ |

It is also proposed that the following text proposal corresponding to understanding 2 should be considered in 38.213.

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| -------------------------------------------------- Start of text proposal ------------------------------------------------------If a UE is scheduled by a DCI format in a first PDCCH reception to transmit a first PUCCH or a first PUSCH of larger priority index that overlaps with a second PUCCH or a second PUSCH transmission of smaller priority index that, if any, is scheduled by a DCI format in a second PDCCH- $T\_{proc,2}$ is based on a value of $μ$ corresponding to the smallest SCS configuration of the first PDCCH, the second PDCCHs, the first PUCCH or the first PUSCH, and the second PUCCHs or the second PUSCHs - if the overlapping group includes the first PUCCH- if *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for the serving cell where the UE receives the first PDCCH and for all serving cells where the UE receives the PDSCHs corresponding to the second PUCCHs, and if *processingType2Enabled* of *PUSCH-ServingCellConfig* is set to *enable* for the serving cells with the second PUSCHs and for the serving cell with the first PUCCH, $N\_{2} $is 5 for $μ=0$, 5.5 for $μ=1$ and 11 for $μ=2$ - else, $N\_{2} $is 10 for $μ$=0*,* 12 for $μ=1$, 23 for $μ=2$, and 36 for $μ=3$;- if the overlapping group includes the first PUSCH - if *processingType2Enabled* of *PUSCH-ServingCellConfig* is set to *enable* for the serving cells with the first PUSCH and the second PUSCHs and for the serving cell with the second PUCCHs and if *processingType2Enabled* of *PDSCH-ServingCellConfig* is set to *enable* for all serving cells where the UE receives the PDSCHs corresponding to the second PUCCHs, $N\_{2} $is 5 for $μ=0$, 5.5 for $μ=1$ and 11 for $μ=2$- else, $N\_{2} $is 10 for $μ$=0*,* 12 for $μ=1$, 23 for $μ=2$, and 36 for $μ=3$;----------------------------------------------------- End of text proposal ------------------------------------------------------ |

# 7 Summary

TBD

# 8 References

**[1] R1-2102371, “Remaining issues on scheduling and HARQ,” OPPO**

**[2] R1-2102593, “Remaining issues on scheduling and HARQ enhancements,” CATT**