**3GPP TSG RAN WG1 #102e R1-** **20xxxxx**

**August 17th – 28th, 2020**

**Agenda item:** 7.2.5.4

**Source:** Qualcomm

**Title:** Summary of the Remaining Issues on HARQ and Scheduling Enhancements for URLLC: Preparation Phase

**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 #102e** | **Companies not supporting to discuss** |
| **Issue #1:** Low priority PUCCH overriding with prioritization  | Vivo, CATT, OPPO |  |
| **Issue #2:** Ambiguity on prioritization procedure | Ericsson |  |
| **Issue #3:** Re-transmission of CBG-based PUSCH with cancellation  | Vivo, Nokia/NSB, MTK, Intel, Samsung, HW/HiSi, Apple, Qualcomm | ZTE, DCM |
| **Issue #4**: Processing order between semi-static TDD configuration and intra-UE prioritization | Vivo, ZTE, Huawei/HiSi, DCM, Qualcomm |  |
| **Issue #5:** Processing order between dynamic SFI and intra-UE prioritization | Vivo, ZTE, Ericsson, CATT, Spreadtrum, LGE, HW/HiSi, DCM, Qualcomm |  |
| **Issue #6:** Handling overlaps between HP UPSCH without UL-SCH and SR | Nokia/NSB |  |
| **Issue #7:** Timeline requirement for cancellation | CATT |  |
| **Issue #8:** Partial Cancellation due to SFI/PDSCH/CSI-RS | HW/HiSi |  |
| **Issue #9:** Cancellation timeline for overlapping channels with different SCS | Asia Pacific Telecom |  |
| **Issue #10:** UE capability for cancellation timeline | Asia Pacific Telecom |  |
| **Issue #11:** Multiplexing timeline extension for high priority channels | Asia Pacific Telecom |  |
| **Issue #12:** Active duration of CSI-RS resources in case of cancellation | Qualcomm |  |
| **Issue #13:** Multiplexing UCI on PUSCHs of the same priority | InterDigital |  |

# 2 Issue #1

RAN1 reached the following agreement in meeting #101e:

**Agreement:**

*If a UE is expected to cancel a scheduled low priority PUCCH/PUSCH due to a first DCI scheduling an overlapping high priority channel, the UE is not expected to transmit the scheduled low priority PUCCH/PUSCH due to a second DCI scheduling PUCCH/PUSCH that is received after the first DCI.*

* *Note: The collision between HP PUSCH and LP PUSCH is not covered by this agreement.*

Vivo [1] proposes that:

***Proposal : If an inter-mediate LP PUCCH “collides” with HP UL transmission, the corresponding UCI can still be transmitted in another LP PUCCH or LP PUSCH following the timeline of PUCCH resource update, or UCI multiplexing on PUSCH.***

CATT [5] proposes to consider the following two clarifications:

**Clarification 1: For PUCCH overriding of a high priority PUCCH, which PUCCH resource for high priority HARQ-ACK is applied to determine whether there is overlapping with low priority UL channel or not.**

* Option 1: The PUCCH resource for HARQ-ACK codebook indicated in the latest corresponding DCI
* Option 2: The PUCCH resource for HARQ-ACK codebook indicated in any corresponding DCI

Comment from the FL: This part is clear; the UE can decide to cancel the LP channel once a HP DCI scheduling an overlapping channel is decoded.

**Clarification 2: For PUCCH overriding of a low priority PUCCH, whether HARQ-ACK codebook could be transmitted in a second PUCCH resource when the second PUCCH resource overrides a first PUCCH and the first PUCCH resource overlaps with a high priority UL channel**

* Option 1: Yes
* Option 2: No

OPPO [8] proposes that:

***Proposal: If implementation complexity of UCI reserving is significant, then dropping UCI based solution is preferred, otherwise, reserving UCI based solution is considered due to no spec impact on current stage.***

HW/HiSi [12] proposes that:

***Proposal: In case a LP PUCCH is canceled due to resource overlap with a HP transmission, the UCI should be handled according to the procedures defined in Rel-15, and the TP in Annex 1 should be endorsed.***

# 3 Issue #2

Ericsson [3] refers to the following agreement and specification clause and mentions that the order of multiplexing and prioritization is unclear:

**Agreement**

If a UE is expected to cancel a scheduled low priority PUCCH/PUSCH due to a first DCI scheduling an overlapping high priority channel, the UE is not expected to transmit the scheduled low priority PUCCH/PUSCH due to a second DCI scheduling PUCCH/PUSCH that is received after the first DCI.

* Note: The collision between HP PUSCH and LP PUSCH is not covered by this agreement.

The agreement was captured as the following in Clause 9 of TS38.213:

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| If a UE detects a first DCI format scheduling a PUCCH or PUSCH transmission of larger priority index that would overlap with a PUCCH or PUSCH transmission of smaller priority index, the UE does not expect to transmit the PUCCHs or PUSCHs of the smaller priority index due to a detection of a second DCI format after the detection of the first DCI format |

This can be explained using the following figure:



**FL comment:** As agreed in the last meeting, the UE does not wait for any other DCI (either low priority or high priority) to decide whether a low priority channel should be cancelled. Hence, there should be no ambiguity.

# 4 Issue #3

When the initial transmission of a low priority PUSCH is interrupted, the UE will stop the processing of the low priority channel. The TB CRC is calculated sequentially, i.e., one code-block is taken from the buffer and the state of the TB CRC encoder is updated. The UE then works on the given code-block before it takes another one from the buffer.

When the UE has to stop the processing, it will not have the final state of the TB CRC encoder. Hence, if the CBG-level re-transmission is configured, and only a set of CBGs are requested for re-transmission, e.g., including the last CBG that has the last CB (note that TB CRC is part of the last CB), the UE processing timeline is stressed.

As an example, assume that each CBG is one CB. After processing the first two CBs, the processing was interrupted. Now, for re-transmission, the gNB only requests the last CB. Hence, to calculate the TB CRC, the UE has to work on all the unprocessed CBs until it can obtain the TB CRC. The impact on the timeline is shown in the figure below.



Figure 1: An illustration of the timeline impact due to CBG-level re-transmission for an interrupted PUSCH.

To address this issue, the following solutions were discussed in RAN1 101e:

***Proposed Agreement: If a UE is configured with a CBG based PUSCH and the initial transmission of a TB is cancelled, adopt one of the following options:***

* ***Option 1:*** *the UE is not expected to be scheduled for a re-transmission of the TB including the last CBG if each of the other CBGs (except for the last one) have either not been transmitted at least once before or are not scheduled for a re-transmission in the same UL grant as the last CBG.*
	+ ***Support: Nokia/NSB, Qualcomm***
* ***Option 1a:*** *The UE is not expected to be scheduled for a re-transmission of a CBG #N in a given TB unless CBG #N-1 has been transmitted*
	+ ***Support: Nokia/NSB, MTK, HW/HiSi, Apple, Qualcomm***

*before or is scheduled in the same UL grant that includes CBG#N.*

* ***Option 2:*** *the TB CRC for the retransmission of the same TB is set to all zeros.*
* *Option 3: It is up to UE implementation to determine which values to use as the TB CRC (which may not be the actual TB CRC) for the retransmission of the same TB.*
	+ ***Support:******vivo, Samsung***
* ***Option 4:*** *the minimum processing time for PUSCH scheduled for re-transmission is extended by D symbols.*
	+ ***Support: Nokia/NSB, Intel,***
* ***Option 5:*** *The UE is not expected to be scheduled with partial TB for the retransmission.*
	+ ***Support: Apple***

On the other hand, ZTE [2] and DCM [14], argued that the problem can be avoided by the gNB scheduler and does not need to be standardized.

* **FL comment:** Could the UE assume that the gNB would never schedule the last CBG before scheduling all the previous CBGs? Is there anything to enforce this behaviour? If not, the UE should always be ready to overcome the possible issues.

# 5 Issue #4

In RAN1#101-e, the following agreement was made, however, the spec update did not capture this due to lack of discussion.

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| **Agreement***After the UE determines the overlapping PUCCH or PUSCH for multiplexing/prioritization, the UE cancels the PUCCH or PUSCH that has overlapping with semi-static configured DL symbols or SSB symbols, and then the multiplexing/prioritization is performed among the non-cancelled overlapping transmissions* |

Based on this agreement, the understanding is that UE will have 3-step processing for to handle the processing order between intra-UE multiplexing/prioritization, and cancellation due to semi-static TDD configuration.

* Step 1: UE follows Rel-15 behaviours for any intermediate procedure to determine the overlapping PUCCH or PUSCH for multiplexing/prioritization
* Step 2: UE cancels the ones that collides with semi-static DL symbols,
* Step 3: UE performs multiplexing/prioritization among the non-cancelled overlapping channels.

Vivo [1] proposing the following TP for adoption:

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| --- |
| TS 38.2139 UE procedure for reporting control information…If in an active DL BWP a UE monitors PDCCH either for detection of DCI format 0\_1 and DCI format 1\_1 or for detection of DCI format 0\_2 and DCI format 1\_2, a priority index can be provided by a priority indicator field. If a UE indicates a capability to monitor, in an active DL BWP, PDCCH for detection of DCI format 0\_1 and DCI format 1\_1 and for detection of DCI format 0\_2 and DCI format 1\_2, a DCI format 0\_1 or a DCI format 0\_2 can schedule a PUSCH transmission of any priority and a DCI format 1\_1 or a DCI format 1\_2 can schedule a PDSCH reception and trigger a PUCCH transmission with corresponding HARQ-ACK information of any priority. When a UE determines overlapping for PUCCH and/or PUSCH transmissions of the same priority indexes, the UE cancels the PUCCH or the PUSCH transmission if the UE determines a PUCCH or a PUSCH transmissions overlapping with DL symbols indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*. Then the UE resolves the overlapping for PUCCH and/or PUSCH transmissions of a same priority index as defined in Clause 9.2.5. When a UE determines overlapping for PUCCH and/or PUSCH transmissions of different priority indexes, the UE cancels the PUCCH or the PUSCH transmission if the UE determines a PUCCH or a PUSCH transmissions overlapping with DL symbols indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, then the UE ~~first~~ resolves the overlapping for PUCCH and/or PUSCH transmissions of a same priority index. Then, if the UE determines to transmit- a first PUCCH of larger priority index scheduled by a first DCI format in a first PDCCH reception, 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 cancels the transmission of the PUSCH or the second PUCCH before the first symbol overlapping with the first PUCCH transmission. The UE expects that the transmission of the first PUCCH does not start before $T\_{proc,2}+d\_{1}$ after a last symbol of the first PDCCH reception- a PUSCH of larger priority index scheduled by a first DCI format in a first PDCCH reception, a PUCCH of smaller priority index, and a transmission of the PUSCH would overlap in time with a transmission of the PUCCH, the UE cancels the transmission of the PUCCH before the first symbol overlapping with the PUSCH transmission. The UE expects that the transmission of the PUSCH does not start before $T\_{proc,2}+d\_{1}$ after a last symbol of the first PDCCH receptionwhere $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… |

ZTE [2] is proposing the following TP:

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| 9 UE procedure for reporting control information<---------------------------Other parts are omitted ------------------------------->If in an active DL BWP a UE monitors PDCCH either for detection of DCI format 0\_1 and DCI format 1\_1 or for detection of DCI format 0\_2 and DCI format 1\_2, a priority index can be provided by a priority indicator field. If a UE indicates a capability to monitor, in an active DL BWP, PDCCH for detection of DCI format 0\_1 and DCI format 1\_1 and for detection of DCI format 0\_2 and DCI format 1\_2, a DCI format 0\_1 or a DCI format 0\_2 can schedule a PUSCH transmission of any priority and a DCI format 1\_1 or a DCI format 1\_2 can schedule a PDSCH reception and trigger a PUCCH transmission with corresponding HARQ-ACK information of any priority. When a UE determines overlapping for PUCCH and/or PUSCH transmissions of the same priority indexes, the UE cancels the PUCCH or the PUSCH transmission if the UE determines a PUCCH or a PUSCH transmissions overlapping with DL symbols indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*. Then the UE resolves the overlapping for PUCCH and/or PUSCH transmissions of a same priority index as defined in Clause 9.2.5. When a UE determines overlapping for PUCCH and/or PUSCH transmissions of different priority indexes, the UE cancels the PUCCH or the PUSCH transmission if the UE determines a PUCCH or a PUSCH transmissions overlapping with DL symbols indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, then the UE ~~first~~ resolves the overlapping for PUCCH and/or PUSCH transmissions of a same priority index. Then, if the UE determines to transmit<---------------------------Other parts are omitted -------------------------------> |

DCM [14] proposes to adopt the following TP:

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| 9 UE procedure for reporting control information [….]If in an active DL BWP a UE monitors PDCCH either for detection of DCI format 0\_1 and DCI format 1\_1 or for detection of DCI format 0\_2 and DCI format 1\_2, a priority index can be provided by a priority indicator field. If a UE indicates a capability to monitor, in an active DL BWP, PDCCH for detection of DCI format 0\_1 and DCI format 1\_1 and for detection of DCI format 0\_2 and DCI format 1\_2, a DCI format 0\_1 or a DCI format 0\_2 can schedule a PUSCH transmission of any priority and a DCI format 1\_1 or a DCI format 1\_2 can schedule a PDSCH reception and trigger a PUCCH transmission with corresponding HARQ-ACK information of any priority. When a UE determines overlapping for PUCCH and/or PUSCH transmissions of the same priority index, the UE resolves the overlapping for PUCCH and/or PUSCH transmissions of a same priority index. Then if, the UE determines a PUCCH or a PUSCH transmissions overlapping with DL symbols indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, the UE cancels the PUCCH or the PUSCH transmission. When a UE determines overlapping for PUCCH and/or PUSCH transmissions of different priority indexes, the UE first resolves the overlapping for PUCCH and/or PUSCH transmissions of a same priority index. Then, if the UE determines a PUCCH or a PUSCH transmissions overlapping with DL symbols indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationCommon*, the UE cancels the PUCCH or the PUSCH transmission. Then, if the UE determines to transmit- a first PUCCH of larger priority index scheduled by a first DCI format in a first PDCCH reception, 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 cancels the transmission of the PUSCH or the second PUCCH before the first symbol overlapping with the first PUCCH transmission. The UE expects that the transmission of the first PUCCH does not start before $T\_{proc,2}+d\_{1}$ after a last symbol of the first PDCCH reception- a PUSCH of larger priority index scheduled by a first DCI format in a first PDCCH reception, a PUCCH of smaller priority index, and a transmission of the PUSCH would overlap in time with a transmission of the PUCCH, the UE cancels the transmission of the PUCCH before the first symbol overlapping with the PUSCH transmission. The UE expects that the transmission of the PUSCH does not start before $T\_{proc,2}+d\_{1}$ after a last symbol of the first PDCCH receptionwhere $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 [….] |

HW/HiSi [12] brings another issue as follows:

***Agreement #1:***

*If a UE is expected to cancel a scheduled low priority PUCCH/PUSCH due to a first DCI scheduling an overlapping high priority channel, the UE is not expected to transmit the scheduled low priority PUCCH/PUSCH due to a second DCI scheduling UCCH/PUSCH that is received after the first DCI.*

* *Note: The collision between HP PUSCH and LP PUSCH is not covered by this agreement.*

***Agreement #2:***

*After the UE determines the overlapping PUCCH or PUSCH for multiplexing/prioritization, the UE cancels the PUCCH or PUSCH that has overlapping with semi-static configured DL symbols or SSB symbols, and then the multiplexing/prioritization is performed among the non-cancelled overlapping transmissions.*



Considering the example above, according to Agreement #2, the collision handling is done based on the final DCI. This would mean that the overlap is determined among LP PUCCH 1, HP PUCCH 2 and SSB. It means when the UE receives the intermediate HP DCI 1 (i.e. it has not received HP DCI 2 yet), the UE will not resolve the collisions between HP PUCCH 1 and LP PUCCH1. Instead the UE will wait to receive the final DCI for the HP PUCCH, i.e. until the DCI scheduling the HP PUCCH 2, and then it will resolve any the collision based on HP PUCCH 2. Thus LP PUCCH 1 will be transmitted. On the other hand, following agreement #1, the UE will resolve the collision between the HP PUCCH 1 and LP PUCCH 1 when it receives HP DCI 1. It means the UE will not wait for any final DCI. Thus LP PUCCH 1 will be canceled.

***Proposal: The collision between PUCCH/PUSCH and SSB is handled first, and then the UE handles the collision between LP channel and HP channel.***

***Proposal: In case of dynamical scheduled PUCCH/PUSCH colliding with semi-static configured DL symbols or with SSB symbols, the resource overlap is determined based any DCI.***

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| **---------------------------------------------------Start of the TP---------------------------------------------------------****9.2.5 UE procedure for reporting multiple UCI types****This Clause is applicable to the case that a UE has resources for PUCCH transmissions or for PUCCH and PUSCH transmissions that overlap in time but do not overlap with SSB symbols or DL symbols indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* and each PUCCH transmission is over a single slot without repetitions. Any case that a PUCCH transmission is with repetitions over multiple slots is described in Clause 9.2.6. If a UE is configured with multiple PUCCH resources in a slot to transmit CSI reports****- if the UE is not provided *multi-CSI-PUCCH-ResourceList* or if PUCCH resources for transmissions of CSI reports do not overlap in the slot, the UE determines a first resource corresponding to a CSI report with the highest priority [6, TS 38.214]****- if the first resource includes PUCCH format 2, and if there are remaining resources in the slot that do not overlap with the first resource, the UE determines a CSI report with the highest priority, among the CSI reports with corresponding resources from the remaining resources, and a corresponding second resource as an additional resource for CSI reporting** **- if the first resource includes PUCCH format 3 or PUCCH format 4, and if there are remaining resources in the slot that include PUCCH format 2 and do not overlap with the first resource, the UE determines a CSI report with the highest priority, among the CSI reports with corresponding resources from the remaining resources, and a corresponding second resource as an additional resource for CSI reporting****- if the UE is provided *multi-CSI-PUCCH-ResourceList* and if any of the multiple PUCCH resources overlap, the UE multiplexes all CSI reports in a resource from the resources provided by *multi-CSI-PUCCH-ResourceList*, as described in Clause 9.2.5.2.** **---------------------------------------------------End of the TP----------------------------------------------------------** |

Qualcomm [15] refers to the following three steps:

* ***Step 1:*** *A UE follows Rel-15 behaviors for any intermediate procedure to determine the overlapping PUCCH or PUSCH for multiplexing/prioritization*
* ***Step 2:*** *UE cancels the ones that collides with semi-static DL symbols,*
* ***Step 3:*** *UE performs multiplexing/prioritization among the non-cancelled overlapping channels.*

and points out a remaining ambiguity in the UE behavior. As an example, after performing step 3, the final PUCCH resource to be used could be overlapping with the DL symbols. Hence, the UE has to perform a step 4 for final checking as well. If such an event happens, then one UE behavior could be to drop the final transmission completely. This might not be the best approach; instead, if the UE is allowed to remove all overlapping PUCCH/PUSCH resources colliding with the DL symbols from the beginning, this issue will not happen.

**Proposal: Clarify whether the PUCCH/PUSCH resources overlapping with the DL symbols can be assumed not useable by the UE apriori and whether a step 4 for the final checking should be assumed.**

# 6 Issue #5

For ordering between ULCI and intra-UE multiplexing/prioritization, RAN1 had reached the following agreement:

**Agreements: (RAN1#100bis-e)**

* *UE behavior of handling intra-UE prioritization/multiplexing for overlapping UL transmissions is not affected by UL CI.*

Similarly, the order between applying SFI and intra-UE multiplexing/prioritization should be defined.

Vivo [1] is proposing the following:

***Proposal:***

* ***If there are both SFI and the DCIs indicating intra-UE multiplexing/prioritization detected by the UE, the UE performs the intra-UE multiplexing/prioritization first without considering the impact from SFI, then perform cancellation based on the SFI, if any.***
	+ ***The spec update is to be discussed further***

ZTE [2] is proposing that:

***Proposal:*** ***If the ending symbol of PDCCH carrying the DL/UL grant scheduling the overlapping UL transmission is earlier than the ending symbol of PDCCH carrying the dynamic SFI or DL grant or UL CI indicating the cancellation, UE performs intra-UE multiplexing/prioritization first. Otherwise, UE performs UL cancellation due to dynamic SFI or DL grant or UL CI first.***

Ericsson [3) proposes to adopt the possible agreement, as mentioned below, from the last meeting:

**Possible agreement**

* The UE processing order between the handling of intra-UE prioritization/multiplexing for overlapping UL transmissions, and the UL cancellation due to dynamic SFI or DL grant on semi-static flexible symbols is determined by the order between the ending symbol of PDCCH carrying the DL/UL grant scheduling the overlapping UL transmission and the ending symbol of PDCCH carrying the dynamic SFI or DL grant indicating the cancellation
	+ If the ending symbol of PDCCH carrying the DL/UL grant scheduling the overlapping UL transmission is earlier than the ending symbol of PDCCH carrying the dynamic SFI or DL grant indicating the cancellation,
		- UE performs UL multiplexing first.
	+ Otherwise,
		- UE performs UL cancellation due to dynamic SFI or DL grant first.

CATT [5] proposes that:

***Proposal: Intra-UE prioritization/multiplexing is always performed before cancellation by*** ***SFI and/or DL grant in case of UL channels overlapping.***

*Spreadtrum [10] has the following proposals:*

***Proposal: UE behaviour 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.***

***Proposal: If a UE is expected to cancel a higher layer configured PUCCH/PUSCH due to a first DCI like dynamic SFI or DL grant,***

* ***UE is not expected to transmit the higher layer configured PUCCH/PUSCH due to a second DCI scheduling PUCCH/PUSCH that is received after the dynamic SFI or DL grant.***

*LGE [11] proposes that:*

*Proposal: Down-select between following two options:*

* *Option 1: After the UE performs multiplexing/prioritization among the non-cancelled overlapping transmissions, the UE cancels the result of multiplexing/prioritization if necessary according to the conditions in Clause 11.1 of TS 38.213*
* *Option 2: After the UE performs multiplexing/prioritization among the non-cancelled overlapping transmissions, the UE doesn’t expect any confliction with slot format indication according to the conditions in Clause 11.1 of TS 38.213*
	+ *The UE doesn’t expect to detect an SFI-index field value in DCI format 2\_0 indicating the set of symbols of the result of multiplexing/prioritization as downlink.*
	+ *If UE performs multiplexing/prioritization only among transmissions configured by higher layer, the UE doesn’t expect to detect an SFI-index field value in DCI format 2\_0 indicating the set of symbols of the result of multiplexing/prioritization as downlink or flexible.*

HW/HiSi [12] proposes that:

***Proposal: 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.***

DCM [14] proposes to adopt the following TP:

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| 9 UE procedure for reporting control information [….]If in an active DL BWP a UE monitors PDCCH either for detection of DCI format 0\_1 and DCI format 1\_1 or for detection of DCI format 0\_2 and DCI format 1\_2, a priority index can be provided by a priority indicator field. If a UE indicates a capability to monitor, in an active DL BWP, PDCCH for detection of DCI format 0\_1 and DCI format 1\_1 and for detection of DCI format 0\_2 and DCI format 1\_2, a DCI format 0\_1 or a DCI format 0\_2 can schedule a PUSCH transmission of any priority and a DCI format 1\_1 or a DCI format 1\_2 can schedule a PDSCH reception and trigger a PUCCH transmission with corresponding HARQ-ACK information of any priority. When a UE determines overlapping for PUCCH and/or PUSCH transmissions of the same priority index, the UE resolves the overlapping for PUCCH and/or PUSCH transmissions of a same priority index. Then if, the UE determines a PUCCH or a PUSCH transmissions overlapping with flexible symbols indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, and if the UE detects a DCI format 2\_0 with an SFI-index field value indicating the set of flexible symbols of the slot as downlink or UE detects a DCI format 1\_0, a DCI format 1\_1, or a DCI format 1\_2 indicating to the UE to receive PDSCH or CSI-RS in the set of flexible symbols of the slot, the UE cancels the PUCCH or the PUSCH transmission. When a UE determines overlapping for PUCCH and/or PUSCH transmissions of different priority indexes, the UE first resolves the overlapping for PUCCH and/or PUSCH transmissions of a same priority index. Then, if the UE determines a PUCCH or a PUSCH transmissions overlapping with DL symbols indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationCommon*, and if the UE detects a DCI format 2\_0 with an SFI-index field value indicating the set of flexible symbols of the slot as downlink or UE detects a DCI format 1\_0, a DCI format 1\_1, or a DCI format 1\_2 indicating to the UE to receive PDSCH or CSI-RS in the set of flexible symbols of the slot, the UE cancels the PUCCH or the PUSCH transmission. Then, if the UE determines to transmit- a first PUCCH of larger priority index scheduled by a first DCI format in a first PDCCH reception, 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 cancels the transmission of the PUSCH or the second PUCCH before the first symbol overlapping with the first PUCCH transmission. The UE expects that the transmission of the first PUCCH does not start before $T\_{proc,2}+d\_{1}$ after a last symbol of the first PDCCH reception- a PUSCH of larger priority index scheduled by a first DCI format in a first PDCCH reception, a PUCCH of smaller priority index, and a transmission of the PUSCH would overlap in time with a transmission of the PUCCH, the UE cancels the transmission of the PUCCH before the first symbol overlapping with the PUSCH transmission. The UE expects that the transmission of the PUSCH does not start before $T\_{proc,2}+d\_{1}$ after a last symbol of the first PDCCH receptionwhere $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 [….] |

Qualcomm [15] proposes that:

**Proposal: Multiplexing/prioritization behavior is not impacted by dynamic SFI, i.e., a UE first applies multiplexing/prioritization steps and then dynamic SFI.**

# 7 Issue #6

In [4], a possible ambiguity on prioritization between a PUSCH without UL-SCH and SR is pointed out (From Section 0 of TS 38.213):

*“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.”*

*“If a UE would transmit on a serving cell a PUSCH without UL-SCH that overlaps with a PUCCH transmission on a serving cell that includes positive SR information, the UE does not transmit the PUSCH.”*

To address the issue, the following TP is proposed:

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| **TP to TS 38.213, Section 9**9 UE procedure for reporting control information **<**Unchanged text is omitted>If a UE would transmit on a serving cell a PUSCH without UL-SCH that overlaps with a PUCCH transmission on a serving cell that includes positive SR information, the UE does not transmit the PUSCH, except when the PUSCH without UL-SCH is of a larger priority index than the positive SR. **<**Unchanged text is omitted> |

# 8 Issue #7

CATT [6] argues that:

For determination the value of $μ$ for Tproc,2, it can be seen that the SCS configuration of the PDCCH providing the DCI for the low/high priority channel, and the SCS configuration of the low/high priority channels are considered. However, in case the low/high priority channel is PUCCH, the SCS configuration of PDSCH corresponding to the low/high priority channels is not considered. Since the SCS configuration of PDSCH is considered in PDSCH processing time, it is proposed that the SCS configuration of the PDSCH is considered in cancellation time.

***Proposal 1: The SCS configuration of the PDSCH corresponding to the overlapping PUCCH should be considered in cancellation time.***

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| A text proposal is provided below for cancellation timeline in section 9 of 38.213.-------------------------------------------------- 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 at least 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 or 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, *N2* is 5 for $μ=0$, 5.5 for $μ=1$ and 11 for $μ=2$ - else, *N2* 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, *N2* is 5 for $μ=0$, 5.5 for $μ=1$ and 11 for $μ=2$- else, *N2* is 10 for $μ$=0*,* 12 for $μ=1$, 23 for $μ=2$, and 36 for $μ=3$;----------------------------------------------------- End of text proposal ------------------------------------------------------ |

# 9 Issue #8

According to [12], in the email thread 101-e-NR-UEFeatures-Others-01, it was discussed whether to introduce a capability for partial cancellation. That is, for the UE not supporting this capability, including Rel-15 UEs, partial cancellation is not supported. Before discussing this issue, it would be better to clarify the UE’s behaviour in Rel-15. The Rel-15 spec text is copied below. Based on this text, it may be misunderstood that Rel-15 already supports partial cancellation which is not correct according to the agreements that had been achieved.

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 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 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 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 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

The agreement from RAN1#94 shown below precludes partial cancellation for RRC configured PUCCH/PUSCH.

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| RAN1#94 Agreements**:**Update the #92bis agreement as follows:For cancellation of RRC configured transmission or reception by SFI or DCI, the cancellation is for a unit of transmission/reception if any OFDM symbol within the unit is cancelled by SFI.* + For RRC configured CSI-RS resource set, the cancellation unit is the CSI-RS resource set
	+ For RRC configured PDSCH and PUSCH with slot aggregation, the cancellation unit is the whole PDSCH or PUSCH within a slot
	+ For RRC configured PDSCH, PUCCH, and PUSCH without slot aggregation, the cancellation unit is the whole PDSCH, PUCCH, and PUSCH
	+ For RRC configured SRS transmission, the cancellation unit is OFDM symbol
 |

In Rel-15, the uplink cancellation unit is the whole PUCCH or PUSCH within a slot rather than partial a PUCCH or PUSCH within a slot. In order to avoid misunderstanding, it would be better to clarify this.

***Proposed conclusion: Partial cancellation for RRC-configured PUCCH/PUSCH/PRACH is not supported in Rel-15.***

***Proposal: Partial cancellation for PUCCH/PUSCH/PRACH is introduced as an optional capability for Rel-16 UEs.***

# 10 Issue #9

In [13], the cancellation timeline agreement made in RAN1 #99 is referred to, and is proposed that:

Proposal: The first overlapping symbol of a high priority channel and a low priority channel are with aligned starting boundary.

FL comment: The agreement was revised in RAN1 #101e; hence, there is no need for further clarification.

# 11 Issue #10

Asia Pacific Telecom [13] refers to the *pdsch-ProcessingType2-Limited* capability and proposes that:

Proposal: The UE processing capability for cancelling low priority channels considers the amount of scheduled RBs of the PDSCHs corresponding to PUCCHs in the overlapping group when UE reported *pdsch-ProcessingType2-Limited*.

# 12 Issue #11

In [13], an ambiguity in extending the minimum processing timeline of a HP channel in case a prioritization happens is pointed out. The idea is illustrated using the following figure:



Even though the HP PUCCH should be multiplexed on the HP PUSCH, since the LP PUCCH gets cancelled, the timeline for the HP PUSCH (which would carry the content of HP PUCCH too) should be extended. This needs to be clarified.

**Proposal: Multiplexing timeline is extended for a group of overlapping high priority channels containing a high priority channel which cancels low priority channels.**

# 13 Issue #12

In RAN1 #101e, RAN1 agreed/concluded that:

**Conclusion: In Rel. 15, if a PUCCH/PUSCH carrying a CSI report is cancelled, the occupied CPUs are remained occupied until the last symbol of “configured/scheduled” PUCCH/PUSCH.**

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| **Modified clause (Section 5.2.1.6 of TS 38.214)**For a CSI report with *CSI-ReportConfig* with higher layer parameter *reportQuantity* not set to 'none', the CPU(s) are occupied for a number of OFDM symbols as follows:- A periodic or semi-persistent CSI report (excluding an initial semi-persistent CSI report on PUSCH after the PDCCH triggering the report) occupies CPU(s) from the first symbol of the earliest one of each CSI-RS/CSI-IM/SSB resource for channel or interference measurement, respective latest CSI-RS/CSI-IM/SSB occasion no later than the corresponding CSI reference resource, until the last symbol of the configured PUSCH/PUCCH carrying the report.- An aperiodic CSI report occupies CPU(s) from the first symbol after the PDCCH triggering the CSI report until the last symbol of the scheduled PUSCH carrying the report. - An initial semi-persistent CSI report on PUSCH after the PDCCH trigger occupies CPU(s) from the first symbol after the PDCCH until the last symbol of the scheduled PUSCH carrying the report.**End** |

According to [15], the active time duration of aperiodic CSI-RS should also be clarified in the same way. The related clause is copied below.

*“In any slot, the UE is not expected to have more active CSI-RS ports or active CSI-RS resources in active BWPs than reported as capability. NZP CSI-RS resource is active in a duration of time defined as follows. For aperiodic CSI-RS, starting from the end of the PDCCH containing the request and ending at the end of the PUSCH containing the report associated with this aperiodic CSI-RS. For semi-persistent CSI-RS, starting from the end of when the activation command is applied, and ending at the end of when the deactivation command is applied. For periodic CSI-RS, starting when the periodic CSI-RS is configured by higher layer signalling, and ending when the periodic CSI-RS configuration is released. If a CSI-RS resource is referred N times by one or more CSI Reporting Settings, the CSI-RS resource and the CSI-RS ports within the CSI-RS resource are counted N times.”*

**Proposal: If the transmission of the PUSCH containing the report associated with the aperiodic CSI-RS is cancelled, the NZP CSI-RS resource is active from the end of the PDCCH containing the request and ending at the end of the “scheduled” PUSCH containing the report.**

# 14 Issue #13

In R16, multiplexing transmissions of different priorities is not supported. In a scenario where the UE transmits multiple PUSCHs of different priorities on different serving cells, application of rules for PUSCH selection may result in selecting a PUSCH of different priority and unnecessarily dropping a transmission.

For example, consider the following scenario:

* the UE transmits high-priority PUSCH in serving cell #0 (PCell)
* the UE transmits low-priority PUSCH in serving cell #1 (SCell without aperiodic CSI)
* the UE transmits low-priority HARQ-ACK

Following the current specifications, the UE first selects the PUSCH in PCell for UCI multiplexing. Since multiplexing UCI and PUSCH of different priorities is not supported, the UE drops the low-priority HARQ-ACK. However, in this case the UE could have instead multiplexed HARQ-ACK in the PUSCH of the SCell, since it is of low priority.



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| <<<<< Start modified section >>>>>9 UE procedure for reporting control information[…] 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.If a UE transmits multiple PUSCHs in a slot on respective serving cells that include first PUSCHs with first priority index and second PUSCHs with second priority index, the UE multiplexes the UCI of first priority index in a PUSCH from the first PUSCHs.[…]<<<<< End modified section >>>>> |

# 15 References

**[1] R1-2005350, “*Enhancements for scheduling/HARQ*,” vivo**

**[2] R1-2005416, “*Remaining issues on enhancements to scheduling/HARQ for NR URLLC*,” ZTE**

**[3] R1-2005509, “*Remaining issues of enhancements to scheduling and HARQ*,” Ericsson**

**[4] R1-2005550, “*Maintenance of Rel. 16 URLLC intra-UE prioritization enhancements*,” Nokia, NSB**

**[5] R1-2005632, “*On the retransmission of a cancelled UL TB*,” MTK**

**[6] R1-2005675, “*Remaining issues on intra-UE prioritization*,” CATT**

**[7] R1-2005852, “*Remaining details on scheduling & HARQ enhancements for URLLC*,” Intel**

**[8] R1-2006052, “*Enhancements to scheduling and HARQ*,” OPPO**

**[9] R1-2006112, “*Maintenance on scheduling/HARQ enhancements*,” Samsung**

**[10] R1-2006280, “*Remaining issues of enhancements to scheduling/HARQ*,” Spreadtrum Communications**

**[11] R1-2006294, “*Remaining issues of enhancements to scheduling/HARQ for NR URLLC*,” LGE**

**[12] R1-2006389, “*Corrections on operation of HARQ*,” Huawei, HiSi**

**[13] R1-2006633, “*Remaining issues on scheduling/HARQ enhancements*,” Asia Pacific Telecom**

**[14] R1-2006698, *“Maintenance for scheduling/HARQ for Rel-16 URLLC,”* DCM**

**[15] R1-2006777, *“Remaining issues on HARQ and scheduling for URLLC,”* Qualcomm**

**[16] R1-2006472, *“UCI enhancements for URLLC,”* InterDigital**