**3GPP TSG RAN WG1 #103-e R1-200xxxx**

**e-Meeting, October 26th – November 13th, 2020**

Source: Moderator (vivo)

Title: Feature lead summary on eCG for NR eURLLC

Agenda Item: 7.2.5

Document for: Discussion and Decision

1. Introduction

In this document, proposals and remaining issues related to URLLC eCG are summarized.

1. Proposed issues for email discussions

It is proposed to include section 3.1.2 proposed conclusion 1 and 2, section 3.1.3 proposed conclusion 3 in one of the email discussions for eURLLC/IIoT:

* 3.1.2: clarifications on overriding rules for Low priority (LP) DG PUSCH with repetitions and High priority (HP) CG PUSCH
* 3.1.3: clarifications on overriding rules for Low priority (LP) CG PUSCH with repetitions and High priority (HP) CG PUSCH

**Noted that the Reply LS to R2-2008599 on Intra UE Prioritization Scenario will be handled under AI 7.2.5 in a different email tread and does not consume the total email budget for eURLLC/IIoT.**

Any comments if other essential corrections need to be made?

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1. Discussions
   1. DG and CG overriding rules

Following agreements and conclusions were made for DG/CG and CG collision handling.

@RAN1#101-e meeting

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| **Conclusion**  In Rel.15, for a DG PUSCH scheduled by a DCI overriding a CG PUSCH configured with repetition factor K>1,   * If the HARQ process is the same between the DG and the CG, DG overrides all remaining repetition occasions after the end of PDCCH reception, under the timeline specified in TS 38.214 section 6.1. * Otherwise, DG overrides only the CG repetition overlapped with DG, under the timeline specified in TS 38.214 section 6.1.   **Conclusion**  **There is no consensus in RAN1 for the support of the following**   * high priority DG cancel the transmission of low priority CG in the physical layer * high priority CG cancel the transmission of low priority DG in the physical layer   **No further discussion for Rel-16.**  Agreement  **Send an LS to RAN2 to indicate that RAN1 was not able to reach consensus to support the following cases:**   * high priority DG cancel the transmission of low priority CG in the physical layer * high priority CG cancel the transmission of low priority DG in the physical layer   For further discussion on other details to add to LS: Such as how RAN2 should consider this aspect in their work  **Conclusion**  For the collision between DG PUSCH and CG PUSCH with same PHY priority, the DG PUSCH can be scheduled overlapping in time with CG PUSCH occasion if Rel-15 timeline satisfies.  Note: it is related to other discussion how UE prioritized and transmit one of grants.  **Agreement**  RAN2 changes MAC specification to accommodate current PHY behavior. With this option, MAC will avoid providing second MAC PDU with the same L1 priority to PHY, meaning that PHY would transmit the packet with lower LCH priority data.   * Send an LS to RAN2 to inform them of this agreement |

@RAN1#102-e meeting

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| **Conclusion:**   * In Rel-16, for a DG PUSCH scheduled by a DCI overlapping a CG PUSCH configured with nominal repetition factor K>1,   + If the HARQ process is the same between the DG and the CG, DG may override all remaining repetition occasions after the end of PDCCH reception, under the timeline specified in TS 38.214 section 6.1.   + Otherwise, DG may override only the actual repetition(s) of the CG overlapped with DG, under the timeline specified in TS 38.214 section 6.1.   + No specification change is needed   Conclusion:   * For the collision between DG PUSCH and CG PUSCH with different priorities, the DG PUSCH can be scheduled overlapping in time with CG PUSCH occasion if Rel-15 timeline satisfies. |

[R1-2007817] and [R1-2008434] further discussed and clarified the DG and CG overriding rules for Rel-16 URLLC for following cases:

* + 1. Case 1: CG PUSCH with repetition type A and DG PUSCH [R1-2007817]
* Proposal 1: In Rel-16, for a DG PUSCH scheduled by a DCI overriding a CG PUSCH with repetition type A,
* If the HARQ process is the same between the DG and the CG, DG may override all remaining repetition occasions after the end of PDCCH reception, under the timeline specified in TS 38.214 section 6.1.
* Otherwise, DG may override only the CG repetition overlapped with DG, under the timeline specified in TS 38.214 section 6.1.
* **FL’s views: proposal 1 was already covered by the conclusion made in RAN1#101-e meeting, see below. Therefore, proposal 1 is not needed.**

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| **Conclusion**  In Rel.15, for a DG PUSCH scheduled by a DCI overriding a CG PUSCH configured with repetition factor K>1,   * If the HARQ process is the same between the DG and the CG, DG overrides all remaining repetition occasions after the end of PDCCH reception, under the timeline specified in TS 38.214 section 6.1. * Otherwise, DG overrides only the CG repetition overlapped with DG, under the timeline specified in TS 38.214 section 6.1. |

Any comments?

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* + 1. Case 2: Low priority (LP) DG PUSCH with repetitions and High priority (HP) CG PUSCH [R1-2007817], [R1-2008434]
* Case 2-1: same HARQ ID between the LP DG and the HP CG

Proposal 2-1 from [R1-2007817]: If the HARQ process is the same between the DG and the CG, CG may override all DG remaining repetition occasions from DG repetition occasion overlapping with CG, under the timeline specified in TS 38.214 section 6.1, and the overriding is achieved no later than the first symbol of CG PUSCH transmission.

Proposal 2-2 from [R1-2008434]: If the HPID of the HP CG is the same as that of the LP DG, three options below are considered:

* Option 1: a UE is prohibited from using a HP CG if its HPID would collide with DG’s.
* Option 2: a UE can use a HP CG with the same HPID as the LP DG’s, and starting from the first repetition of a DG among repetitions of the DG overlapping with a HP CG, all remaining repetitions of the DG are dropped.
* Option 3: a UE just performs repetition by repetition overlap handling. It is up to gNB to ensure soft bits for different transport blocks under the same HPID are not mixed up.
* **FL’s view: based on the discussion and conclusion in the RAN1#103-e meeting that “For the collision between DG PUSCH and CG PUSCH with different priorities, the DG PUSCH can be scheduled overlapping in time with CG PUSCH occasion if Rel-15 timeline satisfies.”, proposal 2-1 and option 2 of proposal 2-2 should be the common understanding as long as the timeline specified in TS 38.214 section 6.1 is satisfied.**
* **Proposed conclusion 1:** 
  + **In Rel-16, for a low priority (LP) DG PUSCH with repetition factor K>1 scheduled by a DCI overriding a high priority (HP) CG PUSCH, if the HARQ process is the same between the LP DG and the HP CG, HP CG overrides all LP DG remaining repetition occasions from DG repetition occasion overlapping with CG, under the timeline specified in TS 38.214 section 6.1, and the overriding is achieved no later than the first symbol of CG PUSCH transmission.**

Any comments for above proposed conclusion?

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* Case 2-2: different HARQ ID between the LP DG and the HP CG

Proposals from [R1-2007817] and [R1-2008434]:

* **Proposed conclusion 2:** 
  + **In Rel-16, for a low priority (LP) DG PUSCH with repetition factor K>1 scheduled by a DCI overriding a high priority (HP) CG PUSCH, if the HARQ process is different between the LP DG and the HP CG, HP CG overrides only the LP DG repetition overlapped with the CG, under the timeline specified in TS 38.214 section 6.1, and the overriding is achieved no later than the first symbol of CG PUSCH transmission.**
* **FL’s view: agree with above conclusion 2.**

Any comments for above proposed conclusion?

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* + 1. Case 3: Multiple CGs [R1-2008434]

Following are the proposals from [R1-2008434] to further clarify the handling among CGs with the same or different priorities.

Assume CG 1 and CG 2 are of the same physical layer priority, and CG 2’s transmission occasion is after CG 1’s transmission occasion

Proposal 3-1: consider the following options for CGs at the same physical priority:

* Option 1: If CG 1 and CG 2 are at the same physical layer priority, CG 2 is not allowed to override CG 1;
* Option 2: CG 2 is allowed to override CG 1.
  + If the HPID of the CG 1 is different from that of the CG 2, repetition by repetition overlap handling is used.
  + If both CGs are associated with the same HPID:
    - Option 2-1: a UE is prohibited from using a second(later) CG if its HPID would collide with a first CG’s.
    - Option 2-2: a UE can use a second (later) CG with the same HPID as the first CG’s, and starting from the first repetition of the first CG among repetitions of the first CG overlapping with the second CG, all remaining repetitions of the first CG are dropped.
    - Option 2-3: a UE just performs repetition by repetition overlap handling for two CGs. It is up to gNB to ensure soft bits for different transport blocks under the same HPID are not mixed up.

Proposal 3-2: consider the following options for CGs at the different physical priorities:

* If the HPID of the HP CG is different from that of the LP CG, repetition by repetition overlap handling is used.
* If both CGs are associated with the same HPID:
* Option 1: a UE is prohibited from using a second (HP) CG if its HPID would collide with a first (LP) CG’s.
* Option 2: a UE can use a second (HP) CG with the same HPID as the first (LP) CG’s, and starting from the first repetition of the first CG among repetitions of the first CG overlapping with the second CG, all remaining repetitions of the first CG are dropped.
* Option 3: a UE just performs repetition by repetition overlap handling for two CGs. It is up to gNB to ensure soft bits for different transport blocks under the same HPID are not mixed up.

**FL’s views:**

* **for proposal 3-1, following were already captured in TS 38.321-g21 section 5.4.1**

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| NOTE 6: If the MAC entity is configured with *lch-basedPrioritization* and if there is overlapping PUSCH duration of at least two configured uplink grants whose priorities are equal, the prioritized uplink grant is determined by UE implementation.  NOTE 7: If the MAC entity is not configured with *lch-basedPrioritzation* and if there is overlapping PUSCH duration of at least two configured uplink grants, it is up to UE implementation to choose one of the configured uplink grants. |

**Therefore, proposal 3-1 is not needed.**

* **for proposal 3-2, following was agreed in RAN1#101-e meeting**

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| **Agreement**   * For collision handling between CG and CG with different priorities   + If MAC delivers two MAC PDUs, it is up to UE implementation to make sure that the low priority CG PUSCH transmission can be cancelled before the start of the high priority CG PUSCH. |

**Therefore, in case HARQ ID is the same between the HP CG and LP CG, option 2 should be the common understanding.**

* **Proposed conclusion 3:** 
  + **In Rel-16, for a low priority (LP) CG PUSCH with repetition factor K>1 overriding a high priority (HP) CG PUSCH, and if MAC delivers two MAC PDUs,**
    - **if the HARQ process is the same between the LP DG and the HP CG, it is up to UE implementation to make sure that the HP CG overrides all LP CG remaining repetition occasions from LP CG repetition occasion overlapping with HP CG, and the overriding is achieved before the start of the high priority CG PUSCH.**
    - **Otherwise, it is up to UE implementation to make sure that HP CG override only the LP CG repetition overlapped with the HP CG, and the overriding is achieved before the start of the high priority CG PUSCH.**

Any comments?

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* 1. Limitations for the nested transmissions

[R1-2008434] proposed following nested transmission may prove challenging to UE implementation, hence it makes sense to limit the number of nested levels.

A picture containing screenshot

Description automatically generated

Figure 1 Nested transmission due to multiple overriding

* **Proposal 4: If nested transmissions are allowed, limit the number of nested transmission levels to X. And at any time, up to X-1 levels of nested transmissions are allowed for CGs so to reserve one level for potential DG overriding.**
* **FL’s views: Rel-15 defined overriding timeline gives sufficient time for MAC layer to do the prioritization and indicate the HARQ entity to deliver the prioritized data to PHY layer, PHY layer just transmits what received from MAC layer. Seems no much complexity at PHY layer. Therefore, proposal 4 is not needed.**

Any comments?

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* 1. HP CG blocking issue

[R1-2007817] discussed when LP DG overlapping with HP CG in the same serving cell, even when satisfying the overriding time, HP data may be blocked by LP DG due to later data arriving (t2 is later than t1) as shown in Figure 2 since only one PDU is expected from MAC for overlapping PUSCHs. Therefore, it was proposed:

**Proposal 5: For overlapping between DG PUSCH and CG PUSCH with different priorities, the first symbol of LP PUSCH should be no earlier than the first symbol of HP PUSCH.**

**FL’s views: Rel-15 defined overriding timeline is sufficient. Proposal 5 is not needed.**

Any comments?

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* 1. PUSCHs overlapping with UCI piggyback

[R1-2007817] discussed UCI multiplexing on overlapped DG/CG PUSCH and CG PUSCH.

* **Overlapping between DG/CG PUSCH and CG PUSCH with same L1 priority**

As shown in Figure 3, PDU for either DG or CG may be delivered to PHY based on LCH priority and PHY is supposed to transmit the corresponding PUSCH. It is possible that MAC delivers a PDU for CG without any PDU delivering for DG, however UCI is supposed to be transmitted on DG in PHY layer, which means by the decision of MAC to deliver CG PDU, UCI is dropped due to no PDU for DG PUSCH which is used to piggyback UCI. Similar issues exist for overlapping between two CG PUSCHs.



Figure.3 DG-CG with same L1 priority and piggybacked UCI

* **Overlapping between DG/CG PUSCH and CG PUSCH with different L1 priorities**

For overlapping between LP DG and HP CG, the HP CG may be selected to piggyback UCI as shown in Figure.4. It is possible that MAC delivers a PDU for LP DG to PHY when there is no data in LCH associated with HP CG (HP CG is skipped). However, since the latest time for PDU delivering of HP CG (t2) may be latter than the time point for deciding UCI piggyback on PUSCH (t3), UE could not go back to prepare UCI on PUCCH when there is no PDU for HP CG, which means UCI may be dropped. In addition, similar issues exist for the overlapping between LP CG and HP DG or the overlapping between two CG PUSCHs with different L1 priorities.



Figure.4 LP DG-HP CG with piggybacked UCI

**[R1-2007817] proposed: we suggest RAN2 considering UCI dropping issue on MAC delivering PDU to PHY by prioritizing PUSCH with UCI piggyback.**

**FL’s views: it is noted that [R1-2008117], [R1-2007797] submitted in AI 5 discussed the similar issue. It can be discussed together.**

Any comments?

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# References

* R1-2007817, Discussion on overlapping between CG PUSCH and DG PUSCH CATT
* R1-2008434, Maintenance of configured grant design in Physical Layer Enhancements for NR URLLC Apple

**Following are the Rely LS submitted in AI 5.**

* [R1-2007702](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007702.zip) Draft Reply LS on Intra-UE Prioritization Scenario Ericsson
* [R1-2007724](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007724.zip) [DRAFT] Reply LS on Intra UE Prioritization Scenario ZTE
* [R1-2007797](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007797.zip) Draft reply LS on intra UE prioritization scenario CATT
* [R1-2008077](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008077.zip) Discussion on RAN2 LS on Intra UE Prioritization Scenario LG Electronics
* [R1-2008117](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008117.zip) Discussion on LS on Intra UE Prioritization Scenario Samsung
* [R1-2008306](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008306.zip) [Draft] Reply LS on Intra UE Prioritization Scenario Nokia
* [R1-2008525](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008525.zip) Discussion on LS on intra-UE prioritization Intel Corporation
* [R1-2008592](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008592.zip) Draft reply LS to RAN 2 LS on intra-UE prioritization Qualcomm Incorporated
* [R1-2008642](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008642.zip) Draft Reply LS on Intra UE Prioritization Scenario vivo