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

**August 17th – 28th, 2020**

**Agenda item:** 7.2.5.4

**Source:** Moderator (Qualcomm)

**Title:** Summary #1 of [102-e-NR-L1enh-URLLC-Scheduling and HARQ-02]

**Document for:** Discussion and Decision

# 1 Introduction

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

[102-e-NR-L1enh-URLLC-Scheduling and HARQ-02] Processing order of intra-UE prioritization and multiplexing and handling CBG-based PUSCH retransmission – Kianoush (Qualcomm)

* Whether/how to perform multiplexing/PUCCH overriding for the LP channels in case of collision.
  + Starting point for the discussion:
    - LP multiplexing is performed similar to Rel. 15 as if HP channels do not exist; this means that LP operations, multiplexing/overriding/etc, are performed before cancellation.
    - HP multiplexing is performed independently.
    - Similar to the current spec., any HP DCI can trigger a cancellation.
* Re-transmission of the CBG-based PUSCH with cancellation
  + 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.
  + 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 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.
  + Option 4: the minimum processing time for PUSCH scheduled for re-transmission is extended by D symbols.
  + Option 5: The UE is not expected to be scheduled with partial TB for the retransmission.
* Discussions/Agreements by 8/21, TPs by 8/28

A summary of the companies’ proposals is captured in [1]. **Companies are encouraged to share their views by Wednesday August 19th.**

# 2 Issue#1: Whether/how to perform multiplexing/PUCCH overriding for the LP channels in case of collision

**Alternative #1:** According to the current specification and the discussion from the last meeting, once a UE detects a HP DCI scheduling a HP channel overlapping with a LP channel, the transmission of the LP channel (including its content) is dropped.

An example is given in the figure below:



Once the UE detects HP DCI1, LP PUCCH including its contents is dropped. Hence, the PUCCH cannot be overridden by another DCI, i.e., LP DCI2, later. In other words, after receiving the HP DCI1, the LP multiplexing/PUCCH overriding operations should be assumed to be reset by the gNB and the UE. There is no ambiguity on either side.

**Alternative #2:** As discussed during the last meeting, the operation can be optimized by requesting the UE to follow the multiplexing/overriding procedures for the LP channels before applying the cancellation. In other words, multiplexing and overriding of the LP channels are not impacted by cancellation; cancellation is applied at the last stage.

Considering the example above, a UE follows the LP PUCCH overriding and then transmits all HARQ-ACKs piggybacked on the LP PUCCH scheduled by LP DCI2. For the case of PUCCH overriding, there is no ambiguity between the UE and the gNB even if the UE applies cancellation during the intermediate steps (There really is no cancellation over the air; the UE only decides not to transmit on some resources, while keeping the content for the future transmissions.)

Now, consider a scenario where a LP PUSCH is in the overlapping group. One example is shown below:



In this case, LP PUCCH gets multiplexed with the LP PUSCH. However, there could be an ambiguity at the gNB; basically, depending on when the UE decides not to transmit the LP PUSCH, the outcome could be different. If the UE decides not to transmit earlier (i.e., before decoding HP DCI2), the final LP channel will not be transmitted. If it decides later, the UE may multiplex HP PUCCH into HP PUSCH and then also transmits the LP PUSCH. Note that the ambiguity is only 1-bit, i.e., the final LP channel does not change; it is where the gNB expects it to be. However, whether a UE transmits on that resource or not depends on when the UE decides to perform cancellation.

**Question #1: In the table below, please state if you prefer Alternative #1 (current specification) or Alternative #2 above? If you prefer Alternative #1, is there a need to further clarify the procedure in the spec? If you prefer Alternative #2, do you agree that a UE should follow the steps mentioned below?**

* **LP multiplexing is performed similar to Rel. 15 as if HP channels do not exist; this means that LP operations, multiplexing/overriding/etc, are performed before cancellation.**
* **HP multiplexing is performed independently.**
* **Similar to the current spec., any HP DCI can trigger a cancellation.**

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| --- | --- | --- |
| **Company** | **Preferred Alternative** | **Comments** |
|  |  |  |

# 2 Issue#2: Retransmission of the CBG-Based PUSCH with Cancellation

To handle the UE processing timeline in case the initial transmission of a CBG-based PUSCH is cancelled, the following options were considered and discussed during RAN1 #101e:

* Re-transmission of the CBG-based PUSCH with cancellation
  + 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.
  + 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 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.
  + Option 4: the minimum processing time for PUSCH scheduled for re-transmission is extended by D symbols.
  + Option 5: The UE is not expected to be scheduled with partial TB for the retransmission.

As discussed, Option 1a is aligned with a reasonable gNB’s operation.

In the table below, please state whether you would agree to adopt Option 1a. If not, please provide your reasoning.

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| --- | --- | --- |
| **Company** | **Option 1a (Yes/No)** | **Reasons** |
|  |  |  |

# 3 References

**[1] R1-200xxxx, “*Summary of the remaining issues on HARQ and scheduling enhancements for URLLC: preparation phase*,” Moderator (Qualcomm)**