**3GPP TSG RAN WG1 Meeting #110 R1-220xxxx**

**e-Meeting, May 9th – 20th, 2022**

**Agenda item: 7.2.2**

**Source: Moderator(ZTE)**

**Title: FL summary of the issue on Type-3 HARQ codebook in case of PUCCH repetition**

**Document for:** **Discussion and Decision**

# Introduction

This document summarizes the discussion on the issue of HARQ-ACK multiplexing on PUSCH proposed by [1].

# Discussion

For Type-3 HARQ-ACK codebook, if the UE receives a PDSCH and has not reported the HARQ-ACK information yet for a HARQ process, the corresponding HARQ information is included in the Type-3 codebook. If the UE has reported the HARQ-ACK information for a HARQ process and has not received a new PDSCH, NACK is generated for the HARQ process. When PUCCH repetition is configured, the understanding of whether or not the HARQ-ACK information has been reported is not clear in case not all the PUCCH repetitions are transmitted.

To align the understanding between the network and the UE, the following proposal and CR are provided [1].

**Proposal 1:** For Type-3 codebook, a UE considers the HARQ-ACK information has been reported for a HARQ process only when all the PUCCH repetitions carrying the HARQ-ACK information are transmitted.

**CR for TS38.213**

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| 9.1.4 Type-3 HARQ-ACK codebook determination **<Unchanged parts are omitted>**  If a UE receives a SPS PDSCH, or a PDSCH that is scheduled by a DCI format that does not support CBG-based PDSCH receptions for a serving cell and if *maxCodeBlockGroupsPerTransportBlock* is provided for serving cell , and *pdsch-HARQ-ACK-OneShotFeedbackCBG* is provided, the UE repeats times the HARQ-ACK information for the transport block in the PDSCH.  A UE determines a HARQ-ACK information for a TB for a HARQ process on a serving cell has been reported only when all the PUCCH repetitions carrying the HARQ-ACK information are transmitted.  **<Unchanged parts are omitted>** |

## First round

Companies are invited to share the views on the proposal and CR.

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| **Company name** | **Comments** |
| Intel | The proposal may result in DTX-ACK error. Assuming the previous PDSCH is correct and UE report ACK using PUCCH repetition. Then due to overlap with DL symbols, not all repetitions of the PUCCH can be transmitted. UE has to report ACK again according to the proposal. However, gNB may already correctly receive the ACK using the transmitted PUCCH repetitions. gNB transmit a new PDCCH/PDSCH using the same HARQ process, but UE miss the PDCCH. Finally, if UE report ACK for the HARQ process, gNB may misunderstand it as ACK for the new PDSCH, which is the error case.  Based on above analysis, UE should report NACK on the current PUCCH if at least one PUCCH repetition of the previous PUCCH is transmitted. Otherwise, it causes error case.  In fact, we don’t think spec changes is necessary since the HARQ-ACK should be considered as ‘reported’ if at least one PUCCH repetition is transmitted by UE |
| Qualcomm | Now we have two solutions on the table, either reporting NACK when all PUCCH repetitions are transmitted or reporting NACK when at least one PUCCH repetitions are transmitted. Both solutions are valid technically. We understand this is not properly discussed in the Rel.16 NR-U time frame. At this phase, we believe we should go with the solution with no spec impact. Our reading of the current spec aligns with Intel’s view that the UE will report NACK if at least one PUCCH repetition is transmitted |
| LG | We share the same view with Intel and QC that according current spec, the UE will report NACK if at least one PUCCH is transmitted, and guaranteeing the performance of PUCCH repetition for the UE is up to the gNB handling. |
| ZTE | We don’t think current spec is clear enough, and we could be ok to clarify this at least with a conclusion. |

## Second round

Apparently, different companies have different views on how to determine whether a UE has been reported the HARQ-ACK information for a HARQ process in case of PUCCH repetition. Based on views from the majority, moderator suggests the following proposed conclusion to consider.

**Proposed conclusion:** For Type-3 codebook, a UE considers the HARQ-ACK information has been reported for a HARQ process if at least one of the PUCCH repetitions carrying the HARQ-ACK information is transmitted.

* No specification change is needed.

Companies are encouraged to provide further inputs below.

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| **Company name** | **Comments** |
| Intel | We are Ok with this conclusion. |

# Reference

1. [R1-2205948](file:///C:\Users\younsun\Documents\3GPP%20documents\RAN1%20tdocs\TSGR1_110\Docs\R1-2205948.zip) Discussion on Type-3 HARQ codebook in case of PUCCH repetition ZTE