**3GPP TSG RAN WG1 #104-e R1-210XXXX**

**e-Meeting, January 25th – February 5th, 2021**

**Agenda item:** 7.1

**Source:** Moderator (CATT)

**Title:** Summary of [104-e-NR-7.1CRs-15] Draft CR on Type-2 HARQ -ACK codebook in physical uplink shared channel

**Document for:** Discussion and Decision

# Introduction

This document is created to facilitate the email discussion of “[104-e-NR-7.1CRs-15] Draft CR on Type-2 HARQ-ACK codebook in physical uplink shared channel”. This email thread is triggered by draft CRs in [1][2][3].

According to TS38.213 clause 9.1.3.2, for a type-2 HARQ-ACK codebook transmission in a PUSCH scheduled by a DCI format 0\_1, UE generates the HARQ-ACK codebook as described in Clause 9.1.3.1 according to the value of  in the DCI format 0\_1, which is used to indicate the total number of HARQ-ACKs in response to PDSCHs associated with PDCCH and PDCCH indicating SPS PDSCH release to be multiplexed in the PUSCH.

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| If a UE multiplexes HARQ-ACK information in a PUSCH transmission that is scheduled by DCI format 0\_1, the UE generates the HARQ-ACK codebook as described in Clause 9.1.3.1, with the following modifications:  - For the pseudo-code for the HARQ-ACK codebook generation in Clause 9.1.3.1, after the completion of the  and  loops, the UE sets  where  is the value of the DAI field in DCI format 0\_1 according to Table 9.1.3-2  - For the case of first and second HARQ-ACK sub-codebooks, DCI format 0\_1 includes a first DAI field corresponding to the first HARQ-ACK sub-codebook and a second DAI field corresponding to the second HARQ-ACK sub-codebook  *- harq-ACK-SpatialBundlingPUCCH* is replaced by *harq-ACK-SpatialBundlingPUSCH*. |

The HARQ-ACK for SPS PDSCH, if any, is appended after the HARQ-ACK(s) in response to PDSCHs associated with PDCCH and PDCCH indicating SPS PDSCH release.

In addition, it is specified in TS38.213 clause 9.1.3.2 that for a type-2 HARQ-ACK codebook transmission in a PUSCH scheduled by DCI format 0\_1, if  in the DCI format 0\_1 and UE has no HARQ-ACK(s) in response to PDSCHs associated with PDCCH, PDCCH indicating SPS PDSCH release or SPS PDSCH, the UE does not multiplex HARQ-ACK in the PUSCH.

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| If a UE is not provided *PDSCH-CodeBlockGroupTransmission* and the UE is scheduled for a PUSCH transmission by DCI format 0\_1 with DAI field value  and the UE has not received any PDCCH within the monitoring occasions for PDCCH with DCI format 1\_0 or DCI format 1\_1 for scheduling PDSCH receptions or SPS PDSCH release on any serving cell  and the UE does not have HARQ-ACK information in response to a SPS PDSCH reception to multiplex in the PUSCH, as described in Clause 9.1.3.1, the UE does not multiplex HARQ-ACK information in the PUSCH transmission.  If a UE is provided *PDSCH-CodeBlockGroupTransmission* and the UE is scheduled for a PUSCH transmission by DCI format 0\_1 with first DAI field value  or with second DAI field value  and the UE has not received any PDCCH within the monitoring occasions for PDCCH with DCI format 1\_0 or with DCI format 1\_1, respectively, for scheduling PDSCH receptions or SPS PDSCH release on any serving cell  and the UE does not have HARQ-ACK information in response to a SPS PDSCH reception to multiplex in the PUSCH, as described in Clause 9.1.3.1, the UE does not multiplex HARQ-ACK information for the first sub-codebook or for the second sub-codebook, respectively, in the PUSCH transmission. |

However, for the similar case as above except that UE has HARQ-ACK for SPS PDSCH to be multiplexed in the PUSCH, UE would multiplex 5 bits in the PUSCH according to Rel-15 specifications. Therefore, the draft CRs in [1][2][3] propose to clarify that for a type-2 HARQ-ACK codebook transmission in a PUSCH scheduled by DCI format 0\_1, if  in the DCI format 0\_1 and UE has HARQ-ACK(s) for SPS PDSCH only (i.e. no HARQ-ACK(s) in response to PDSCHs associated with PDCCH or PDCCH(s) indicating SPS PDSCH release), the UE multiplexes HARQ-ACK(s) for SPS PDSCH only in the PUSCH.

# Company views

**Q1:** In Rel-15, for a type-2 HARQ-ACK codebook transmission in a PUSCH scheduled by DCI format 0\_1, if  in the DCI format 0\_1 and UE has a HARQ-ACK for SPS PDSCH only (i.e. no HARQ-ACK(s) in response to PDSCHs associated with PDCCH or PDCCH(s) indicating SPS PDSCH release), **what is the intended UE behaviour**?

* Alternative 1: UE multiplexes 1-bit HARQ-ACK for SPS PDSCH in the PUSCH
* Alternative 2: UE multiplexes 5-bit HARQ-ACKs in the PUSCH

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| **Company** | **Alternative 1 or Alternative 2** | **Comment** |
| OPPO | Alternative 2, if  in the DCI format 0\_1 | If only one SPS PDSCH is transmitted by gNB, the value of  in the DCI format 0\_1 should be smaller, e.g. 1.  If the value of  in the DCI format 0\_1 is 4, then the intended behavior is alternative 2. |
| vivo | Alternative 1 | DAI in the DCI format 0\_1 is used to count DG PDSCHs/SPS release only without considering SPS PDSCH.  is used to indicate there is no HARQ-ACK for DG PDSCH/SPS release (if the UE has not received any PDCCH within the monitoring occasions). |
| Qualcomm |  | We expect to see different answers to this question. But this is not the main point. The point is that: is this a critical issue to begin with? Our view is that this is just a corner case, not a critical issue. gNB can set =1 to bypass the issue. At this stage, we don’t want to introduce NBC change to Rel-15 spec, unless it is definitely needed. Unfortunately, this issue does not meet the bar for Rel-15 NBC change. |
| NTT DOCOMO | Alt 1 | In this situation, only 1 bit HARQ-ACK should be the intended behavior. |
| Huawei | Alt.1 | When the issue was discussed, the intended UE behavior was that only 1 bit HARQ-ACK is multiplexed on PUSCH. However, the current specification still works and system is not broken. |

**Q2:** In Rel-15, for a type-2 HARQ-ACK codebook transmission in a PUSCH scheduled by DCI format 0\_1, if  in the DCI format 0\_1 and UE has a HARQ-ACK for SPS PDSCH only (i.e. no HARQ-ACK(s) in response to PDSCHs associated with PDCCH or PDCCH(s) indicating SPS PDSCH release), **what is the UE behaviour according to current specification**?

* Alternative 1: UE multiplexes 1-bit HARQ-ACK for SPS PDSCH in the PUSCH
* Alternative 2: UE multiplexes 5-bit HARQ-ACKs in the PUSCH

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| **Company** | **Alternative 1 or Alternative 2** | **Comment** |
| OPPO | Alternative 2 | The same comment as Q1 |
| vivo | Alternative 1 | The same comment as Q1 |
| Qualcomm |  | Same comment as to Q1 |
| NTT DOCOMO | Alt 2 | Based on the current pseudo-code, if V^UL\_DAI is 4, it seems that unnecessary 4-bits are generated before generating HARQ-ACK for SPS PDSCH. |
| Huawei | Alt.2 | The HARQ-ACK bits is generated based on the pseudo-code. In this case, the UE will multiplex 5 bits in PUSCH. |

**Q3:** Do you agree with the principle of the CRs? If not, why?

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| **Company** | **Agree or not** | **Comment** |
| OPPO | No | Current specification works. It is not an essential issue. |
| vivo | agree |  |
| Qualcomm | No | Similar to OPPO’s view, this is not a critical issue. Current specification works. No need to introduce NBC change to Rel-15 spec to address this noncritical issue. |
| NTT DOCOMO | No for at least Rel-15 | This CR for Rel-15 would be NBC change.  For Rel-16, the change might be OK. |
| Huawei | No | It is NBC change for Rel-15 and the issue is not critical. |

# Conclusion

To be added after the discussion.

# Reference

1. [R1-2100083](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104-e/Docs/R1-2100083.zip) Draft CR on Type-2 HARQ-ACK codebook in physical uplink shared channel ZTE

1. [R1-2100324](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104-e/Docs/R1-2100324.zip) Correction on HARQ-ACK transmission in PUSCH CATT

1. [R1-2100325](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104-e/Docs/R1-2100325.zip) Correction on HARQ-ACK transmission in PUSCH CATT