**3GPP TSG RAN WG1 Meeting #101-e                     R1-200xxxx**

**e-Meeting, May 25th – June 5th, 2020**

**Agenda Item: 7.2.2.2.3**

**Source: Moderator (Huawei)**

**Title: Feature lead summary#1 on 101-e-NR-unlic-NRU-HARQ-01 (enhanced Type-2 HARQ-ACK codebook)**

**Document for: Discussion and Decision**

# Introduction

This document provides updated proposals on issues A5, A7 and A18 that are prioritized for RAN1#101e among the issues identified for the **NR-U enhanced Type-2 HARQ-ACK codebook** [1].

[101-e-NR-unlic-NRU-HARQ-01] Email discussion/approval on issues A5, A18 and A7 (limited to clarification of “if any”) from R1-2004692 until 5/29; if necessary, endorse associated TPs by 6/4 – David (Huawei)

* Issue A5: nHARQ-ACK definition for power control with enhanced dynamic codebook is missing
* Issue A7: Clarification of whether “if any” refers to RRC configuration or DCI format detection for setting Vtemp2 according to T-DAI for the non-scheduled group when two sub-codebooks (for TB and CBG) are configured
* Issue A18: Handling of DCI format 1\_0 indicating a SPS PDSCH release in enhanced dynamic HARQ-ACK codebook

Each sub-section per issue includes an initial FL proposal based on the summary of the submitted Tdocs, and provides a table for collecting companies’ views on the FL’s proposal.

# Issue A5

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| A5 | TS38.213 clause 9.1.3.3: nHARQ-ACK definition for power control with enhanced dynamic codebook is missing |

FL summary: there are just small differences between the various TPs. Before discussing the detailed TP, companies are requested to provide views on the following principles.

Proposal:

* nHARQ-ACK should be defined for the cases where
  + UE is not provided PDSCH-CodeBlockGroupTransmission for any cell
  + UE is provided PDSCH-CodeBlockGroupTransmission for  < 
* Type 2 CB rule for is used separately for each PDSCH group, and SPS PDSCH is considered separately from the two PDSCH groups
*  is given by , when available, for the (g+1)mod2
* nHARQ-ACK should be defined for cases where q=1 and q=0

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| **Company** | **Comments on the proposal above** |
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| **Company** | **Summary of proposals** |
| Huawei  (R1-2003514) | In NR-U, since the DAI are accumulated within each PDSCH group, and the SPS PDSCH does not belong to any group, if HARQ-ACK feedback for both groups are requested, and , UE should determine the number of HARQ-ACK information bits for each group and SPS, separately. The TP is provided as following:  **TP#4 for TS 38.213 Clause 9.1.3.3**  === Unchanged part omitted ===  If , the UE  includes only the first HARQ-ACK information for multiplexing in PUCCH transmission occasion  elseif  if g = 1  appends the first HARQ-ACK information to the second HARQ-ACK information for multiplexing in PUCCH transmission occasion  else  append the second HARQ-ACK information to the first HARQ-ACK information for multiplexing in PUCCH transmission occasion  end if  end if  If a UE is not provided *PDSCH-CodeBlockGroupTransmission* for each of the  serving cells, or for PDSCH receptions scheduled by a DCI format that does not support CBG-based PDSCH receptions, or for SPS PDSCH reception, or for SPS PDSCH release, and if , the UE determines a number of HARQ-ACK information bits  for obtaining a transmission power for a PUCCH, as  where   * is the number of SPS PDSCH receptions by the UE on serving cell  for which the UE transmits corresponding HARQ-ACK information in the PUCCH * is defined in clause 9.1.3.1 * is defined in clause 9.1.3.1 with and counted separately for each PDSCH group * and are defined in clause 9.1.3.1 except that the numbers are counted separately for each PDSCH group. If , =.   If a UE   * is provided *PDSCH-CodeBlockGroupTransmission* for  serving cells; and * is not provided *PDSCH-CodeBlockGroupTransmission*, for  serving cells where   If , the UE also determines  for obtaining a PUCCH transmission power, as described in Clause 7.2.1, with  where   * is defined in clause 9.1.3.1 * is defined in clause 9.1.3.1 with and counted separately for each PDSCH group * and are defined in clause 9.1.3.1 except that the numbers are counted separately for each PDSCH group. If , =.   === Unchanged part omitted === |
| Samsung  (R1-2003862) | Rel-15 equation is reused for each PDSCH group respectively, except the following revision:  (1) for group (g+1)mod2, if , the last DCI contains T-DAI for group (g+1)mod2 and should be determined by .  (2) The number of SPS PDSCH receptions  is only calculated in group g and set to 0 for group (g+1)mod2 to avoid duplicated calculation.  Proposal 1: For enhanced dynamic HARQ-ACK codebook using PUCCH format 2 or PUCCH format 3 or PUCCH format 4, if the number of UCI bits is smaller than or equal to 11, the HARQ-ACK information bits for power control should consist of the HARQ-ACK information bits for both PDSCH groups and SPS PDSCH reception(s) when gNB triggers HARQ-ACK feedback for both PDSCH groups..  TP for clause 9.1.3.3  ------------------ Unchanged part omitted ------------------------  The UE appends the HARQ-ACK information corresponding to SPS PDSCH receptions, if any, as described in Clause 9.1.3.1, after the first and second, if any, HARQ-ACK information.  If , the UE determines a number of HARQ-ACK information bits  for obtaining a transmission power for a PUCCH, as described in Clause 7.2.1, as    where  and eare determined as in Clause 9.1.3.1 for PDSCH group *g* and e, respectively, except that for group , and if , .  ------------------ Unchanged part omitted ------------------------ |
| Vivo  (R1-2003372) | Proposal 2: For enhanced dynamic codebook, to apply should be the sum of across all reported PDSCH group(s) in a PUCCH transmission occasion, i.e. , when the number of UCI bits for the PUCCH transmission occasion is smaller than or equal to 11. |
| Nokia  (R1-2004257) | **Proposal 1:** Type 2 CB rule for is used separately for each PDSCH group.  is given by , when available, for the non-scheduled PDSCH group.  **TP for TS38.213:** 9.1.3.3 Type-2 HARQ-ACK codebook grouping and HARQ-ACK retransmission <unchanged text omitted >  If , the UE  includes only the first HARQ-ACK information for multiplexing in PUCCH transmission occasion  elseif  if g = 1  appends the first HARQ-ACK information to the second HARQ-ACK information for multiplexing in PUCCH transmission occasion  else  append the second HARQ-ACK information to the first HARQ-ACK information for multiplexing in PUCCH transmission occasion  end if  end if  If , the UE determines a number of HARQ-ACK information bits groups and separately as described in Clause 9.1.3.1, with the following modification that if , UE sets = . If , the UE sets else UE sets for obtaining a transmission power for a PUCCH.  <unchanged text omitted > |
| Qualcomm  (R1-2004445) | If a UE is not provided *PDSCH-CodeBlockGroupTransmission* for each of the  serving cells, or for PDSCH receptions scheduled by a DCI format that does not support CBG-based PDSCH receptions, or for SPS PDSCH reception, or for SPS PDSCH release, and if , and if the UE includes both first and second HARQ-ACK information for multiplexing in the PUCCH, the UE determines a number of HARQ-ACK information bits  for obtaining a transmission power for a PUCCH, as described in Clause 7.2.1, as    where   * and are defined in Clause 9.1.3.1. * and are defined in Clause 9.1.3.1 except that the numbers are counted each PDSCH group index separately. * is defined in Clause 9.1.3.1 except that it is determined for each PDSCH group index separately. If and for , . |
| Ericsson  (R1-2003845) | Adopt TP in R1-2002532  Proposals might have an issue with counting the HARQ-ACK information corresponding to SPS receptions twice or even not counting them at all since the generation of the codebook for each group excludes the generation of HARQ-ACK information for SPS PDSCH receptions. |

# Issue A7

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| A7 | TS38.213 clause 9.1.3.3: Clarification of whether “if any” refers to RRC configuration or DCI format detection for setting Vtemp2 according to T-DAI for the non-scheduled group when two sub-codebooks (for TB and CBG) are configured. |

Issues A7 addresses the following text in TS38.213 section 9.1.3.3:

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| If or , generate second HARQ-ACK information for PUCCH transmission occasion in a slot, as described in Clause 9.1.3.1, where  […]  - if , after the completion of the and loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, set for both sub-codebooks, if any. |

Companies’ views on the clarification of the interpretation of “if any” are invited:

* Alt1: “if any” refers only to the configuration of *PDSCH-CodeBlockGroupTransmission*
  + is set for both sub-codebooks if *PDSCH-CodeBlockGroupTransmission* provided for at least one serving cell.
* Alt2: “if any” refers to DCI format detection for a cell configured with *PDSCH-CodeBlockGroupTransmission*
  + is set for a sub-codebook only if the UE has detected at least one DCI format scheduling a PDSCH for the sub-codebook.

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| **Company** | **Comments on the alternatives above** |
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| **Company** | **Summary of proposals** |
| Huawei  (R1-2003514) | A potential ambiguity remains in the interpretation of “if any”, which could be interpreted either as configuration of two sub-codebooks or detection of DCIs for both sub-codebooks in the set of monitoring occasions corresponding to the PUCCH occasion.  **TP#1 for TS 38.213 Clause 9.1.3.3(on top of R1-2003180)**  === Unchanged part omitted ===  - the PUCCH transmission occasion is a last one for multiplexing second HARQ-ACK information and it is not after PUCCH transmission occasion  - if ,   * if the UE is provided *PDSCH-CodeBlockGroupTransmission* for serving cells, and is not provided *PDSCH-CodeBlockGroupTransmission* for serving cells , after the completion of the and loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, set for both sub-codebooks before appending the second sub-codebook to the first sub-codebook. * Otherwise, after the completion of the and loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, set .   === Unchanged part omitted === |
| Vivo  (R1-2003372) | It should be determined how to indicate and apply when the second HARQ-ACK codebook contains two sub-codebooks  In Figure below, when there are a number of consecutive DCI format(s) at the end of a sub-codebook and miss-detected by UE, with the number smaller than 4 which is supposed by NR Rel-15, applying a same total DAI of either the smaller or larger one to two sub-codebooks will cause misalignment between UE and gNB.    *Proposal:* *When the RRC parameter NFI-TotalDAI-Included-r16 = enable and two sub-codebooks may be applied, i.e., PDSCH-CodeBlockGroupTransmission is provided at least for a serving cell, indicating separate total DAIs for each sub-codebook respectively for the non-scheduled PDSCH group in a non-fallback DCI format.* |
| OPPO  (R1-2004087) | Proposal 6: Two T-DAIs for TB sub-codebook and CBG sub-codebook of the non-scheduled PDSCH group can be configured in DCI format 1\_1 |
| LG  (R1-2004015) | For the case when CBG based PDSCH transmission is configured and T-DAI indication for the non-scheduled PDSCH group is configured for DL DCI, Two T-DAI values are indicated for the non-scheduled PDSCH group:   * One value corresponds to TB-based PDSCH. * The other value corresponds to CBG-based PDSCH   For the case when CBG based PDSCH transmission is configured and T-DAI indication for both or one of two PDSCH groups is configured for UL DCI, the following is adopted, two T-DAI values are indicated per PDSCH group.   * One value corresponds to TB-based PDSCH. * The other value corresponds to CBG-based PDSCH. |
| Mediatek  (R1-2001904) | Introduce 2 additional bits for T-DAI field: DAI field in DCI format 1\_1 has 8 bits for enhanced dynamic HARQ-ACK codebook with two HARQ-ACK sub-codebooks and with NFI-TotalDAI-Included-r16 = enable. The 4 MSB bits are the counter DAI and the total DAI for the scheduled PDSCH group. The 4 LSB bits are the total DAI for the non-scheduled PDSCH group, where two bits apply separately for each HARQ-ACK sub-codebook. |
| Nokia  (R1-2004257) | Proposal 2: Given that no consensus could be reached on the issue A7 in RAN1#100b, we propose not to discuss issue any more in RAN1#101 |
| Qualcomm  (R1-2004445) | The procedures described in Section 9.1.1.3 should be done separately for the two sub-codebooks:  --Unchanged part omitted------------------------  If or , generate second HARQ-ACK information for PUCCH transmission occasion in a slot, as described in Clause 9.1.3.1, where  - the second HARQ-ACK information corresponds to detections of DCI formats each providing a same value of , of and to detections of DCI formats that do not provide a value of , of , but are associated with a same value of , of ,  - at least one of the DCI formats provides a value  - corresponds to a PDCCH monitoring occasion, where the UE detects a DCI format that provides a value of or that is associated with a value of , that is the first PDCCH monitoring occasion after a PDCCH monitoring occasion where the UE detects another DCI format that provides a value different than  - the PUCCH transmission occasion is a last one for multiplexing second HARQ-ACK information and it is not after PUCCH transmission occasion  - if , after the completion of the and loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, set .  --Unchanged part omitted------------------------  The UE appends the HARQ-ACK information corresponding to SPS PDSCH receptions, if any, as described in Clause 9.1.3.1, after the first and second, if any, HARQ-ACK information.  If a UE is provided *PDSCH-CodeBlockGroupTransmission* for at least one serving cell, the procedures described in this Clause are applied separately for the first sub-codebook and the second sub-codebook, where the second sub-codebook is the CBG-based sub-codebook as described in Clause 9.1.3.1.  If the HARQ-ACK information is multiplexed in a PUSCH transmission, the HARQ-ACK information is determined as  --Unchanged part omitted------------------------ |
| Samsung  (R1-2003862) | Regarding how to understand “if , after the completion of the and loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, set for both sub-codebooks, if any”, some companies have some concerns about “if any”. In our understanding, “if any” means a UE is provided *PDSCH-CodeBlockGroupTransmission*. The UE behaviour is clear that, UE determines HARQ-ACK bits for both CBG and TB sub-codebooks according to the single , if a UE is provided *PDSCH-CodeBlockGroupTransmission* for at least one serving cell. gNB may only schedules one sub-codebook for a PDSCH group for a PUCCH, the UE still has to report some bits of NACK for non-scheduled sub-codebook according to . Although additional UCI overhead may be required, DCI overhead can be reduced. In addition, gNB can control the UCI overhead through a proper scheduling.  Observation: No need to further clarify the interpretation of T-DAI in DCI 1\_1 for the non-scheduled group when two sub-codebooks (for TB and CBG) are configured. |

# Issue A18

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| A18 | Handling of DCI format 1\_0 indicating a SPS PDSCH release in enhanced dynamic HARQ-ACK codebook |

Companies are invited to provide their detailed comments on the possible TP starting from the proposal in R1-2003658.

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| **Company** | **Summary of proposals and further companies’ comments** |
| MediaTek  (R1-2003658) | In NR, DCI format 1\_0 is possible to be used for indicating a DL SPS release. However, if UE detects a DCI format 1\_0 indicating a DL SPS release, it is not clear in current specification how UE handle the DCI format 1\_0 since only defines behavior for PDSCH reception scheduled by DCI format 1\_0. We believe that the missing UE behaviour should be also completed in TS38.213 clause 9.1.3.3.  **Proposal 2: Text proposal 2 is adopted in TS38.213 clause 9.1.3.3 to complete UE behavior to DCI format 1\_0 indicating a SPS PDSCH release in enhanced dynamic HARQ-ACK codebook.**  ====**Text Proposal 2 Starts**==== 9.1.3.3 Type-2 HARQ-ACK codebook grouping and HARQ-ACK retransmission \*\*\* Unchanged text is omitted \*\*\*  If a UE detects DCI formats with respective PDSCH-to-HARQ\_feedback timing field values indicating a same PUCCH transmission occasion and none of the DCI formats that the UE detects after a last PUCCH transmission occasion for includes a New\_Feedback indicator field for , and at least one of the DCI formats is DCI format 1\_0, the UE generates HARQ-ACK information only for PDSCH receptions scheduled by detections of DCI format 1\_0 and SPS PDSCH releases indicated by detections of DCI format 1\_0 by detections of DCI format, as described in Clause 9.1.3.1 or 9.1.3.2 for multiplexing in the PUCCH transmission occasion.  If a DCI format indicating a slot for a PUCCH transmission occasion does not include a New\_Feedback indicator field, a PDSCH reception scheduled by the DCI format or a SPS PDSCH release indicated by the DCI format is associated with PDSCH group 0 and a value of *h*(*g*) associated with the DCI format is set only if *h*(*g*) is provided by another DCI format that provides a value of *h*(*g*) for PDSCH group 0 and indicates the slot for the PUCCH transmission occasion.  \*\*\* Unchanged text is omitted \*\*\*  ===== **Text Proposal 2 Ends**==== |
| Qualcomm | This is editorial, and there may be easier ways, e.g. not mention “PDSCH reception” |
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# Conclusions

TBD

# References

1. R1-2004692 FL summary\_1 for 72223 NRU HARQ moderator (Huawei), RAN1#101-e
2. R1-2003372 Remaining issues on HARQ operation for NR-U vivo
3. R1-2003452 Remaining issues on the HARQ for NR-U ZTE, Sanechips
4. R1-2003514 Maintenance on HARQ-ACK enhancement Huawei, HiSilicon
5. R1-2003658 Remaining issues on HARQ operation for NR-U MediaTek Inc.
6. R1-2003730 Enhancements to HARQ for NR-unlicensed Intel Corporation
7. R1-2003823 Text proposals for HARQ enhancement for NR-U Lenovo, Motorola Mobility
8. R1-2003845 HARQ enhancement Ericsson
9. R1-2003862 HARQ enhancement for NR-U Samsung
10. R1-2004015 Remaining issues of HARQ procedure for NR-U LG Electronics
11. R1-2004087 Discussion on the remaining issues of HARQ enhancements OPPO
12. R1-2004257 Remaining issues on NR-U HARQ scheduling and feedback Nokia, Nokia Shanghai Bell
13. R1-2004325 Remaining issues and corrections on HARQ enhancement for NR-U Sharp
14. R1-2004445 TP for Enhancements to Scheduling and HARQ Operation for NR-U Qualcomm Incorporated
15. R1-2004529 Text proposal for enhanced dynamic HARQ procedures Google Inc.