**3GPP TSG RAN WG1 Meeting #100bis                     R1-200xxxx**

**e-Meeting, April 20th – 30th, 2020**

**Agenda Item: 7.2.2.2.3**

**Source: Moderator (Huawei)**

**Title: Feature lead summary#1 on email discussion 100b-e-NR-unlic-NRU-HARQ-02 (Type-2 HARQ-ACK codebook)**

**Document for: Discussion and Decision**

# Introduction

This document provides updated proposals on issues A7, A8, A9 that are prioritized for RAN1#100b-e among the issues identified for the **NR-U Type-2 HARQ-ACK codebook** during the preparation phase.

[100b-e-NR-unlic-NRU-HARQ-02] Email discussion/approval on following issues related to Type-2 enhanced HARQ-ACK codebook by 4/24; if necessary, followed by endorsing the corresponding TPs by 4/30 – David (Huawei)

* A9: How to determine NFI, number of requested groups and PUCCH occasions i(g) and i((g+1) mod 2) when multiple DCIs provide these values
* A7: How is T-DAI interpreted in DCI 1\_1 for the non-scheduled group when two sub-codebooks (for TB and CBG) are configured
* A8: Second HARQ-ACK information generation in case of toggled NFI for the non-scheduled group in a DCI scheduling PDSCH for another group

Each sub-section per issue (and sub-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.

# Discussion

## Issue A7

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| A7 | TS38.213 clause 9.1.3.3: How is T-DAI interpreted in DCI 1\_1 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 $h^{\left(g+1\right)mod2}\left(g\right)=∅$ or $h^{\left(g+1\right)mod2}\left(g\right)=h(\left(g+1\right)mod2)$, generate second HARQ-ACK information for PUCCH transmission occasion $i(\left(g+1\right)mod2)$ in a slot, as described in Clause 9.1.3.1, where[…]- if $V\_{DAI}^{\left(g+1\right)mod2}\ne ∅$, after the completion of the $c$ and $m$ loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, set $V\_{temp2}=V\_{DAI}^{\left(g+1\right)mod2}$ for both sub-codebooks, if any. |

FL proposal:

* Clarify that codebook generation procedures in 38.213 clause 9.1.3.3 are applied separately for the first sub-codebook and the second sub-codebook
* Handling of T-DAI for the non-scheduled group
	+ Alt1: Clarify that a UE is not expected to generate HARQ-ACK information if T-DAI for the non-scheduled group in DCI 1\_1 is smaller than T-DAI received for any of the two sub-codebooks (TB, CBG) in earlier DCIs scheduling the same group if NFI was not toggled for the group.
	+ Alt2: Introduce 2 additional bits for T-DAI field in DCI format 1\_1 when *NFI-TotalDAI-Included-r16 is configured* and PDSCH-CodeBlockGroupTransmission is configured for at least one serving cell, i.e. T-DAI is provided for the non-scheduled group for both sub-codebooks
	+ Alt3: UE is not expected to be configured with *NFI-TotalDAI-Included-r16* when PDSCH-CodeBlockGroupTransmission is configured for at least one serving cell

Please complete/revise/add your company’s view on the proposal in the table below.

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| **Company** | **Comments on FL proposal** |
| MediaTek | Either Alt2 or Alt3 is acceptable |
| Nokia, NSB | Alt.2, is simple and error- free solution. If CBG is configured to a UE for at least one cell, then overhead in UL and also in DL is not an issue.  |
| ZTE | Alt.1 is preferred |
| Sharp | Alt2.Full flexibility is supported by Alt2 at the cost of modifying both 38.212 and 38.213. DCI overhead and HARQ-ACK volume can be controlled by configurations of non-scheduled group T-DAI and CBG. |
| Samsung | Alt 1 is preferred. Though apparently a gNB would not indicate a smaller T-DAI which leads to dropping some HARQ-ACK bits, it’s fine to clarify the behavior. The DCI overhead for Alt 2 is undesirable, because additional 2-bits is added in every DCI no matter another PDSCH group only schedules a single sub-codebook or two sub-codebooks for a PUCCH. Alt 3 sacrifices robustness when CBG is configured for at least one serving cell.  |
| LG | Alt 2 is preferred for the robustness/reliability and to avoid DL scheduling restriction.Alternatively, if we have to consider only one T-DAI for the non-scheduled group, the T-DAI corresponds to TB-based PDSCH or scheduled PDSCH type (according to the combination of scheduled PDSCH types). |
| vivo | Either Alt.2 or Alt.3 is ok, Alt.2 is slightly preferred. |
| OPPO | Support Alt-2 |

Summary of proposals in submitted Tdocs

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| **Company** | **Summary of proposals** |
| Huawei (R1-2001536) | No correction is needed for issue A7, gNB indicates the larger of T-DAI for these two sub-codebooks and UE appends NACK(s) to the smaller one, as supported by specification TS 38.213 V16.1.0 clause 9.1.3.3. |
| Vivo (R1-2001654) | It should be determined how to indicate and apply $V\_{DAI}^{\left(g+1\right)mod2}$ when the second HARQ-ACK codebook contains two sub-codebooksA way to avoid this limitation is 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, two separate total DAI fields for PDSCH group $\left(g+1\right)mod2$ will be indicated in a non-fallback DCI format, one for the TB-based sub-codebook and the other for the CBG-based sub-codebook, when applicable.Another alternative way is that when two sub-codebooks may be applied, the RRC parameter *NFI-TotalDAI-Included-r16* is always not configured to avoid above scheduling limitation or indication overhead. |
| OPPO(R1-2001761) | Proposal 7: 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 (R1-2001937) | 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

A similar proposal is made for UL-DAI. |
| 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(R1-2002227) | For enhanced TYPE2 CB, separate T-DAIs for TB and CBG sub-codebooks of the non-scheduled group can be configured for DCI 1\_1**TP for TS38.212:**7.3.1.2.2 Format 1\_1<unchanged text omitted >- Downlink assignment index – number of bits as defined in the following-10 bits if more than one serving cell are configured in the DL, the higher layer parameter *NFI-TotalDAI-Included-r16 = enable,* and HARQ-ACK codebook contains two HARQ-ACK sub-codebooks. The 6 MSB bits are the counter DAI, the total DAI for the first HARQ-ACK sub-codebook, and the total DAI for the second HARQ-ACK sub-codebook of the scheduled PDSCH group, and the 4 LSB bits are the total DAI for the first HARQ-ACK sub-codebook and the second HARQ-ACK sub-codebook of the non-scheduled PDSCH group.* 6 bits if more than one serving cell are configured in the DL and the higher layer parameter *NFI-TotalDAI-Included-r16 = enable*. The 4 MSB bits are the counter DAI and the total DAI for the scheduled PDSCH group, and the 2 LSB bits are the total DAI for the non-scheduled PDSCH group.

<unchanged text omitted > |
| Qualcomm(R1-2002532) | The procedures described in Section 9.1.1.3 should be done separately for the two sub-codebooks, similar to the description of CBG-based sub-codebook of Rel. 15 in Section 9.1.3.1: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. |
| Samsung | UE operation is very clear in the specification, and the system works properly (no error leads to a broken system) according to the current spec. So, we think no need of discussion for this issue becuase it is not a critical correction |
| ZTE | It is an optimization rather than critical issue |

## Issue A8

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| A8 | Second HARQ-ACK information generation in case of toggled NFI for the non-scheduled group in a DCI scheduling PDSCH for another group |

Issues A8 addresses the following text in TS38.213 section 9.1.3.3:

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| If $h^{\left(g+1\right)mod2}\left(g\right)\ne ∅$ and $h^{\left(g+1\right)mod2}\left(g\right)\ne h(\left(g+1\right)mod2)$, generate second HARQ-ACK information, as described in Clause 9.1.3.1, by setting $V\_{C-DAI,c,m}^{DL}=0$ for all $c$ and all $m$ and, after the completion of the $c$ and $m$ loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, setting $V\_{temp2}=V\_{DAI}^{\left(g+1\right)mod2}$. |

Proposal:

* TP for TS 38.213 Clause 9.1.3.3
	+ Reason for change: for second HARQ-ACK information generation in case of toggled NFI for the non-scheduled group in a DCI scheduling PDSCH for another group, it is unclear which PDCCH monitoring occasion corresponds to m=0, which could result in HARQ-ACK codebook size mismatch between gNB and UE.

**TP for TS 38.213 Clause 9.1.3.3**

============= Unchanged part omitted =============

If $h^{\left(g+1\right)mod2}\left(g\right)\ne ∅$ and $h^{\left(g+1\right)mod2}\left(g\right)\ne h(\left(g+1\right)mod2)$, generate second HARQ-ACK information, as described in Clause 9.1.3.1, by setting $V\_{C-DAI,c,m}^{DL}=0$ ~~for all~~ $c$ ~~and all~~ $m$ $M=0$ and, after the completion of the $c$ and $m$ loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, setting $V\_{temp2}=V\_{DAI}^{\left(g+1\right)mod2}$.

============= Unchanged part omitted =============

Please complete/revise/add your company’s view on the proposal in the table below.

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| **Company** | **Comments on FL proposal** |
| MediaTek | Agree with the proposed TP |
| Nokia, NSB | Setting M=0 is OK, but should C-DAI still be reset as well if NFI is toggled? |
| ZTE | Agree with the FL proposal |
| Sharp | Agree with FL’s proposal.$h^{\left(g+1\right)mod2}\left(g\right)\ne ∅$ and $h^{\left(g+1\right)mod2}\left(g\right)\ne h(\left(g+1\right)mod2)$ is the condition for handling error cases that the gNB transmits PDCCH(s) for the other group but UE fails to detect the PDCCH(s). Thus, it is necessary to assume an empty PDCCH monitoring occasion set. Otherwise, redundant HARQ-ACK bits would be generated according to current pseudocode. |
| Samsung  | Agree with the FL’s proposal |
| LG | Seems to be OK. |
| vivo | Agree with the FL’s proposal |
| OPPO | Support the TP |

Summary of proposals in submitted Tdocs

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| --- | --- |
| **Company** | **Summary of proposals** |
| Huawei(R1-2001536) | TP#1 for TS 38.213 Clause 9.1.3.3============= Unchanged part omitted =============If $h^{\left(g+1\right)mod2}\left(g\right)\ne ∅$ and $h^{\left(g+1\right)mod2}\left(g\right)\ne h(\left(g+1\right)mod2)$, generate second HARQ-ACK information, as described in Clause 9.1.3.1, by setting $V\_{C-DAI,c,m}^{DL}=0$ ~~for all~~ $c$ ~~and all~~ $m$ $M=0$ and, after the completion of the $c$ and $m$ loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, setting $V\_{temp2}=V\_{DAI}^{\left(g+1\right)mod2}$.============= Unchanged part omitted ============= |
| Vivo (R1-2001654) | The corresponding operation when a DCI format scheduling PDSCH group g indicates an NFI value for PDSCH group (g+1)mod2 other than an NFI value indicated by a latest DCI format scheduling PDSCH group (g+1)mod2 for exactly the scheduled group should be clarified. |
| Nokia(R1-2002227) | 9.1.3.3 Type-2 HARQ-ACK codebook grouping and HARQ-ACK retransmission<unchanged text omitted >If $h^{\left(g+1\right)mod2}\left(g\right)\ne ∅$ and $h^{\left(g+1\right)mod2}\left(g\right)\ne h(\left(g+1\right)mod2)$, generate second HARQ-ACK information, as described in Clause 9.1.3.1, by setting the set of PDCCH monitoring occasions m empty and $V\_{C-DAI,c,m}^{DL}=0$ for all $c$ ~~and all~~ $m$ and, after the completion of the $c$ and $m$ loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, setting $V\_{temp2}=V\_{DAI}^{\left(g+1\right)mod2}$.<unchanged text omitted > |
| Sharp(R1-2002384) | The proposal in R1-2002384 is to make an additional assumption that the set of PDCCH monitoring occasions is empty (i.e., M = 0):-------- Unchanged contents are omittedIf $h^{\left(g+1\right)mod2}\left(g\right)\ne ∅$ and $h^{\left(g+1\right)mod2}\left(g\right)\ne h(\left(g+1\right)mod2)$, generate second HARQ-ACK information, as described in Clause 9.1.3.1, by assuming an empty set of PDCCH monitoring occasions for all $c$ and all $m$ and, after the completion of the $c$ and $m$ loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, setting $V\_{temp2}=V\_{DAI}^{\left(g+1\right)mod2}$.-------- Unchanged contents are omitted |

## Issue A9

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| A9 | TS38.213 clause 9.1.3.3: how to determine NFI, number of requested groups, PUCCH occasions i(g) and i((g+1)mod2) when multiple DCIs provide these values. Example 1: two DCIs pointing to the same PUCCH for different groups (without using requesting feedback for both PDSCH groups in the same DCI)Example 2: the first DCI of a PDSCH group is DCI format 1\_0 without NFI field, for which the associated NFI value is temporarily not available until the next DCI format 1\_1 of the same PDSCH group is received.Example 3: UE does not expect to receive a DL grant which schedules a PDSCH of the same PDSCH group and indicates a PUCCH resource in a slot later than a pending PUCCH transmission of the same PDSCH groupExample 4: different pseudocode for generating “first HARQ-Ack information” and “second HARQ-Ack information” if some DCIs are missing.Example 5: ordering of NFI bits for scheduled group and non-scheduled group is not specifiedExample 6: which DCI determines group g? (e.g. does a DCI format 1\_0 define the scheduled group g if it is received as the last DCI for a PUCCH transmission occasion and if other earlier DCIs scheduled PDSCH group 0 and group 1 for the same PUCCH transmission occasion?)Example 7: how to interpret NFI for the non-scheduled group in a DL DCI if q=0 for the number of requested PDSCH group(s)? |

FL proposal: companies provide views on the following questions related to the examples in issue A9 (there is no one-to-one mapping between the examples and the questions).

Q1: can we clarify that the 1 MSB bit is the NFI for the scheduled PDSCH group, and the 1 LSB bit is the NFI for the non-scheduled PDSCH group?

Q2: should it be expected to receive DCIs with q=0 pointing to the same PUCCH transmission occasion for different PDSCH groups?

Q3: should it be expected to receive a DCI with q=0 after receiving a DCI with q=1 pointing to the same PUCCH transmission occasion?

Q4: should it be expected to receive DCIs on different cells in the same monitoring occasion if the DCI formats indicate different values of *q* or different values of *h*(*g*)?

Q5: do we need to clarify that if the DCI format scheduling PDSCH reception does not include a *New\_Feedback indicator* field, set *h*(*g*) to the value provided by another DCI format, if any, providing the same value of *g* and providing a value of *k* indicating the same slot?

Q6: do we need to clarify that if the DCI format scheduling PDSCH reception does not include a Number of requested PDSCH group(s), set *q* to the value provided by another DCI format, if any, providing the same value of *g* and providing a value of *k* indicating the same slot?

Q7: does a DCI format 1\_0 define the scheduled group g if it is received as the last DCI for a PUCCH transmission occasion and if other earlier DCIs scheduled PDSCH group 0 and group 1 for the same PUCCH transmission occasion?

Q8: can we clarify that a UE does not expect to receive a DL grant which schedules a PDSCH of the same PDSCH group and indicates a PUCCH resource in a slot later than a pending PUCCH transmission of the same PDSCH group?

Q9: can we clarify that a UE should ignore the NFI and DAI fields for the non-scheduled group in a DL DCI if *q*=0 for the number of requested PDSCH group(s) in that DCI?

Q10: can we clarify that a slot of PUCCH occasion i(($g$+1)mod2) is determined by a value of k(($g$ +1)mod2) from at least one DCI format scheduling the non-scheduled group?

Q11: can we clarify that the NFI and DAI values for the non-scheduled group are determined from the last DCI format providing the value of $g$ and indicating PUCCH occasion i($g$)?

Please complete/revise/add your company’s view on the proposal in the table below.

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| **Company** | **Comments** |
| MediaTek | Q1: Okay to clarify in TS38.212Q2: UE can expect this case. It is not excluded by current spec and RAN1 agreements. When this case happens, it is covered by the following agreement.**Agreement in RAN1#99:**For enhanced dynamic HARQ-ACK codebook, when more than one PDSCH group exists in a HARQ-ACK feedback report, the placement of HARQ-ACK feedback for the two groups is ordered based on increasing group index.Q3: UE can expect this case. Similar to the PUCCH resource determination from the last DCI, the number of requested groups could be also determined based on the same rule on the last DCI providing values of q and g, which provides flexibility when gNB decides to separate the HARQ-ACK feedbacks for the two groups into two PUCCH occasions (more reliable to avoid codebook size misalignment).Q4-1 (should it be expected to receive DCIs on different cells in the same monitoring occasion if the DCI formats indicate different values of *q*): Yes, it is similar to the PUCCH resource determination.Q4-2 (should it be expected to receive DCIs on different cells in the same monitoring occasion if the DCI formats indicate different values of *h*(*g*)): No. As we know, gNB toggles *h*(*g*) when it successfully receives the HARQ-ACK feedback for group *g*. We don't see why gNB has to toggle *h*(*g*) on different cells in the same occasion. Q5: It would be clear to have this clarification. However, it is also possible to set *h*(*g*) to the value provided by another DCI format, if any, providing a value of $\left(g+1\right)mod2$ and providing a value of *k(*$\left(g+1\right)mod2$*)* indicating the same slot, if the higher layer parameter *NFI-TotalDAI-Included-r16* is configured.Q6: If the value of *q* is determined based on the last DCI (as we mentioned in Q3), this clarification is not needed. Q7: We don't quite understand for this question. What is the issue if we allow it in spec?Q8: Yes, this case should be excluded in spec, which makes no sense.Q9: Okay to clarify it. However, if Q2 is expected, we should say that UE should ignore the NFI and DAI fields for the non-scheduled group in a DL DCI when only the scheduled group is multiplexed in a PUCCH occasion.**We add two more questions according to the proposals including in A9:**Q10: Yes. For PUCCH occasion i(g), how to determine the corresponding slot is already clarified in current spec. For PUCCH occasion i((g+1)mod2), the determination should be aligned. Q11: Yes. |
| Nokia, NSB | Q1: YesQ2: NoQ3: NoQ4: NoQ5: YesQ6: YesQ7: No, because DCI format 1\_0 has no q. We think that q,h,g should be obtained from the same last DCI format 1\_1 in association set. On the other hand, if 1\_0 happens to be the last DCI format in association set, then PRI comes from there.Q8: This would be out of order HARQ, so yes we can excludeQ9: Yes |
| ZTE | Yes to Q1/Q5/Q6/Q7/Q8No to Q2/Q3/Q4For Q9 we think it can be left to UE implementation, as in some cases it is beneficial to read the NFI and DAI fields, for example if the previous one is miss-detected. |
| Sharp | Q1: supportive.Q2: Yes if $g$ can be given deterministically. A potential problem of such scheduling is that generating the HARQ-ACK information for which PDSCH group is unclear. This problem could be solved by firstly determining $g$ by the last DCI.Q3: find no reason to expect such case.Q4: find no reason to expect such case.Q5: supportive.Q6: supportive.Q7: By allowing DCI 1\_0 as the last DCI, a potential problem is, for scheduling like DCI 1\_1 with g=1 and DCI 1\_0 (no DCI 1\_1 with g=0) where $g=0$ is determined by DCI 1\_0, how to determine $h\left(g\right)$.Q8: fine.Q9: supportive.In addition, we suggest that the first problem to be addressed is how to determine $g$ because determination of several parameters depends on $g$. The value of $g$ should be given in a deterministic manner, rather than by an arbitrary/up-to-UE-implementation manner in current spec. Suggest specifying the order of parameter determination in TS38.213 9.1.3.31. Clarify how to determine $g$ and $q$
2. Clarify how to determine $h\left(g\right), h^{\left(g+1\right)mod2}\left(g\right), V\_{DAI}^{\left(g+1\right)mod2}$
 |
| Samsung | Q1: YesQ2/Q3/Q4: Prefer no. These cases seem unreasonable. But if it happens, UE just follows the indication of last DCI. Q5/Q6: Yes. Then, even if the last DCI is a fallback DCI, we can still simply specify UE follows q and NFI value of last received DCI. Q7: Yes, if ‘other earlier DCIs’ includes an NFI corresponding to group #0. Q8: Yes. Q9: Seems no need to forbid UE to read NFI for another PDSCH group when q=0Q2 ~ Q7 are all relevant to ‘last DCI’. It is beneficial to clarify the ordering of DCIs first to determine last DCI, e.g. first in ascending order of serving cell index and then in an ascending order of PDCCH monitoring occasion index. |
| LG | Q1: YesQ2: NoQ3: NoQ4: NoQ5: YesQ6: Yes, with the following correction: “by another DCI format, if any, ~~providing the same value of~~ *~~g~~* ~~and~~ providing a value of *k* indicating the same slot”Q7: No, since q and h are to be obtained from the non-fallback DCI format 1\_1, and the values of q and h from multiple DCI format 1\_1 should be the same for a same PUCCH occasion. BTW, as commented earlier by Nokia, PRI is to be obtained from the last DCI as in legacy Rel-15.Q8: No, due to the OOO constraint.Q9: Yes |
| vivo | Q1: YesQ2: Yes. Agree with MTK’s view for Q2Q3: NOQ4: NOQ5: YESQ6: YESQ7: YES. The h(g) and q can be derived by respective rules in Q5 and Q6Q8: YESQ9: YESQ10: YESQ11: This DCI may be the last non-fallback DCI for group g. |
| OPPO | Q1: OKQ2: NoQ3: it should not be expected to receive a non-FB DCI with q=0 after receiving a DCI with q=1 pointing to the same PUCCH transmission occasion. Q4: if the non-FB DCIs on different cells in the same monitoring occasion indicate a same slot for PUCCH transmission, the value of q and h(g) should be the same. Q5: in RAN1#99 agreement, there is no restriction on the same PUCCH occasion. This would need a new agreement. Agreement:If enhanced dynamic codebook is configured, for a PDSCH scheduled by DL DCI 1\_0:* NFI for group #0 is not signalled in DCI 1\_0
* If the UE detects a DCI that indicates an NFI corresponding to group #0 since the last scheduled PUCCH that includes feedback for group #0 and before the PUCCH occasion that includes feedback corresponding to PDSCH scheduled with the DCI 1\_0
	+ UE follows the indicated NFI (in DCI 1\_1) to determine the codebook.
* If the UE does not detect a DCI that indicates an NFI corresponding to group #0 since the last scheduled PUCCH that includes feedback for group #0 and before the PUCCH occasion that includes feedback corresponding to PDSCH scheduled with the DCI 1\_0
	+ UE assumes that the PDSCHs scheduled by DCI 1\_0 since the latest PUCCH occasion do not belong to any group, and the UE only reports HARQ-ACK feedback for the PDSCHs scheduled by DCI 1\_0 since the latest PUCCH occasion (as in Rel-15)
	+ If the C-DAI received in the first DCI format 1\_0 received after the latest PUCCH occasion is not equal to 1, and if the UE didn’t detect a DCI format 1\_1 since the latest PUCCH occasion, the UE assumes that missed DCIs are DCI formats 1\_0

Q6: if the DCI 1\_0 is the last DCI, the q should be set to the same value q of the latest DCI 1\_1, which is received after the last scheduled PUCCH including feedback of group #0.Q7: no, this case should not be expected from UE side. Q8: yes, it is reasonable.Q9: yes, the fields should be reserved. |

Summary of proposals from submitted Tdocs

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| **Company** | **Summary of proposals** |
| Huawei(R1-2001536) | Proposed additions/revisions to clause 9.1.3.3:A UE is not expected to generate HARQ-ACK information if the UE received a DCI format indicating *Number of requested PDSCH group(s) =* 0 after receiving another DCI format indicating *Number of requested PDSCH group(s) =* 1 where the two DCIs correspond to the same PUCCH transmission occasion.A UE is not expected to generate HARQ-ACK information if the UE received two DCI formats indicating *Number of requested PDSCH group(s) =* 0 where the two DCI formats correspond to the same PUCCH transmission occasion and the two DCI formats indicated different values for the *PDSCH group index* field.A UE is not expected to generate HARQ-ACK information if the UE received DCI formats on different cells in the same monitoring occasion if the DCI formats indicate different values of *q* or different values of *h(g)*.Set $h(g)$ to the value of a first New\_Feedback indicator field, if any, in a DCI format providing a value of $g$. If the DCI format schedules PDSCH reception and does not include a New\_Feedback indicator field, set $h\left(g\right)$ to the value of the (first) New\_Feedback indicator field in a following DCI format providing a same value of $g$, if any, and providing a value of $k$ indicating the same slot. |
| Vivo(R1-2001654) | It should be captured in TS38.213 that in any case when the first HARQ-ACK information and the second HARQ-ACK information are multiplexed in a same PUCCH transmission occasion, they should be placed in an ascending order of group index.TP: For any case that HARQ-ACK information for both PDSCH groups is multiplexed in a PUCCH transmission or PUSCH transmission, HARQ-ACK information for $g=1$ is appended to that for $g=0$. |
| ZTE(R1-2001707) | Proposal 1: for the NFI indication with 2bits, 1 MSB bit is for the scheduled PDSCH group, and the 1 LSB bit is for the non-scheduled PDSCH group Adopt TP#1 and TP#2 for the corresponding change in 38.212 and 38.213 respectively< Start of text proposal for 38.212 [1]>================== Beginning of text proposal 1 ===================7.3.1.2.2 Format 1\_1DCI format 1\_1 is used for the scheduling of PDSCH in one cell. \*\*\* Unchanged text omitted \*\*\*- New feedback indicator – 0, 1 or 2 bits. - 1 bit if the higher layer parameter *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16* and the higher layer parameter *NFI-TotalDAI-Included-r16* is not configured;- 2 bits if the higher layer parameter *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16* and the higher layer parameter *NFI-TotalDAI-Included-r16 = enable*; and the 1 MSB bit is the NFI for the scheduled PDSCH group, and the 1 LSB bit is the NFI for the non-scheduled PDSCH group;- 0 bit otherwise. < End of text proposal 1>< Start of text proposal for 38.213 [2]>================== Beginning of text proposal 2 ===================9.1.3.3 Type-2 HARQ-ACK codebook grouping and HARQ-ACK retransmission\*\*\* Unchanged text omitted \*\*\*Set $h(g)$ to the value of a first New\_Feedback indicator field for group $g$, if any, in a DCI format providing a value of $g$Set $h^{\left(g+1\right)mod2}(g)$ to a value of a second New\_Feedback indicator field for group $\left(g+1\right)mod2$, if any, in a DCI format providing a value of $g$< End of text proposal 2> |
| Intel (R1-2001989) | Proposal 1: Revise the specification to clarify the operations of two cases of DCI format 1\_0. * Case 1: the first DCI of a PDSCH group is DCI format 1\_0 without NFI field, for which the associated NFI value is temporarily not available until the next DCI format 1\_1 of the same PDSCH group is received.
* Case 2: the last DCI of a PDSCH group is DCI format 1\_0 without NFI field, for which the associated NFI value is derived by a previous DCI format 1\_1 of the same PDSCH group.

Proposal 2: A UE does not expect to receive a DL grant which schedules a PDSCH of the same PDSCH group and indicates a PUCCH resource in a slot later than a pending PUCCH transmission of the same PDSCH group. Proposal 3: If NFI/T-DAI is configured to be present in a DCI for both two PDSCH groups, and if q=0 for the number of requested PDSCH group(s) field, the NFI/T-DAI field for the non-scheduled group is ignored.9.1.3.3 Type-2 HARQ-ACK codebook grouping and HARQ-ACK retransmissionIf a UE is provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE determines HARQ-ACK information for multiplexing in a PUCCH transmission occasion according to the following procedure. Set $g$ to the value of a PDSCH group index field in a DCI format. If the DCI format schedules PDSCH reception and does not include a PDSCH group index field, set $g=0$.Set $i(g)$ to denote a PUCCH transmission occasion for multiplexing HARQ-ACK information Set $k$ to the value of a PDSCH-to-HARQ\_feedback timing field, if any, in a DCI format providing a value of $g$. If the DCI format does not include a PDSCH-to-HARQ\_feedback timing field, set $k$ to the value provided by *dl-DataToUL-ACK*Set $h(g)$ to the value of a first New\_Feedback indicator field, if any, in a DCI format providing a value of $g$ and indicating a slot for HARQ-ACK transmission. If the DCI format schedules PDSCH reception and does not include the first New\_Feedback indicator field, set $h(g)$ to the value of $h(g)$ provided by another DCI format, if any, providing the same value of $g$ and indicating the same slot for HARQ-ACK transmissionSet $h^{\left(g+1\right)mod2}(g)$ to a value of a second New\_Feedback indicator field, if any, in a DCI format providing a value of $g$Set $V\_{DAI}^{\left(g+1\right)mod2}$ to the value of a total DAI field for group $\left(g+1\right)mod2$, if any, in a DCI format providing a value of $g$Set $q$ to the value of a number of requested PDSCH group(s) field, if anyGenerate first HARQ-ACK information for PUCCH transmission occasion $i(g)$ in a slot, as described in Clause 9.1.3.1, where- the first HARQ-ACK information corresponds only to detections of DCI formats each providing a same value of $g$, of $h(g)$, if any, and at least one of the DCI formats providing a value of $k$ indicating the slot- at least one of the DCI formats provides a $h(g)$ value- $m=0$ corresponds to a PDCCH monitoring occasion, where the UE detects a DCI format that provides a value of $g$, that is the first PDCCH monitoring occasion after a PDCCH monitoring occasion where the UE detects another DCI format that provides the same value of $g$ and a different $h(g)$ valueIf $h^{\left(g+1\right)mod2}\left(g\right)=∅$ or $h^{\left(g+1\right)mod2}\left(g\right)=h(\left(g+1\right)mod2)$, generate second HARQ-ACK information for PUCCH transmission occasion $i(\left(g+1\right)mod2)$ 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 $\left(g+1\right)mod2$, of $h(\left(g+1\right)mod2)$, if any- at least one of the DCI formats provides a $h(\left(g+1\right)mod2)$ value- $m=0$ corresponds to a PDCCH monitoring occasion, where the UE detects a DCI format that provides a value of $\left(g+1\right)mod2$, that is the first PDCCH monitoring occasion after a PDCCH monitoring occasion where the UE detects another DCI format that provides the same value of $g$ and a different $h(\left(g+1\right)mod2)$ value- the PUCCH transmission occasion $i(\left(g+1\right)mod2)$ is a last one for multiplexing second HARQ-ACK information. The UE does not expect that $i(\left(g+1\right)mod2)$ is later than PUCCH transmission occasion $i(g)$- if $V\_{DAI}^{\left(g+1\right)mod2}\ne ∅$, after the completion of the $c$ and $m$ loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, set $V\_{temp2}=V\_{DAI}^{\left(g+1\right)mod2}$ for both sub-codebooks, if any. |
| Mediatek (R1-2001904) | Clarify how to determine a slot of PUCCH occasion *i*((*g*+1)*mod2*)==========**Text Proposal 1 Starts**===========9.1.3.3 Type-2 HARQ-ACK codebook grouping and HARQ-ACK retransmission\*\*\* Unchanged text is omitted \*\*\*Set $k(g)$ to the value of a PDSCH-to-HARQ\_feedback timing field, if any, in a DCI format providing a value of $g$. If the DCI format does not include a PDSCH-to-HARQ\_feedback timing field, set $k(g)$ to the value provided by *dl-DataToUL-ACK*\*\*\* Unchanged text is omitted \*\*\*Generate first HARQ-ACK information for PUCCH transmission occasion $i(g)$ in a slot, as described in Clause 9.1.3.1, where- the first HARQ-ACK information corresponds only to detections of DCI formats each providing a same value of $g$, of $h(g)$, if any, and at least one of the DCI formats providing a value of $k(g)$ indicating the slot- at least one of the DCI formats provides a $h(g)$ value- $m=0$ corresponds to a PDCCH monitoring occasion, where the UE detects a DCI format that provides a value of $g$, 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 $h(g)$If $h^{\left(g+1\right)mod2}\left(g\right)=∅$ or $h^{\left(g+1\right)mod2}\left(g\right)=h(\left(g+1\right)mod2)$, generate second HARQ-ACK information for PUCCH transmission occasion $i(\left(g+1\right)mod2)$ 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 $\left(g+1\right)mod2$, of $h(\left(g+1\right)mod2)$, if any, and at least one of the DCI formats providing a value of $k(\left(g+1\right)mod2)$ indicating the slot- at least one of the DCI formats provides a $h(\left(g+1\right)mod2)$ value- $m=0$ corresponds to a PDCCH monitoring occasion, where the UE detects a DCI format that provides a value of $\left(g+1\right)mod2$, 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 $h(\left(g+1\right)mod2)$- the PUCCH transmission occasion $i(\left(g+1\right)mod2)$ is a last one for multiplexing second HARQ-ACK information and it is not after PUCCH transmission occasion $i(g)$- if $V\_{DAI}^{\left(g+1\right)mod2}\ne ∅$, after the completion of the $c$ and $m$ loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, set $V\_{temp2}=V\_{DAI}^{\left(g+1\right)mod2}$ for both sub-codebooks, if any.\*\*\* Unchanged text is omitted \*\*\*=============== **Text Proposal 1 Ends**============== |
| Nokia(R1-2002227) | For enhanced TYPE2 CB, the q is set to the value of a number of requested PDSCH group of the last DL assignment for which HARQ-ACK is to be reported in a PUCCH.9.1.3.3 Type-2 HARQ-ACK codebook grouping and HARQ-ACK retransmission<unchanged text omitted >Set $q$ to the value of a number of requested PDSCH group(s) field~~, if any~~ in the last DCI format indicating PUCCH transmission occasion $i(g)$ and providing a value of $q$ where the DCI formats are first indexed in an ascending order across serving cells indexes for a same start time of search space sets associated with DCI formats and are then indexed in an ascending order of start times of the search space sets. <unchanged text omitted > |
| Sharp(R1-2002384) | --------- beginning of text proposal for TS 38.2139.1.3.3 Type-2 HARQ-ACK codebook grouping and HARQ-ACK retransmissionSet $q$ to the value of a Number of requested PDSCH group(s) field in a DCI format determining the PUCCH resource for $i(g)$, if any. If $q=0$, set $g$ to the value of a PDSCH group index field in the DCI format determining the PUCCH resource for $i(g)$.--------- end of text proposal |
| Qualcomm(R1-2002532) | Issue 1: The procedures in Section 9.1.3.3 in 38.213 work fine if there are no two DCIs pointing to the same slot for HARQ-Ack transmission scheduling different PDSCH groups. For PUCCH transmission occasion i(g), it is not clear if g=0 or g=1 should be considered in the pseudocode. pseudocode as the steps for generating “first HARQ-Ack information” is different than the steps for generating “second HARQ-Ack information” if some DCIs are missing.Issue 2: The current procedures do not specify how the values of h(g), h^(g+1)mod2 (g), and q are determined as multiple DCIs provide these values============TP for 38.213 Section 9.1.3.3====================================If a UE is provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE determines HARQ-ACK information for multiplexing in a PUCCH transmission occasion according to the following procedure. Consider a set of DCI formats that schedule PDSCH reception, that the UE detects, and that indicate a same slot for PUCCH transmission, and for which the UE transmits corresponding HARQ-ACK information in the PUCCH. The detected DCI formats are first indexed in an ascending order across serving cells indexes for a same PDCCH monitoring occasion and are then indexed in an ascending order across PDCCH monitoring occasion indexes.Set $g$ to the value of a PDSCH group index field in a last DCI format that includes the field in the set of DCI formats.Set $i(g)$ to denote a PUCCH transmission occasion for multiplexing HARQ-ACK information Set $k$ to the value of a PDSCH-to-HARQ\_feedback timing field, if any, in a DCI format providing a value of $g$. If the DCI format does not include a PDSCH-to-HARQ\_feedback timing field, set $k$ to the value provided by *dl-DataToUL-ACK*Set $h(g)$ to the value of a first New\_Feedback indicator field in the last DCI format providing the value of $g$Set $h^{\left(g+1\right)mod2}(g)$ to a value of a second New\_Feedback indicator field, if any, in the last DCI format providing the value of $g$Set $V\_{DAI}^{\left(g+1\right)mod2}$ to the value of a total DAI field for group $\left(g+1\right)mod2$, if any, in the last DCI format providing the value of $g$. If $g=1$ and a last DCI format in the set of DCI formats does not include a PDSCH group index field, set $\_{}^{\left(\right)}$Set $q$ to the value of a Number of requested PDSCH group(s) field in the last DCI format providing the value of $g$Generate first HARQ-ACK information for PUCCH transmission occasion $i(g)$ in a slot, as described in Clause 9.1.3.1, where--Unchanged part 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 $g=0$ includes a New\_Feedback indicator field for $g=0$, 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, as described in Clause 9.1.3.1 or 9.1.3.2 for multiplexing in the PUCCH transmission occasion. Otherwise, UE assumes PDSCH group index 0 for a DCI format that does not include a PDSCH group index field.--Unchanged part omitted------------------------ |
| Ericsson(R1-2002690) | Add a clarification in 9.1.1.3 to ensure that the UE is not expected to multiplex feedback for more than one group if q = 0:“If $h^{\left(g+1\right)mod2}\left(g\right)=∅$ or $h^{\left(g+1\right)mod2}\left(g\right)=h(\left(g+1\right)mod2)$, and $q = 1$, generate second HARQ-ACK information for PUCCH transmission occasion $i(\left(g+1\right)mod2)$ in a slot, as described in Clause 9.1.3.1, where”Issues: the description of the reference PDCCH monitoring occasion $m$, which impact the codebook size determination does not take in consideration that the DCI does not explicitly provide an $h(g)$ value. The pseudo code does not assume the case where the DCI does not explicitly provide a q value.Set $h(g)$ to the value of a first New\_Feedback indicator field, if any, in a DCI format providing a value of $g$. If the DCI format schedules PDSCH reception and does not include a PDSCH\_group indicator field, and UE detects at least one DCI format including New\_Feedback indicator field for $g=0$, after a last PUCCH transmission occasion and with respective PDSCH-to-HARQ\_feedback timing field values indicating a same PUCCH transmission occasion as the DCI not including PDSCH\_group value, set $h(g)$ to the same value provided by the DCI format that includes a New\_Feedback indicator field for $g=0.$Set $q$ to the value of a Number of requested PDSCH group(s) field, if any. If the DCI format schedules PDSCH reception and does not include a PDSCH\_group indicator field, and UE detects at least one DCI format including $q$ for $g=0$, after a last PUCCH transmission occasion and with respective PDSCH-to-HARQ\_feedback timing field values indicating a same PUCCH transmission occasion as the DCI not including PDSCH\_group value, set $q$ to the same value provided by the DCI format that includes $q $for $g=0.$ |

# Conclusions

# References

1. R1-2001268 Feature lead summary#1 on NR-U phase 2 email discussion 100e-NR-unlic-NRU-HARQandULscheduling-02 (Type-3 HARQ-ACK codebook)
2. R1-2001269 Feature lead summary#1 on NR-U phase 2 email discussion 100e-NR-unlic-NRU-HARQandULscheduling-01 (enhanced Type-2 HARQ-ACK codebook)
3. R1-2001270 Feature lead summary of email discussion 100e-NR-unlic-NRU-HARQandULscheduling-03 (multi-PUSCH scheduling with DCI 0\_1)
4. R1-2002696 Feature lead summary#1 on NR-U HARQ, RAN1#100b-e
5. R1-2001536 Maintainance on HARQ-ACK enhancement Huawei, HiSilicon
6. R1-2001654 Remaining issues on HARQ operation for NR-U vivo
7. R1-2001707 Remaining issues on the HARQ for NR-U ZTE, Sanechips
8. R1-2001761 Discussion on the remaining issues of HARQ enhancements OPPO
9. R1-2001904 Remaining issues on HARQ operation for NR-U MediaTek Inc.
10. R1-2001937 Remaining issues of HARQ procedure for NR-U LG Electronics
11. R1-2001974 Remaining issues for HARQ enhancement for NR-U Lenovo, Motorola Mobility
12. R1-2001989 Enhancements to HARQ for NR-unlicensed Intel Corporation
13. R1-2002690 HARQ enhancement Ericsson
14. R1-2002119 HARQ enhancement for NR-U Samsung
15. R1-2002227 Remaining issues on NR-U HARQ scheduling and feedback Nokia, Nokia Shanghai Bell
16. R1-2002249 HARQ enhancement ETRI
17. R1-2002306 One shot HARQ ACK feedback InterDigital, Inc.
18. R1-2002384 Remaining issues and corrections on HARQ enhancement for NR-U Sharp
19. R1-2002532 TP for Enhancements to Scheduling and HARQ Operation for NR-U Qualcomm Incorporated
20. R1-2002631 Text proposal for enhanced dynamic HARQ procedures Google Inc.