**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 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. |

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 |
| QC | With the first bullet “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”, it seems that none of the alternatives are needed.  In Rel. 15, cDAI/tDAI of the DCIs scheduling TB-based vs CBG-based PDSCHs are independent. Same principle should be followed in the case of enhanced Type 2 CB. tDAI for the non-scheduled group is applied to TB-based sub-codebook if the DCI schedules TB-based PDSCH. Similarly, it is applied to CBG-based sub-codebook if the DCI schedules CBG-based PDSCH. This means that the codebook construction (including cDAI/tDAI interpretation for the non-scheduled group) is completely independent across TB-based vs CBG-based sub-codebooks, which is same principle as Rel. 15.  At this stage, we prefer to not introduce more bits to DCI. If we follow Alt2, then why not add yet another 2 bits for tDAI of the other sub-codebook for the scheduled group? |
| Lenovo, Motorola Mobility | We prefer Alt 2.  Since *NFI-TotalDAI-Included-r16* is configured in DCI when overhead is considered not an issue, additional two bits for each sub-codebook can make system work more properly.  If overhead is considered an issue, then RRC signaling can configure no NFI and TDAI in DCI. |
| Intel | We prefer Alt 2, which is the best for HARQ-ACK transmission with sacrifice of DCI overhead. |
| FL summary | Question to Qualcomm: it is not clear how the first bullet solves the problem of interpretation of the T-DAI for the non-scheduled group. In your answer, it seems that you assume an interpretation according to Alt4 below (see updated alternatives), also mentioned by LG, but do you think the current specification text can be interpreted as Alt4?  Question to LG: You also mentioned Alt4, and I have also added Alt5 based on your response. But please see below for an analysis of Alt4 and Alt5 with an example.  Only Qualcomm provided a comment on the first bullet. Please also provide your views on the first bullet that proposes to 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.  Summary of companies views:   * Alt1: ZTE, Samsung, Huawei (from Tdoc) * Alt2: Mediatek, Nokia, Sharp, LG, vivo, OPPO, Lenovo, Intel   + Concerns on Alt2: Samsung, Qualcomm * Alt3: Mediatek, vivo (2nd choice) * Alt4: Qualcomm, LG * Alt5: LG7   Alternatives (with addition of Alt4 and Alt5):   * 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   + Alt4: T-DAI for the non-scheduled group is associated to the TB or CBG type of the scheduled PDSCH   + Alt5: T-DAI for the non-scheduled group is always associated to the TB type scheduling   Concerns were expressed on Alt2 due to increasing DCI size. Implicit rules were proposed and added as Alt4 and Alt5. Feedback on these additional alternatives is requested, in addition to answers to the questions highlighted in yellow.  Observations on Alt4 and Alt5 are provided considering the following example:    For Alt4 and Alt5 where only TB type can be indicated or assumed for the non-scheduled group, in this example the HARQ-ACK bits of the PDSCHs scheduled on the CBG-based cell will not be reported in the second PUCCH. So Alt4 and Alt5 are not robust and may miss some HARQ-ACK information.  Alt1 allows carrying all necessary HARQ-ACK information although it may also carry useless NACK information but without incurring additional DCI overhead. So between Alt1 and Alt2, the question is which overhead is more critical (in PUCCH or in PDCCH?). Qualcomm also pointed out that T-DAI of the other sub-codebook is not signaled for the scheduled group, so why signal it for the non-scheduled group in case of Alt2? |
| OPPO | We still prefer Alt-2 due to it is clean and robust. |
| LG | First of all, our first preference is Alt 2 to guarantee the robustness/reliability of HARQ-ACK feedback as well as to avoid PDSCH scheduling restriction.  Regarding the newly added Alt 4, it seems necessary to clarify on our proposal as below that it is originally intended to follow similar approach as for the case with only one UL DAI in UL grant DCI.   * 1. If both or none of TB-based PDSCH and CBG-based PDSCH is scheduled for the non-scheduled group, T-DAI corresponds to TB-based PDSCH.   2. If only one PDSCH type between TB PDSCH and CBG PDSCH is scheduled for non-scheduled group, T-DAI corresponds to the scheduled PDSCH type.   Regarding the newly added Alt 5, it seems to correctly capture our proposal. |
| Intel | Yellow Q1: No. in our understanding to the current spec, the single T-DAI for non-scheduled group repeatedly applies to the two sub-codebook  Yellow Q2: Not sure how to understand ‘separately’ in the question. 9.1.3.3 describe the behavior in the level of PDSCH group. Then, for each group, if there are two sub-codebook, pseudo code in 9.1.3.1 applies. The NFI value for a group, no matter for the scheduled group or for the non-scheduled group should be same.  Alt 4, Alt5: Agree with FL analysis that, since T-DAI only applies to one sub-codebook, it is lack of protection for the other sub-codebook.  Alt 1 vs Alt 2:   * One clarification: how to check T-DAI is ‘smaller’? T-DAI is generated by modulo 4 operation, so we can always make it equal to larger than the T-DAI of a PDSCH of the non-scheduled group * I assume Alt 1 is to apply the single T-DAI for non-scheduled group to both two sub-codebook. In addition to the comparison between PUCCH overhead (Alt 1) and PDCCH overhead (Alt 2), one drawback of Alt 1 is vulnerable to missing PDCCH.   + Since the two sub-codebook may have different total number of PDCCHs, but only one T-DAI is signaled, the codebook size may be wrong for a sub-codebook if 1 or 2 or 3 PDCCHs are missing.   + As a comparison, if there is a dedicated T-DAI for each sub-codebook, error happens when UE miss the last 4 PDCCH of a sub-codebook. |
| Nokia, NSB | We are not convinced that +2bits is too big overhead when operating with CBG. Still prefer Alt-2. In fact we are OK with QC proposal to add 4bits for the CBG case, which was our original proposal.  For first bullet, *It should be clarified in 9.1.3.3 what T-DAIs are assumed when 9.1.3.1 is called.* |
| QC | In our view, Alt4 is not “implicit rule”. In fact, the spec does not need to mention any rule. It is only sufficient to clarify that the generation of the TB-based and CBG-based sub-codebooks are independent (no dependency including tDAI). This is the same as Rel. 15. In addition, we need to delete the following in the current spec (please also see the TP in our contribution: last TP in Section3):  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 .  We agree with the fact that missing DCI can lead to codebook size mismatch, but that is the same issue in Rel. 15 for the case of TB-based and CBG-based sub-codebooks (since they have separate DAIs, and there is no tDAI for the other sub-codebook). We have been supporting more reliability in the previous discussions during the WI. But at this stage, we prefer to not add more DAI bits (up to 4 more bits, or even up to 6 more bits based on discussions below) for this corner case. More importantly, Alt2 leads to the following issue:   * The need to also add q or the need to specify reserved tDAI: What if feedback for the other group is requested but UE only received DCI for TB-based PDSCH and no DCI for CBG-based PDSCH for the other group?   + For the case of UL DCI, reserved tDAI=4 is used for this purpose. Do we need similar rule even for DL DCI?   + For the case of DL DCI, the field q is used to know if feedback for the other group is requested. In this case, should we have two q values for requesting feedback for the other group separately for the TB-based and CBG-based sub-codebooks (total 3 q fields if we also count other sub-codebook for the scheduled group)? * In general, when we create dependency between TB-based and CBG-based sub-codebooks, some of the existing procedures in Rel. 15 also need to change, e.g. power control formula for n\_HARQ-Ack cannot be simply summation of values for TB-based and CBG-based n\_HARQ-Ack as the “last DCI” cannot be independently used in the formulas (since tDAI may be updated after the last DCI, which is similar to the case of across PDSCH groups and only adds to that complication). |

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 when the second HARQ-ACK codebook contains two sub-codebooks  A 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 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 ecause 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 and , generate second HARQ-ACK information, as described in Clause 9.1.3.1, by setting for all and all and, after the completion of the and loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, setting . |

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 and , generate second HARQ-ACK information, as described in Clause 9.1.3.1, by setting  ~~for all and all~~  and, after the completion of the and loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, setting .

============= 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.  and 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 |
| Ericsson | Agree with FL proposal |
| QC | Support the TP |
| Lenovo, Motorola Mobility | Agree with FL proposal. |
| Intel | Agree with FL proposal |
| FL summary | There seems to be consensus on the proposal.  @ Nokia: the UE doesn’t have any C-DAI for the non-scheduled group, and C-DAI won’t be used in the loop if we set M=0. So why do you think we still need to set C-DAI = 0? |
| Nokia, NSB | I thought that C-DAI should be reset if NFI it toggled, but other part of pseudo-code takes care of it, so we are OK with the proposal. |

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 and , generate second HARQ-ACK information, as described in Clause 9.1.3.1, by setting  ~~for all and all~~  and, after the completion of the and loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, setting .  ============= 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 and , generate second HARQ-ACK information, as described in Clause 9.1.3.1, by setting the set of PDCCH monitoring occasions m empty and for all ~~and all~~  and, after the completion of the and loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, setting .  <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 omitted  If and , generate second HARQ-ACK information, as described in Clause 9.1.3.1, by assuming an empty set of PDCCH monitoring occasions for all and all and, after the completion of the and loops for the pseudo-code for the second HARQ-ACK codebook generation in Clause 9.1.3.1, setting .  -------- 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 group  Example 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 specified  Example 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((+1)mod2) is determined by a value of k(( +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 and indicating PUCCH occasion i()?

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 TS38.212  Q2: 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 and providing a value of *k()* 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: Yes  Q2: No  Q3: No  Q4: No  Q5: Yes  Q6: Yes  Q7: 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 exclude  Q9: Yes |
| ZTE | Yes to Q1/Q5/Q6/Q7/Q8  No to Q2/Q3/Q4  For 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 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 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 is determined by DCI 1\_0, how to determine .  Q8: fine.  Q9: supportive.  In addition, we suggest that the first problem to be addressed is how to determine because determination of several parameters depends on . The value of 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 9.1.3.3   1. Clarify how to determine and 2. Clarify how to determine |
| Samsung | Q1: Yes  Q2/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=0  Q2 ~ 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: Yes  Q2: No  Q3: No  Q4: No  Q5: Yes  Q6: 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: Yes  Q2: Yes. Agree with MTK’s view for Q2  Q3: NO  Q4: NO  Q5: YES  Q6: YES  Q7: YES. The h(g) and q can be derived by respective rules in Q5 and Q6  Q8: YES  Q9: YES  Q10: YES  Q11: This DCI may be the last non-fallback DCI for group g. |
| OPPO | Q1: OK  Q2: No  Q3: 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 ignaled 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. |
| Ericsson | Some of the cases below are simply error case and misconfiguration. We strongly suggest to not spend time in listing all the possible combinations that results in error case with the intention of specifying them.  Q1: Yes  Q2: No. If report for both groups is requested, i.e. when q=1.  Q3: No. Once a group is requested to report, it should not be changed.  Q4: No. This is inconsistent way of signaling. No point in doing so.  Q5: Yes. This is to resolve the issue when fall-back DCI is used to schedule PDSCH and how to determine the reference point for m=0.  Q6: Yes. This is to resolve the issue when fall-back DCI scheduling PDSCH is not followed by another DCI scheduling a PDSCH, and indicating a K1 value corresponding to the same slot for PUCCH.  Q7: DCI 1\_0 defines a scheduled group (g=0). But the problem is similar to Q6.  The key question is how to set the q and NFI (h(g), h(g=0)) for fall-back.  Q8: Yes. Otherwise, there would be complications with DAI and NFI interpretation. For such a case, the best way is to use different groups.  Q9: Yes. When q=0, only the CB for the scheduled group is relevant. |
| QC | Q1: Fine to clarify in 212.  Q2: No. We prefer to capture in the spec that the UE does not expect this case.  Q3: No.  Q4: No need to distinguish different PDCCH monitoring occasions vs different cells in the same PDCCH monitoring occasion. Given that there is already a rule for PRI in Rel. 15 (and a corresponding ordering for the DCIs), the same rule can be reused to determine the last DCI.  Q5: No, h(g) in the pseudocode should be based on a DCI that provides this value (last DCI that includes g, and hence, also includes h(g) field). The case of only fallback DCIs is already covered as a separate paragraph, and for that case there is no assumption on h(g) as Rel. 15 is used.  Q6: Same answer as Q5. Our understanding of the pseudocode in Section 9.1.3.3 is that the values of g, h(g), q, etc. are not per-DCI, but they are determined as one value for codebook generation. Of course, within the pseudocode, we check the last time that NFI was reset, e.g., “ corresponds to a PDCCH monitoring occasion, where the UE detects a DCI format that provides 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 ” but we only have one value of g, h(g), q, etc. per HARQ-Ack opportunity.  Q7: No. Answering to this question may not matter from functionality perspective, but matters from viewpoint of how to fix the current pseudocode. The values of g, h(g), q can be obtained from the last DCI that provides these values. Other ways are also possible but requires bigger surgery on the pseudocode.  Q8: Unless if we misunderstood the question, it has nothing to do with out-of-order. With this limitation, how to schedule a PDSCH when both groups are already used (pending), but for this PDSCH, there is not enough time to decode, e.g. assume PDSCH0 with g=0, PDSCH1 with g=1, HARQ-Ack for both scheduled in PUCCH1, but PDSCH3 received before PUCCH1 points to PUCCH2 later (due to not enough time for decoding PDSCH3 and send HARQ-Ack in PUCCH1). Then what should be the group for PDSCH3?  Q9: No need to mention that in the spec unless if it clarifies some ambiguity.  Q10: Seems ok.  Q11: Yes. In addition, we can say that g and h(g) (NFI of the scheduled group) are determined from the same DCI. |
| Lenovo, Motorola Mobility | Q1: Yes  Q2: No. Spec can capture that UE does not expect such case.  Q3: No  Q4: No  Q5: Yes. Related spec change is needed for fallback DCI scheduled PDSCH.  Q6: Yes. Related spec change is needed for fallback DCI scheduled PDSCH.  Q7: No, because DCI format 1\_0 has no q.  Q8: Yes.  Q9: Yes |
| Intel | Q1: Yes  Q2: No, gNB can avoid this case by setting q=1 for a latter DCI. It is OK to capture that UE doesn’t expect such behavior  Q3: No  Q4: No, if the DCIs in same MO are scheduling the same PDSCH group. Yes, if the DCI in same MO are scheduling different PDSCH groups  Q5: Yes  Q6: Yes, this applies to fallback DCI. value of q should be determined by another DCI 1\_1 scheduling PDSCH group 0  Q7: Yes. We have agreement it is PDSCH group 0 for fallback DCI. value of q can be derived by other DCI(s)  Q8: Yes. Otherwise, the mechanism of NFI doesn’t work  Q9: Yes  Q10: fail to see the intention for Q10  Q11: NFI must be derived by the last DCI format 1\_1. C-DAI in the actual last DCI can active as T-DAI if the actual last DCI is DCI format 1\_0 |
| FL summary | Here is a summary of the companies views on 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?**  Yes: MediaTek, Nokia, ZTE, Sharp, Samsung, LG, vivo, OPPO, Ericsson, Qualcomm, Lenovo, Intel  FL summary: there seems to be consensus, so a proposal is provided below and no further discussion is expected. We will plan to prepare a TP for it.  FL proposal 1: 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?**  Yes: MediaTek, Sharp, vivo  No: Nokia, ZTE, Samsung, LG, OPPO, Ericsson, Qualcomm, Lenovo, Intel  FL summary: a large majority prefer to clarify that this case is not expected. The fact that q was defined means that it is not expected to rely on K1 only for signaling to report two groups in the same PUCCH. There seems to be no benefit to allow this case since the expected behavior would be unambiguously provided by requesting feedback for two groups using q=1.  FL proposal 2: clarify that it is not 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?**  Yes: MediaTek;  No: Nokia, ZTE, Sharp, Samsung, LG, vivo, OPPO, Ericsson, Qualcomm, Lenovo, Intel  FL summary: a large majority of companies think that Q3 describes an error case.  FL proposal 3: clarify that it is not 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*)?**  Yes: MediaTek (for q), Qualcomm (the behavior can be clear with an ordering cells in the same monitoring occasion)  No: MediaTek (for h(g)), Nokia, ZTE, Sharp, Samsung, LG, vivo, OPPO, Ericsson, Lenovo, Intel  FL summary: there seems to be consensus on the behavior related to h(g), but one company has a different view for the number of requested groups q.  Question to Qualcomm: do you agree that this should not be expected for h(g)?  Question to Mediatek and Qualcomm: even ordering of cells in the same monitoring occasion, it seems unlikely that there would be sufficient scheduling time at the gNB to decide to toggle the NFI in one cell and not in other cells. Likewise for the number of requested PDSCH groups, how would a gNB decide to request two groups in the last ordered cell in the same monitoring occasion after have already prepared the DCIs for all the other scheduled cells?  FL proposal 4: it should not be expected to receive DCIs on different cells in the same monitoring occasion if the DCI formats indicate different values of h(g) [or different values of q].  **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?**  Yes: MediaTek, Nokia, ZTE, Sharp, Samsung, LG, vivo, Ericsson, Lenovo, Intel  No: Qualcomm  FL summary: a large majority of companies think that a clarification is needed.  Response to Qualcomm: it should be have been clarified in this question that determining the value of h(g) is for being able to determine the correct m=0 when the first DCI is a fallback DCI, and this is only for the case where both DCI format 1\_0 and DCI format 1\_1 scheduling group 0 are received for the same PUCCH transmission occasion. It was not the intent to discuss the case where DCI format 1\_0 is received but no DCI format 1\_1 scheduling group 0, as this was already clarified at the last meeting (paragraph at the end of 9.1.4). Without the clarification, m=0 would start at the first DCI format 1\_1 scheduling group 0 and any fallback DCI received before that may be discarded from the HARQ-ACK codebook (depending on which unspecified assumption the UE takes for NFI corresponding to a DCI format 1\_0). Contrary to q and g, an assumption on NFI seems to be needed for this first fallback DCI. If we clarify this then all subsequent fallback DCIs for the same PUCCH occasion would follow the same NFI assumption as the first fallback DCI.  C:\Users\d00441999\AppData\Roaming\eSpace_Desktop\UserData\d00441999\imagefiles\2CD99D3E-69EE-46B0-B69C-2727798B3061.png  Response to MediaTek (it is also possible to set *h*(*g*) to the value provided by another DCI format, if any, providing a value of and providing a value of *k()* indicating the same slot, if the higher layer parameter *NFI-TotalDAI-Included-r16* is configured): you are talking about the case where DCI 1\_1 schedules group 1 and indicates NFI for group 0. If there is another DCI 1\_1 scheduling group 0 then your proposal is not needed since that DCI will provide NFI for group 0. If there is no other DCI 1\_1 scheduling group 0 then we clarified at the last meeting that HARQ-ACK feedback for group 1 should be dropped, so it is not expected that the gNB would actually provide this DCI 1\_1 scheduling group 1 and providing NFI for group 0. So I think your proposal is not needed.  Q5 (update):   * do we need to clarify that if a first DCI format scheduling PDSCH reception and providing the first indication for a PUCCH transmission occasion does not include a *New\_Feedback indicator* field, the value of *h*(*g*) for this PDSCH reception is set only if *h*(*g*) is provided by another DCI format providing a value of h(g) and the same value of *g* and indicating the same PUCCH transmission occasion? In this case, this first DCI determines m=0. * do we need to clarify that for a DCI format scheduling PDSCH reception that does not include a *New\_Feedback indicator* field, the value of h(g) for this PDSCH reception is set only if h(g) is provided by an earlier DCI format providing a value of h(g) and the same value of *g* and indicating the same PUCCH transmission occasion, if any?   Is this update acceptable to Qualcomm and other companies?  **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?**  No: MediaTek, Qualcomm (same reason as Q5)  Yes: Nokia, ZTE, Sharp, Samsung, LG (delete “providing the same value of g”), vivo, OPPO, Ericsson, Lenovo, Intel  FL summary: a majority of companies think that a clarification is needed especially if the fallback DCI is the last DCI. But it seems the clarification may not be needed if the value of q is provided by at least one DCI indicating the same PUCCH transmission occasion as the fallback DCI. As Qualcomm commented, there is no need to set q for each DCI but only to have one assumption for q for a PUCCH transmission occasion.  A possible conclusion is that this clarification from Q6 is not needed. What may be needed is to clarify the assumption on q for a PUCCH transmission occasion (see Q7 update).  **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?**  Yes: ZTE, Sharp (concern), Samsung, MediaTek , vivo, Ericsson, Intel  No: Nokia, LG, OPPO, Qualcomm, Lenovo  FL summary: several companies commented that this potential ambiguity would be solved if we clarified that g and q are obtained from the last non-fallback DCI format 1\_1 providing these values for a PUCCH transmission occasion. While some companies also provided the NFI in this list, the question from NFI may be a little different (see Q5).  Q7 (update): can we clarify that g and q are obtained from the last non-fallback DCI format 1\_1 providing these values for a 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?**  Yes: Nokia, ZTE, Sharp, Samsung, MediaTek, vivo, OPPO, Ericsson, Lenovo, Intel  No: LG, Qualcomm  FL summary: this question was motivated by the example from Intel’s Tdoc R1-2001989 (copied below for reference). As pointed out by Qualcomm, there seems to be no inconsistency in the UE behavior if this case is not precluded and can be left up to the gNB scheduling choice, with the understanding of the potential drawbacks explained in R1-2001989.  A possible conclusion is that this clarification from Q8 is not needed.  *However, there is no explicit agreement that whether PDSCH group 0 could be used in the first two blue PDSCHs or same group can be also indicated to both green and blue PDSCHs. If PDSCH group 0 is used, it become problematic regardless of whether NFI is set to 0 or 1. As shown in Figure 3, if NFI for the blue PDSCH equals to 1, i.e. toggled compared to green PDSCHs, there is no chance to retransmit HARQ-ACK for green PDSCH if PUCCH U2 is failed. On the other hand, if NFI for the blue PDSCH equals to 0, C-DAI/T-DAI has to be continuous for all green and blue PDSCHs, and then the HARQ-ACK transmission on PUCCH U1 becomes useless.*    ***Figure 3 [R1-2001989]: Enhanced dynamic codebook using single 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?**  Yes: Nokia, Sharp, MediaTek, LG, vivo, OPPO, Ericsson, Lenovo, Intel  No: ZTE, Samsung, Qualcomm  FL summary: several companies answering yes or no mentioned that this could be left to UE implementation as it doesn’t seem to affect the specified behavior. A correction related to Q9 does not seem critical.  A possible conclusion is that this clarification from Q9 is not needed.  **Q10 (added by MediaTek): can we clarify that a slot of PUCCH occasion i((+1)mod2) is determined by a value of k(( +1)mod2) from at least one DCI format scheduling the non-scheduled group?**  Yes: MediaTek, vivo, Qualcomm  FL summary: more companies are invited to comment on Q10. But perhaps this clarification may not be needed if we answer question Q7 with the proposed update? One company did not understand the intention for Q10. More clarification may be needed on the question.  **Q11 (added by MediaTek): 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 and indicating PUCCH occasion i()?**  Yes: MediaTek, Qualcomm  FL summary: more companies are invited to comment on Q11.  FL comment: It is not entirely clear to me why such clarification is needed, otherwise what was the point to introduce the configurable signaling of NFI and T-DAI for the non-scheduled group? The behavior seems obvious in relation to that RRC parameter.  Qualcomm proposed that in addition, we can say that g and h(g) (NFI of the scheduled group) are determined from the same DCI. Discussions on Q5 and Q7 are related. |
| OPPO | Q1: we support FL proposal.  Q2: we support FL proposal.  Q3: we support FL proposal.  Q4: we support FL proposal.  Q5: not support, we think Q5 intends to revert the RAN1 agreement.  Reusing FL’s example, if the last PDSCH scheduled by FB-DCI (K1=3) does not exist and the last PDSCH scheduled by non-FB-DCI is indicated with NNK1, then the PDSCH scheduled by FB-DCI (K1=5) should be categorized in group 0 according to RAN1#99 agreement. The Q5 seems to change the RAN1 agreement.  Agreement:  If enhanced dynamic codebook is configured, for a PDSCH scheduled by DL DCI 1\_0:   * NFI for group #0 is not signaled 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   C:\Users\d00441999\AppData\Roaming\eSpace_Desktop\UserData\d00441999\imagefiles\2CD99D3E-69EE-46B0-B69C-2727798B3061.png  Q6: support FL proposal.  Q7: support to clarify  Q8: we think the clarification is needed, we can further discuss how to clarify in the spec  Q9: we prefer to clarify but we can respect majority view  Q10: we support FL’s observation that Q10 may not be needed.  Q11: the question is not clear, does it tend to say that the NFI and DAI values for the non-scheduled group must be obtained from the DCI that schedules this group? Maybe MTK can elaborate the question. |
| LG | On the updated Q5:  It seems the difference between two bullets under the above updated Q5 is whether the non-fallback DCI referred for NFI value is to be earlier than fallback DCI. If this understanding is correct, it is not required for the non-fallback DCI to be earlier than fallback DCI.  On the updated Q7:  As commented earlier, the values of q and h from multiple DCI format 1\_1 indicating a same PUCCH occasion should be the same, and thus it means that it is not required to specify “last” for this case. On the other hand, PRI is to be obtained from the last DCI as in legacy Rel-15.  On the newly added Q10:  The answer to the above updated Q7 can be referred.  On the newly added Q11:  The answer to the above updated Q7 can be referred. |
| Intel | Q4: It is better to clarify the impact of PDSCH groups. Actually, the impact is different to h(g) and q. suggest to revise FL proposal 4 as  Revised FL proposal 4: It should not be expected to receive DCIs on different cells in the same monitoring occasion if the DCI formats indicate the same PDSCH group and different values of h(g). It should not be expected to receive DCIs on different cells in the same monitoring occasion if the DCI formats indicate different values of q.  Q5 (update): first bullet is fine. If ‘another DCI format’ in the first bullet can be either an earlier or later DCI, it seems the second bullet is covered by first bullet. If ‘another DCI format’ in the first bullet only means a later DCI, the second bullet is needed if there is no later DCI providing a value of h(g) and the same value of *g* and indicating the same PUCCH transmission occasion.  Q7 (update): Yes  Q8: Given this is a majority view that a clarification of Q8 is needed, I still prefer to clarify that UE doesn’t except such case to happen. I agree that gNB may choose to avoid it. However, there is always concern what is the UE implementation. Without the clarification, does it mean that UE need to prepare to handle such case. the handling is quite complicated.  Q9: it is not an issue just up to implementation, since we need to align understanding between gNB and UE. If q=1, NFI for the non-scheduled group is used to form the codebook of the non-scheduled group, which means the NFI value will be used later to check NFI toggling for later PUCCH HARQ-ACK transmission. Then, for q=0, we need to make gNB and UE aligned that whether NFI for non-scheduled group is valid or not. The most simple way is to ignore the NFI/T-DAI, but we need to define the behavior to avoid confusion.  Q10: Yes  Q11: I assume the question is regarding q=1, and determination of codebook for the non-schedule group. In this case,   * if NFI/T-DAI is not configured for non-scheduled group in a DCI, NFI must be derived by the last DCI format 1\_1. C-DAI in the actual last DCI can active as T-DAI if the actual last DCI is DCI format 1\_0 * if NFI/T-DAI is configured for non-scheduled group in a DCI, it seems no clarification is needed. |
| MediaTek | We are OK with the FL proposals 1, 2, 3, 4  On Q4: If the determination of q follows the same principle of determining PUCCH resource, then it doesn’t matter to change q in different MOs or different cells in the same MO. However, if the majority view is that NW will not change q after it decides to request feedback for two groups, we are fine with FL proposal 4.  On Q5: In my understanding to current spec from the last meeting, if there is no other DCI 1\_1 scheduling group 0 and no other DCI 1\_1 proving NFI for group 0 (which could schedule group 1 but without signaling of NFI for the non-scheduled group), then UE generates information only for PDSCH receptions scheduled by detections of DCI format 1\_0. However, it is still possible that the gNB could provide DCI 1\_1 scheduling group 1 and providing NFI for group 0 since the HARQ-ACK feedback for group 1 will not be dropped according to current spec.  Spec from TS38.213 clause 9.1.3.3:  *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, as described in Clause 9.1.3.1 or 9.1.3.2 for multiplexing in the PUCCH transmission occasion.*  On Q6: The answer to the updated Q7 can be referred.  On updated Q7: We agree that both g and q are obtained from the last DCI format 1\_1 providing these values for PUCCH transmission occasion i(g).  On Q8: Prefer to clarify it  On Q10: In Q10, we’d like clarify the association between a group and it’s corresponding PUCCH occasion. Regarding PUCCH occasion , current spec clearly describes that at least one of the DCI formats provides a value of g and a value of indicating the slot of PUCCH occasion . However, such description for PUCCH occasion is missing. This issue can be simply fixed by:   * the second HARQ-ACK information corresponds to detections of DCI formats each providing a same value of , of , if any, and at least one of the DCI formats providing a value of indicating the slot   On Q11: Sorry, I didn't accurately describe the question. The question we'd like to ask is: **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 and indicating PUCCH occasion i(), if the higher layer parameter NFI-TotalDAI-Included-r16 is configured?**  The intension to have this proposal is that when generate HARQ-ACK information for the non-scheduled group, the values of and are not per-DCI, but they are determined as one value for the second HARQ-ACK bits generation, Thus, similar to q and g, UE only has to check these values in the last DCI 1\_1 providing these values. |
| Nokia, NSB | P1-P4 OK including square brackets.  Q5 Proposal: DCI format 1\_0 obtains h(g) from previous DCI format 1\_1 if any, otherwise from next DCI format 1\_1 if any within the same DL association set (i.e. between two PUCCH).  Q6: OK  Q7: Support  Q8: We misunderstood the question, after closer look at R1-2001989, it is not out-of-order HARQ, maybe not wise from gNB to schedule, but nothing seems to be broken.  Q9: No strong opinion  Q10: Agree that Q7 would clarify this  Q11: Agree with FL assessment |
| QC | FL proposal 1, 2: Agree.  FL proposal 3: Agree, but we do not see specific benefit capturing this in the spec. Does it have an impact of HARQ-Ack generation procedures?  FL proposal 4: To answer the question from FL: Yes, we agree that this should not be expected / it is not a reasonable gNB scheduling. But is there a benefit to capture this? If the last DCI rule in Rel. 15 is reused, should this be captured? If yes, then why for PRI the same is not captured in the spec for PUCCH resource determination in Rel. 15?  Q 5: Thanks for the explanation. We understand the intention now (to determine the correct m=0), and we agree that an assumption for NFI for fallback DCI is needed in order to determine m=0.  Q 6: Agree that clarification is not needed for q of fallback DCI.  Q 7 (update): Agree.  Q 8: Agree that clarification is not needed as explained before.  Q 9: Agree that clarification is not needed. Looking at intel’s answer above (what if NFI is toggled for the non-scheduled group, then later what is the reference to when NFI is reset), we think it is related to issue A8 as originally proposed by Nokia. As also Nokia pointed out, this is taken care of by the following parts:      Q 10: Fine either way.  Q 11: Clarification is needed. Agree with MTK. This is about how UE determines and in the case that DCIs includes these additional fields, which should be similar to Q7 (can be merged with Q7). |
| Ericsson | Q1: Agree with FL proposal  Q2: Agree but not sure if clarification in spec is needed for this case.  Q3: Agree with the conclusion but we don’t think we should specify the error case.  Q4: Agree with FL proposal  Q5: Agree with the FL proposal and also appreciate the FL’s effort 😊  Q6 & Q7: OK with FL suggestion.  Q8: OK  Q9: OK |
| Sharp | Q1: Agree with FL proposal 1.  Q2: OK with FL proposal 2.  Q3: Agree with FL proposal 3.  Q4: Agree with FL proposal 4.  Q5: Yes to the first bullet. For the second bullet, clarification is not necessary since we cannot see why restrict to “an earlier” DCI 1\_1.  Q6: Clarification is not needed if it is agreed that q is explicitly provided by the last non-fallback DCI.  Q7: Yes to the updated Q7. Our preference to the previous Q7 is “no” (not use DCI 1\_0 as the last DCI).  Q8: OK  Q9: OK with FL summary.  Q10, Q11: Merge to the updated Q7 |

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 to the value of a first New\_Feedback indicator field, if any, in a DCI format providing a value of . If the DCI format schedules PDSCH reception and does not include a New\_Feedback indicator field, set to the value of the (first) New\_Feedback indicator field in a following DCI format providing a same value of , if any, and providing a value of 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 is appended to that for . |
| 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\_1  DCI 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 to the value of a first New\_Feedback indicator field for group , if any, in a DCI format providing a value of  Set to a value of a second New\_Feedback indicator field for group , if any, in a DCI format providing a value of  < 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 retransmission 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.  Set 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 .  Set to denote a PUCCH transmission occasion for multiplexing HARQ-ACK information  Set to the value of a PDSCH-to-HARQ\_feedback timing field, if any, in a DCI format providing a value of . If the DCI format does not include a PDSCH-to-HARQ\_feedback timing field, set to the value provided by *dl-DataToUL-ACK*  Set to the value of a first New\_Feedback indicator field, if any, in a DCI format providing a value of 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 to the value of provided by another DCI format, if any, providing the same value of and indicating the same slot for HARQ-ACK transmission  Set to a value of a second New\_Feedback indicator field, if any, in a DCI format providing a value of  Set to the value of a total DAI field for group , if any, in a DCI format providing a value of  Set to the value of a number of requested PDSCH group(s) field, if any  Generate first HARQ-ACK information for PUCCH transmission occasion 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 , of , if any, and at least one of the DCI formats providing a value of indicating the slot  - 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 , 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 and a different value  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 , if any  - 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 , 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 and a different value  - the PUCCH transmission occasion is a last one for multiplexing second HARQ-ACK information. The UE does not expect that is later than 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 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 to the value of a PDSCH-to-HARQ\_feedback timing field, if any, in a DCI format providing a value of . If the DCI format does not include a PDSCH-to-HARQ\_feedback timing field, set to the value provided by *dl-DataToUL-ACK*  \*\*\* Unchanged text is omitted \*\*\*  Generate first HARQ-ACK information for PUCCH transmission occasion 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 , of , if any, and at least one of the DCI formats providing a value of indicating the slot  - 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 , 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  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 , if any, and at least one of the DCI formats providing a value of indicating the slot  - 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 , 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 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 to the value of a number of requested PDSCH group(s) field~~, if any~~ in the last DCI format indicating PUCCH transmission occasion and providing a value of 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 38.213 9.1.3.3 Type-2 HARQ-ACK codebook grouping and HARQ-ACK retransmission Set to the value of a Number of requested PDSCH group(s) field in a DCI format determining the PUCCH resource for , if any. If , set to the value of a PDSCH group index field in the DCI format determining the PUCCH resource for .  --------- 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 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 to denote a PUCCH transmission occasion for multiplexing HARQ-ACK information  Set to the value of a PDSCH-to-HARQ\_feedback timing field, if any, in a DCI format providing a value of . If the DCI format does not include a PDSCH-to-HARQ\_feedback timing field, set to the value provided by *dl-DataToUL-ACK*  Set to the value of a first New\_Feedback indicator field in the last DCI format providing the value of  Set to a value of a second New\_Feedback indicator field, if any, in the last DCI format providing the value of  Set to the value of a total DAI field for group , if any, in the last DCI format providing the value of . If and a last DCI format in the set of DCI formats does not include a PDSCH group index field, set  Set to the value of a Number of requested PDSCH group(s) field in the last DCI format providing the value of  Generate first HARQ-ACK information for PUCCH transmission occasion 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 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, 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 or , and , generate second HARQ-ACK information for PUCCH transmission occasion in a slot, as described in Clause 9.1.3.1, where”  Issues: the description of the reference PDCCH monitoring occasion , which impact the codebook size determination does not take in consideration that the DCI does not explicitly provide an value. The pseudo code does not assume the case where the DCI does not explicitly provide a q value.  Set to the value of a first New\_Feedback indicator field, if any, in a DCI format providing a value of . 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 , 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 to the same value provided by the DCI format that includes a New\_Feedback indicator field for  Set 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 for , 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 to the same value provided by the DCI format that includes for |

# Conclusions

# References

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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
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7. R1-2001707 Remaining issues on the HARQ for NR-U ZTE, Sanechips
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14. R1-2002119 HARQ enhancement for NR-U Samsung
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