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

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

**Agenda Item: 7.2.2.2.3**

**Source: Moderator (Huawei)**

**Title: Feature lead summary#1 on 101-e-NR-unlic-NRU-HARQ-03 (NNK1 value)**

**Document for: Discussion and Decision**

# Introduction

This document provides updated proposals on issues C1, C2 and C3 that are prioritized for RAN1#101e among the issues identified for the **corrections related to NNK1 value** [1].

[101-e-NR-unlic-NRU-HARQ-03] Email discussion/approval on issues C1, C2 and C3 from R1-2004692 until 5/28; if necessary, endorse associated TPs by 6/3 – David (Huawei)

* Issue C1 (leftover):
  + FFS: DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate Scell dormancy
  + FFS: DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate SPS release (note: some dependency on B6)
* Issue C2: DCI format 1\_2 usage with PUCCH priority in case of NNK1 value signaled in PDSCH-to-HARQ\_feedback timing indicator
* Issue C3: Out-of-Order issue for NNK1

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

# Issue C1

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| C1 | - FFS: DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate Scell dormancy  - FFS: DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate SPS release |

Summary of companies’ views:

DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate Scell dormancy

* Support (10): ZTE, Sanechips, Huawei, HiSilicon, LGE, Qualcomm, vivo, Lenovo, Motorola Mobility, OPPO
* Do not support (6): Nokia, Nokia Shanghai Bell, Ericsson, MediaTek, Samsung, Intel

DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate SPS release

* Support (8): ZTE, Sanechips, Huawei, HiSilicon, LGE, Qualcomm, vivo, OPPO
* Do not support (8): Nokia, Nokia Shanghai Bell, Ericsson, MediaTek, Samsung, Lenovo, Motorola Mobility, Intel

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| **Company** | **Comments on issue C1** |
| Ericsson | Our preference is that DCI 1\_1 can indicate NNK1 regardless if it schedules PDSCH, or indicate SPS release, or Scell dormancy. There is no need to include artificial exceptions in the spec. Instead, it is cleaner if we have a common general procedure. In fact, excluding those cases, adds some scheduling restrictions on the gNB. |
| QC | Support both proposals.  Regarding SPS release and depending on the outcome B-6 in Email thread 2, there could be confusion if the DCI indicates NN-K1 (since the value of the one bit that is added to Type-3 depends on whether the SPS release DCI points to the same slot for PUCCH or not).  For both SPS release and Scell dormancy, if NN-K1 is allowed, there will be additional specification impact. This is because NN-K1 is currently defined only for a DCI that schedules PDSCH:  “If a UE receives a first PDSCH scheduled by a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK*, …”  In addition, the use case for SPS release DCI or Scell dormancy DCI indicating NN-K1 is not clear. |
| Nokia, NSB | Why these cases should be precluded and gNB scheduling flexibility limited? Any technical issues?  The one above issue pointed out by QC would not happen when any of 2C options in B6 is adopted, because DL SPS release is assigned to HARQ process ID.  Motivation for two cases is clear, allow DL SPS release and Dormancy indication at the end of COT. |
| ZTE | We support both proposals. We do not see the strong motivation for SPS release DCI or Scell dormancy DCI indicating NN-K1. And the spec impact of introducing such functionality is not trivial. |
| MediaTek | No big issue if support NNK1 and SPS release/dormancy indication simultaneously |
| Samsung | Agree with E/// and Nokia that these cases should not be precluded unless there is any technical issue. |
| LG | Support both proposals.  Those DCIs should not be allowed to indicate NNK1 value since the ACK feedback corresponding to such DCIs needs be received by the gNB on time for the confirmation of the DCI reception by the UE.  The reason is that the ACK response corresponding to those DCIs is delayed, then whether SPS PDSCH reception or Scell PDCCH monitoring by the UE is stopped or not would be ambiguous in the gNB side. |
| vivo | Support both proposals.  We share the same view as LG. While the HARQ-ACK timing is not determined when gNB sends a DCI indicating SCell dormancy/SPS release, it is unclear why gNB choose to send the DCI at the end of a COT. |
| Lenovo, Motorola Mobility | (1) We support the first proposal: DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate Scell dormancy  (2) We support the 2nd proposal. In the case that gNB intends to indicate SPS release at the end of a COT, it does make sense that gNB indicates NNK1 value for this SPS release. Then a second DCI format in the next COT can indicate applicable K1 timing for reporting the HARQ-ACK feedback for SPS release. Moreover, we don’t see any drawback if DCI format 1-1 can simultaneously indicate NNK1 value and SPS release. |
| Intel | We agree with E///, Nokia and Samsung. The two case under discussion can be early supported.  In fact, when gNB decides to control dormancy or SPS related behavior at end of a COT, it is more beneficial to allow gNB to indicate NNK1 instead of enforcing an applicable K1 value, since gNB is not sure about the time of next channel occupation. |
| OPPO | Support the proposals |
| FL summary | The views are almost equally split for both cases. The use case under discussion is for indicating SPS release or to control Scell dormancy at the end of a COT, but some companies indicated that it may not be a desired network behaviour due to the uncertainty on when the feedback can be received.  One question that remains to be clarified is on the additional specification impact if NNK1 value can be signaled in a DCI format indicating Scell dormancy or SPS release. Qualcomm mentioned that the specification text that defines the behavior associated with NNK1 value is only defined for a first DCI format that schedules PDSCH reception.  So is it the correct understanding that a similar definition as in section 9.1.3 would need to be added if a first DCI format does not schedule PDSCH reception and indicates SCell dormancy or SPS release and a NNK1 value, so that a second DCI format can provide a numerical K1 value?  Further views are invited on the specification impact of supporting a NNK1 value to be signaled in a first DCI format indicating Scell dormancy or SPS release. Views in the form of a TP are welcome as well. |
| Nokia, NSB | Indeed, the specification would need to be updated,  If a UE receives ~~a first PDSCH scheduled by~~ a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK*,  if the UE detects a second DCI format, the UE multiplexes the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format, where  However, the full TP depends on whether B6 is resolved, and cannot be provided yet. |
| MediaTek | If NNK1 and SPS release/dormancy indication simultaneously is supported, spec change is needed. But it could be easy, as pointed out by Nokia. |
| Lenovo, Motorola Mobility | If NNK1 and SPS release can be indicated in one DCI, the TP could be better to elaborate the purpose of the first DCI format, e.g., for scheduling a first PDSCH, for indicating DL SPS release, etc. |
| LG | Rather than estimating the expected spec impact if the NNK1 indication is allowed, it needs to be clarified first on the essentiality to allow the NNK1 indication for such special DCIs requiring a prompt response to gNB. We still don’t see the essential reason to allow the delayed response corresponding to those DCIs which would cause uncertainty in gNB side. |
| Ericsson | We would like to clarify that it is not only about allowing SPS release/dormancy at the end of the COT. In fact allowing any of the DL DCIs that require feedback to signal NNK1 gives the gNB flexibility in when to schedule PUCCH within a COT (only 8 K1 values can be signalled, but the COT can be larger than 8 slots, so some slots within the COT might be signalled with nnk1 value if the gNB prefers only one switching point from DL to UL at the end of the COT). Otherwise, if the SPS release/dormancy has to be sent with a valid K1 value, this might put restrictions on the gNB scheduling, e.g. multiple switching points within a COT just to allow PUCCH corresponding to those DCIs or restrictions in which slots those DCIs can be signalled so that the feedback can be multiplexed in a preferred PUCCH occasion. |
| QC | **Question for clarification to Ericsson**: For issue B6, you mentioned that “we prefer to assume that the gNB will not trigger and SPS release ACK and Type 3 codebook in the same PUCCH and not to discuss any of those optimizations”. Then, isn’t requesting type-3 codebook in a SPS release DCI against that preference? Can you clarify? |
| Nokia, NSB | We provided the use-case, spec change is minimal for TYPE-2 and e-TYPE-2. And if B6 Alt 2c is selected, spec change is simple as well for TYPE-3 CB, which has additional use-case pointed out by Ericsson. I hope this addresses LG concern. |
| FL summary#2 | Thank you for the further feedback. Clarifications have been provided on the possible use cases of signaling SPS release or SCell dormancy with NNK1.  I would like to focus on the understanding of the potential spec impact for completing the UE behavior if the UE receives signaling of NNK1 value in a DCI not scheduling PDSCH but indicating SPS release or SCell dormancy.  Nokia provided a TP for TS38.213 section 91.3 for handling the case of SPS release (HARQ feedback for SPS release is included at least in (e)Type2 CB):  If a UE receives ~~a first PDSCH scheduled by~~ a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK*,  - if the UE detects a second DCI format, the UE multiplexes the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format, where  - if the UE is not provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one  - if the UE is provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in Clause 9.1.3.3  - if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in Clause 9.1.4.  - otherwise, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission.  For SCell dormancy indication, the same TP would also handle the signaling of NNK1 value, but the specification seems incomplete for reporting HARQ information corresponding to SCell dormancy in enhanced dynamic codebook, referring to this text in section 9.1:  If a UE detects a DCI format 1\_1 indicating  - SCell dormancy, as described in Clause 10.3, and  - is provided *pdsch-HARQ-ACK-Codebook = dynamic*  the UE generates a HARQ-ACK information bit as described in Clause 9.1.3 for a DCI format 1\_1 indicating SCell dormancy and the HARQ-ACK information bit value is ACK.  The text above does not specify that the UE generates HARQ-ACK information for SCell dormancy in enhanced dynamic HARQ-ACK codebook. So a TP for section 9.1 would also be needed as below:  If a UE detects a DCI format 1\_1 indicating  - SCell dormancy, as described in Clause 10.3, and  - is provided *pdsch-HARQ-ACK-Codebook = dynamic* *or enhancedDynamic-r16*  the UE generates a HARQ-ACK information bit as described in Clause 9.1.3 for a DCI format 1\_1 indicating SCell dormancy and the HARQ-ACK information bit value is ACK.  Companies are invited to comment on whether the TPs above are sufficient to complete the UE behavior for reporting the corresponding HARQ-ACK information if the UE receives signaling of NNK1 value in a DCI not scheduling PDSCH but indicating SPS release or SCell dormancy. |
| QC | It seems to us that we may need to first reach a conclusion / agreement for issue B6. |
| Nokia, NSB | For use-case of TYPE1 + TYPE-3 CB part depends on B6, however, for end of COT use-case and e-TYPE2 and TYPE-2 no dependency. |
| FL summary #3 | Even if the TP above would remove the restriction that the first DCI format has to schedule a PDSCH, additional impact to specify how to map the SPS release bit to Type-3 codebook would still be needed separately (issue B6). So I don’t see an issue with discussing the TP for all types of codebook, with the understanding that the case of Type-3 CB needs additional spec impact.  So I note here that, as an answer to my earlier question, the TP above is not sufficient to completely specify the UE behavior for Type-3 codebook.  Do companies think that the TPs above are sufficient to completely specify the UE behavior for Type-2 and enhanced Type-2 codebook, when NNK1 value is signaled with SPS release or Scell dormancy? |
| Nokia, NSB | I suppose, now when we concluded that HARQ-ACK for DL SPS release is not reported in TYPE-3 CB in R16 and I suppose the same fate follows CASE 2 Scell dormancy. We could agree on the following TP if consensus.  If a UE receives ~~a first PDSCH scheduled by~~ a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK*,  - if the UE detects a second DCI format, the UE multiplexes the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format, where  - if the UE is not provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one  - if the UE is provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in Clause 9.1.3.3  - if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback-r16*, the first DCI format is neither of DL SPS release and DCI format indicating Scell Dormancy, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook , as described in Clause 9.1.4.  - otherwise, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission.  Other option is to stop the discussion here, cause the current specification does not support first DCI format which is not scheduling PDSCH. |
| QC | The second option mentioned by Nokia is preferred “stop the discussion here, cause the current specification does not support first DCI format which is not scheduling PDSCH”. Then, we should simplify the TP agreed last time regarding SPS activation / release validation as shown below (no need to mention anything about Scell dormancy DCI since it unnecessarily adds to spec rather than simplifying):  A UE validates, for scheduling activation or scheduling release, a DL SPS assignment PDCCH or a configured UL grant Type 2 PDCCH if  - the CRC of a corresponding DCI format is scrambled with a CS-RNTI provided by *cs-RNTI*, and  - the new data indicator field in the DCI format for the enabled transport block is set to '0', and  - the DFI flag field, if present, in the DCI format is set to '0', and  - the PDSCH-to-HARQ\_feedback timing indicator field,if present, does not provide an inapplicable value from *dl-DataToUL-ACK*.  If a UE is provided a single configuration for UL grant Type 2 PUSCH or for SPS PDSCH, validation of the DCI format is achieved if all fields for the DCI format are set according to Table 10.2-1 or Table 10.2-2. |
| FL summary #4 | As already summarized by Nokia and Qualcomm, the conclusion on B6 has some impact on this discussion since it is not possible to report SPS release in Type-3 codebook, including the case where SPS release would be allowed to the signaled along with a NNK1 value.  For type-2 CB and enhanced type-2 CB, the discussion could continue. Nokia and Qualcomm also proposed the option to stop the discussion, meaning to accept the original proposals to not support signaling NNK1 value and simultaneously signaling SPS release or SCell dormancy, in which case a correction to section 10.2 would be needed as clarified by Qualcomm. So the updated companies’ views are shown below, now indicating a majority of companies who support not allowing NNK1 value with SPS release or SCell dormancy in Rel-16.  DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate Scell dormancy   * Support (12): ZTE, Sanechips, Huawei, HiSilicon, LGE, Qualcomm, vivo, Lenovo, Motorola Mobility, OPPO, Nokia, Nokia Shanghai Bell * Do not support (6): Nokia, Nokia Shanghai Bell, Ericsson, MediaTek, Samsung, Intel   DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate SPS release   * Support (10): ZTE, Sanechips, Huawei, HiSilicon, LGE, Qualcomm, vivo, OPPO, Nokia, Nokia Shanghai Bell * Do not support (8): Nokia, Nokia Shanghai Bell, Ericsson, MediaTek, Samsung, Lenovo, Motorola Mobility, Intel   In summary, we still have the two alternatives below to discuss:   * **Alt1 with TP#1**: DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate Scell dormancy or SPS release * **Alt2 with TP#2**: Allow DCI format 1\_1 to simultaneously indicate a NNK1 value and indicate Scell dormancy or SPS release, for reporting in Type-2 or enhanced Type-2 HARQ-ACK codebook   The TP#1 for Alt1 would be:  ================== Start of TP1 ===================  **10.2 PDCCH validation for DL SPS and UL grant Type 2**  \*\*\* Unchanged text omitted \*\*\*  A UE validates, for scheduling activation or scheduling release, a DL SPS assignment PDCCH or a configured UL grant Type 2 PDCCH if  - the CRC of a corresponding DCI format is scrambled with a CS-RNTI provided by *cs-RNTI*, and  - the new data indicator field in the DCI format for the enabled transport block is set to '0', and  - the DFI flag field, if present, in the DCI format is set to '0', and  - the PDSCH-to-HARQ\_feedback timing indicator field,if present, does not provide an inapplicable value from *dl-DataToUL-ACK*.  If a UE is provided a single configuration for UL grant Type 2 PUSCH or for SPS PDSCH, validation of the DCI format is achieved if all fields for the DCI format are set according to Table 10.2-1 or Table 10.2-2.  \*\*\* Unchanged text omitted \*\*\*  ================== End of TP1 ===================  The TP for Alt2 would be for section 9.1.3 in TS38.213:  ================== Start of TP2 ===================  **9.1 HARQ-ACK codebook determination**  \*\*\* Unchanged text omitted \*\*\*  If a UE detects a DCI format 1\_1 indicating  - SCell dormancy, as described in Clause 10.3, and  - is provided *pdsch-HARQ-ACK-Codebook = dynamic* *or enhancedDynamic-r16*  the UE generates a HARQ-ACK information bit as described in Clause 9.1.3 for a DCI format 1\_1 indicating SCell dormancy and the HARQ-ACK information bit value is ACK.  \*\*\* Unchanged text omitted \*\*\*  **9.1.3 Type-2 HARQ-ACK codebook determination**  \*\*\* Unchanged text omitted \*\*\*  If a UE receives a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK*,  - if the UE detects a second DCI format, the UE multiplexes the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format, where  - if the UE is not provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one  - if the UE is provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in Clause 9.1.3.3  - if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback-r16*, the first DCI format is neither of DL SPS release and DCI format indicating Scell Dormancy, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook , as described in Clause 9.1.4.  - otherwise, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission.  \*\*\* Unchanged text omitted \*\*\*  ================== End of TP2 =================== |

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| **Company** | **Summary of proposals** | |
| ZTE  (R1-2003452) | DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate SPS release.  DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate Scell dormancy. | |
| Huawei  (R1-2003514) | DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate Scell dormancy  DCI format 1\_1 should not simultaneously indicate a NNK1 value and indicate SPS release  **TP#2 for TS 38.213 Clause 10.2(on top of R1-2003180)**  === Unchanged part omitted ===  A UE validates, for scheduling activation or scheduling release, a DL SPS assignment PDCCH or a configured UL grant Type 2 PDCCH if  - the CRC of a corresponding DCI format is scrambled with a CS-RNTI provided by *cs-RNTI*, and  - the new data indicator field in the DCI format for the enabled transport block is set to '0', and  - the DFI flag field, if present, in the DCI format is set to '0', and  - if the PDSCH-to-HARQ\_feedback timing indicator field in the DCI format is present, the PDSCH-to-HARQ\_feedback timing indicator field does not provide an inapplicable value from *dl-DataToUL-ACK*.  === Unchanged part omitted ===  **TP#3 for TS 38.213 Clause 10.3(on top of R1-2003180)**  === Unchanged part omitted ===  If a UE is provided search space sets to monitor PDCCH for detection of DCI format 1\_1, and if  - the CRC of DCI format 1\_1 is scrambled by a C-RNTI or a MCS-C-RNTI, and if  - *resourceAllocation* = *resourceAllocationType0* and all bits of the frequency domain resource assignment field in DCI format 1\_1 are equal to 0, or  - *resourceAllocation* = *resourceAllocationType1* and all bits of the frequency domain resource assignment field in DCI format 1\_1 are equal to 1  - *resourceAllocation = dynamicSwitch* and all bits of the frequency domain resource assignment field in DCI format 1\_1 are equal to 0 or 1  - if the PDSCH-to-HARQ\_feedback timing indicator field in the DCI format is present, the PDSCH-to-HARQ\_feedback timing indicator field does not provide an inapplicable value from *dl-DataToUL-ACK*.  the UE considers the DCI format 1\_1 as indicating SCell dormancy, not scheduling a PDSCH reception or indicating a SPS PDSCH release, and for transport block 1 interprets the sequence of fields of  === Unchanged part omitted === | |
| LG  (R1-2004015) | Proposal #7: DCI format 1\_1 indicating Scell dormancy operation or DL SPS release is not allowed to indicate NNK1 value (simultaneously) | |
| Nokia  (R1-2004257) | For both DL SPS release and Scell dormancy indication, precluding NNK1 value in DCI would imply a scheduling restriction, since DL SPS release nor Scell dormancy indication could be transmitted in the end of gNB COT. On the other hand, there is no specification impact from supporting these cases.  **Proposal 10: *Inapplicable value of K1 in DL SPS release and Scell dormancy DCI is not precluded*** | |
| Qualcomm  (R1-2004445) | | Proposal 1. If UE is configured with a SPS configuration, one bit is appended to the end of Type-3 HARQ-Ack codebook. If UE detects a DCI format releasing an SPS configuration and indicates the slot in which the Type-3 HARQ-Ack is reported, the bit is set to Ack; otherwise, the bit is set to Nack.   * UE does not expect NN-K1 in a SPS release DCI.   ===TP for 38.213 Section 10.2==  A UE validates, for scheduling activation or scheduling release, a DL SPS assignment PDCCH or a configured UL grant Type 2 PDCCH if  - the CRC of a corresponding DCI format is scrambled with a CS-RNTI provided by *cs-RNTI*, and  - the new data indicator field in the DCI format for the enabled transport block is set to '0', and  - the DFI flag field, if present, in the DCI format is set to '0', and  - the PDSCH-to-HARQ\_feedback timing indicator field,if present, does not provide an inapplicable value from *dl-DataToUL-ACK*.  If a UE is provided a single configuration for UL grant Type 2 PUSCH or for SPS PDSCH, validation of the DCI format is achieved if all fields for the DCI format are set according to Table 10.2-1 or Table 10.2-2.  --Unchanged part omitted------------------------ | |

# Issue C2

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| C2 | DCI format 1\_2 usage with PUCCH priority in case of NNK1 value signaled in PDSCH-to-HARQ\_feedback timing indicator |

Companies are invited to provide their views using the table below, considering the following cases. Type 3 HARQ-ACK codebook is not mentioned since there is no field in DCI Format 1\_2 for triggering a request for Type 2 HARQ-ACK codebook.

* When two HARQ-ACK codebooks are configured for the same serving cell, if the UE detects a DCI format 1\_2 scheduling a PDSCH and indicating Priority indicator value, please provide your views on whether providing an inapplicable value for PDSCH-to-HARQ\_feedback timing indicator field is supported and if so in which conditions using the table below:

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|  | NNK1 value is not expected to be signaled in DCI format 1\_2 | NNK1 value can be signaled in DCI format 1\_2 |
| Case1: UE is configured with Type1 HARQ-ACK codebook | **QC** (DCI format 1\_2 cannot indicate NN-K1 as the configuration *dl-DataToUL-ACK-ForDCIFormat1\_2* does not include “-1”), **ZTE**, **LG** (agree with QC and ZTE that the combination of NR-U HARQ feature and URLLC HARQ feature should be avoided in this late Rel-16 phase, then can be discussed further in Rel-17),**vivo**, **Lenovo** (NNK1 is proposed only for unlicensed spectrum due to unpredictable HARQ timing. It is not justified to introduce this feature to URLLC HARQ), **Motorola Mobility** | **Ericsson** (feedback for PDSCH scheduled with NNK1, can be included in the Type3 codebook if triggered)  **Nokia, NSB** (If configured with TYPE-3 CB) |
| Case2: UE is configured with Type2 HARQ-ACK codebook | **QC** (same comment) , **ZTE, LG** (same comment),**vivo**, **Lenovo**(same as above), **Motorola Mobility** | **Ericsson** (feedback is multiplexed in PUCCH occasion indicated by the immediate next DCI scheduling another PDSCH and indicating the same Priority indicator value and applicable value for PDSCH-to-HARQ\_feedback timing indicator.)  **Nokia, NSB**  **MediaTek** (according to current specification, UE only multiplexes UCIs with the same priority index in a PUCCH or PUSCH. Spec change is not needed) |
| Case3: UE is configured with enhanced Type2 HARQ-ACK codebook | **QC** (same comment; please also see more comments in the table below).  **Nokia, NSB** (e-TYPE2 CB is in general not supported with DCI format 1\_2), **ZTE, LG** (same comment),**vivo**, **Lenovo** (same as above), **Motorola Mobility** | **Ericsson** (the enhanced dynamic codebook related parameters are not necessarily indicated in DCI 1\_2) |

Companies are invited to provide more detailed (lengthy) comments using the table below:

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| **Company** | **Summary of proposals and further companies’ views** |
| MediaTek  (R1-2003658) | Proposal 1: When enhanced dynamic HARQ-ACK codebook is configured, reuse the mechanism specified for handling DCI format 1\_0 to handle DCI format 1\_2  On handling of DCI format with inapplicable K1 value, UE may multiplex the HARQ-ACK information corresponding to a first DCI format indicating an inapplicable K1 value in a PUCCH that is indicated by an applicable value in a second DCI format. According to current specification, UE only multiplexes UCIs with the same priority index in a PUCCH or PUSCH, and multiplexing procedure is behaved independently for each HARQ-ACK codebook that is associated with a PUCCH with one of the priority indexes. Thus, it is pretty clear that UE multiplexes the HARQ-ACK information corresponding to the first DCI format only when the second DCI format indicates a PUCCH with the same priority index.  **Extracted from TS38.213 clause 9 UE procedure for reporting control information**  A PUSCH or a PUCCH, including repetitions if any, can be of priority index 0 or of priority index 1. If a priority index is not provided for a PUSCH or a PUCCH, the priority index is 0. If in an active DL BWP a UE monitors PDCCH either for detection of DCI format 0\_1 and DCI format 1\_1 or for detection of DCI format 0\_2 and DCI format 1\_2, a priority index can be provided by a priority indicator field. If a UE indicates a capability to monitor, in an active DL BWP, PDCCH for detection of DCI format 0\_1 and DCI format 1\_1 and for detection of DCI format 0\_2 and DCI format 1\_2, a DCI format 0\_1 or a DCI format 0\_2 can schedule a PUSCH transmission of any priority and a DCI format 1\_1 or a DCI format 1\_2 can schedule a PDSCH reception and trigger a PUCCH transmission with corresponding HARQ-ACK information of any priority. If, after resolving overlapping for PUCCH and/or PUSCH transmissions of a same priority index, a UE determines to transmit  - a first PUCCH of larger priority index, a PUSCH or a second PUCCH of smaller priority index, and a transmission of the first PUCCH would overlap in time with a transmission of the PUSCH or the second PUCCH, the UE does not transmit the PUSCH or the second PUCCH  - a PUSCH of larger priority index, a PUCCH of smaller priority index, and a transmission of the PUSCH would overlap in time with a transmission of the PUCCH, the UE does not transmit the PUCCH  - a first PUSCH of larger priority index on a serving cell, a second PUSCH of smaller priority index on the serving cell, and a transmission of the first PUSCH would overlap in time with a transmission of the second PUSCH, the UE does not transmit the second PUSCH, where at least one of the two PUSCH is not scheduled by a DCI format  In the remaining of this Clause, a UE multiplexes UCIs with same priority index in a PUCCH or a PUSCH. A PUCCH or a PUSCH is assumed to have a same priority index as a priority index of UCIs a UE multiplexes in the PUCCH or the PUSCH.  Observation 2: If a UE receives a first DCI providing an inapplicable K1 value, and the UE detects a second DCI indicates a slot of PUCCH or PUSCH transmission by an applicable K1 value, it is clear in current specification that UE only multiplexes the corresponding HARQ-ACK information in the PUCCH or PUSCH transmission of a same priority index indicated by the first DCI, if applicable. |
| Ericsson  (R1-2003845) | Proposal 6: When two HARQ-ACK codebooks are configured for the same serving cell, if the UE detects a DCI scheduling a PDSCH and indicating Priority indicator value and inapplicable value for PDSCH-to-HARQ\_feedback timing indicator field, the HARQ-ACK information corresponding to the PDSCH is multiplexed in PUCCH occasion indicated by the immediate next DCI scheduling another PDSCH and indicating the same Priority indicator value and applicable value for PDSCH-to-HARQ\_feedback timing indicator.  Proposal 7: The presence of (PDSCH group index, New feedback indicator, Number of requested PDSCH group(s), total DAI for non-scheduled group) in DCI 1\_2 and (total DAI for non-scheduled group) in DCI 0\_2 can be disabled even when enhanced dynamic codebook is configured.  Proposal 8: The presence of One-shot HARQ-ACK request field in DCI 1\_2 can be disabled even if higher layer parameter pdsch-HARQ-ACK-OneShotFeedback-r16 is configured. |
| Nokia, NSB (from prioritization discussion) | NN-K1 should be supported with 1\_2 (spec clarification is essential) |
| ZTE (from prioritization discussion) | At least the enhanced type2/type3 CB for DCI format 1\_2 should not be discussed in Rel-16 |
| QC | The proposal is not clear. Priority indicator field is also present in DCI format 1\_1 (and not only in DCI format 1\_2). There are two aspects related to this proposal:   1. Whether DCI format 1\_2 can indicate NN-K1 (i.e. whether to add “-1” that represents NN-K1 to *dl-DataToUL-ACK-ForDCIFormat1\_2*) 2. Whether the feature of NN-K1 in Rel. 16 NRU should be enhanced / optimized for combining with the feature of two HARQ-ACK codebooks in Rel. 16 eURLLC.   For both issues (as well as other issues such as enhanced Type 2 / Type 3 feature combined with eURLLC HARQ-Ack features), it does not belong to Rel. 16. There is already a WI in Rel. 17 to study such cases in IIOT /URLLC WI (RP-193233):   1. *Identify potential enhancements to ensure Release 16 feature compatibility with unlicensed band URLLC/IIoT operation in controlled environment [RAN1, RAN2]*   Introducing new functionalities should be avoided in Rel. 16 at this stage. |
| ZTE | We share the similar view as QC. This can be further discussed in Rel-17 URLLC WI, as at this stage it is not clear if the related design for DCI format 1\_1 can be directly re-used for DCI format 1\_2. |
| Samsung | Enhancements to ensure applicability of R16 IIOT/URLLC featured in NR-U is currently under the discussion on the scope of Rel17 WI enhanced IIOT/URLLC. No need to discuss it in Rel-16 at this stage. |
| vivo | We share similar view as QC, ZTE and Samsung. It can be discussed in corresponding Rel-17 WI. |
| Intel | Prefer to discuss URLLC related issues in Rel-17. |
| OPPO | Open up the discussion on DCI format 0\_2 and 1\_2 might involve many other potential issues, for which we don’t have enough time to go through all the details. Thus, we suggest to postpone it to next release.  Proposal: Supporting DCI format 0\_2 and 1\_2 in NRU should not be discussed in Rel.16. |
| FL summary | A majority of companies prefer to discuss enhancements to the joint configuration of URLLC and NRU features in Rel-17. It was clarified that some functionalities are not supported for DCI format 1\_2 in Rel-16 (signaling NNK1 value “-1”, signaling enhanced Type-2 codebook parameters, triggering of Type-3 codebook). If there are proposals to introduce those features in Rel-16, there is no consensus to do so. This means, proposals 7 and 8 in R1-2003845 are not going to be considered (in fact they would first require an agreement to introduce those fields in DCI format 1\_2 before being able to disable them).  However, there was also feedback that specifications may already allow some joint configurations to operate without ambiguity, i.e. when the UE is configured to monitor both DCI format 1\_1 and DCI format 1\_2. Let’s focus the remaining discussion on the compatibility of the configurations that are already defined for Rel-16, without targeting to introduce new functionalities. I tried summarizing the cases mentioned by Ericsson and Nokia below, to see if there is a common understanding on the current specs.  Case 1: handling of a PDSCH scheduled by DCI format 1\_1 with a NNK1 value when the next DCI providing a numerical K1 value is a DCI format 1\_2.   * Case 1-1: When the UE is configured with type-2 HARQ-ACK codebook, specs indicate that a second DCI provides the K1 value for the first DCI, and reporting in the same PUCCH will only occur if the PUCCH priority indicators are the same in both DCIs. * Case 1-2: When the UE is configured with enhanced type-2 HARQ-ACK codebook, an additional condition for the second DCI to provide K1 for the first DCI is that both DCI formats should correspond to the same PDSCH group. Since PDSCH group indicator cannot be signaled in a DCI format 1\_2, this DCI format 1\_2 cannot provide the K1 value for the first PDSCH.   Is the understanding above correct? If so, is any further clarification needed for these cases?  Case 2: handling of HARQ-ACK feedback for a PDSCH scheduled by DCI format 1\_2 if the UE receives a request for Type-3 codebook in a DCI format 1\_1. Ericsson’s and Nokia’s interpretation is that this is allowed and supported by the specifications, the UE will report HARQ-ACK information for the PDSCH scheduled by DCI format 1\_2 in the Type-3 HARQ-ACK codebook requested with DCI format 1\_1, only if the same value of PUCCH priority indicator is signaled in DCI format 1\_1 and DCI format 1\_2?  Is the understanding above correct? If so, is any further clarification needed for this case? |
| Nokia, NSB | Also note that Priority indicator may or may not be present in 1\_1 or 1\_2. And if not provided priority is 0. In this case there is no issue for TYPE2 and TYPE-3 CBs  Priority indicator – 0 bit if higher layer parameter *PriorityIndicator-ForDCIFormat1\_2* is not configured; otherwise 1 bit as defined in Clause 9 in [5, TS 38.213].  For TYPE-3 CB indeed first and second DCI should be of the same priority, but in TYPE-3 CB, UE shall   * transmit HARQ-ACK for all HARQ processes irrespective of priority or * only those of the same priority, and set other HARQ processes should be set to NACK?   For TYPE-2 CB, no issue. |
| QC | We think further optimization could be useful for combining these different features in some cases. However, all those aspects can be discussed in Rel. 17. There is no time in Rel. 16 for them. Please see some comments specific to the cases mentioned above:  Case 1-1: This is relevant only if UE is configured with two HARQ-ACK codebooks (PDSCH-HARQ-ACK-CodebookList-r16) as well as NN-K1 (dl-DataToUL-ACK-r16 with a “-1” value configured) at the same time for at least one of the lists. DCI format 1\_2 is not relevant for this case (both DCI formats 1\_1 and 1\_2 can have priority indicator field). Even in this case, for determining HARQ-Ack timing of the first DCI, the current rule is followed irrespective of the priority. The spec only says how K1 is determined (“in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI”). It does not say the feedback for both are reported in the same PUCCH. If they have different priorities, existing eURLLC rules are followed. Yes, it is possible to optimize this, but that’s why we have the Rel. 17 sub-agenda for this purpose.  Case 1-2: We would be ok to treat DCI format 1\_2 same as DCI format 1\_0 in enhanced type-2 codebook (since in both cases, fields related to enhanced type 2 do not exist). In this case, this is not only for NN-K1 in the case of enhanced type 2, but in general for enhanced type 2 codebook. For this, some small changes to specification is needed (mostly limited to one paragraph in Section 9.1.3.3 that talks about DCI format 1\_0).  Case 2: We do not think HARQ-Ack in type 3 CB should be a function of priority. In type 3, HARQ-Ack for all HARQ-IDs are reported. Why this should be a function of priority? |
| MediaTek | On Case 1-1, agree the understanding and no further clarification is needed. According current spec from eURLLC, UE multiplexes UCIs with the same priority index in a PUCCH or PUSCH. Thus, it is true that the second DCI providing the K1 value for the first DCI and reporting in the same PUCCH only happens if the PUCCH priority indicators are the same in both DCIs.  On Case 1-2, agree the understanding. Since the second DCI with format 1\_2 is not associated with any group according to current spec, it cannot provide the K1 value for the first DCI. No further clarification is needed for this case, and it seems joint configurations will not cause any ambiguity. Based on this observation, when both eURLLC HARQ feature and eType2 CB are configured, the PDSCHs scheduled by DCI format 2\_0 would be handled as the “third” group. However, as mentioned in our contribution, we are also fine to treat DCI format 1\_2 same as DCI format 1\_0.  On Case 2, we share similar view with Nokia and Qualcomm, TYPE-3 CB generation may conflict with the priority rule defined in eURLLC since UE transmits HARQ-ACK for all HARQ processes irrespective of priority. Further clarification in spec is needed, but it could be discussed in R17. |
| Lenovo, Motorola Mobility | On Case 1-1, why not add the restriction on the second DCI format, i.e., the second DCI is not DCI 1-2? If we add such restriction, then case 1-1 becomes the issue when HARQ-ACK CB for NR-U collides with HARQ-ACK CB for URLLC in same slot. Considering URLLC is more important than NR-U, the HARQ-ACK CB for URLLC is transmitted while HARQ-ACK CB for NR-U is dropped and waits for retransmission via GI, NFI and RI.  On Case 1-2, agree the understanding.  On Case 2, we share similar view with Nokia and Qualcomm, In Type 3 CB, HARQ-ACK feedback for all HARQ processes are reported regardless of priority indication. |
| Samsung | For case 1-1, agree the understanding,  For case 1-2, it is not clear which PDSCH group is associated with DCI 1\_2. For example, is it a separate PDSCH group other than PDSCH g=0/1? Is it a separate or same PDSCH group with DCI 1\_0? It seems reasonable to apply the same handling for DCI 1\_0 and DCI 1\_2. However, we still think it is better to deal it in Rel-17 rather than rush to a conclusion at such late stage in Rel-16.  For case 2, it is not clear whether UE should report valid HARQ-ACK for all HARQ processes or UE should report valid HARQ-ACK for HARQ processes for one priority and report NACK for HARQ processes for another priority. It is also unclear why first and second DCI should be of the same priority, if UE should report valid HARQ-ACK for all HARQ processes. Further clarification is needed, and it is better to discuss it in Rel-17 rather than rush to a conclusion at such late stage in Rel-16. |
| LG | Basically, considering this very late stage of Rel-16, the discussion on those issues involved with potential combination of NR-U and URLLC HARQ features, needs to be postponed to Rel-17. Nevertheless, the answers to each case from our side are given below.   * Case 1-1: Probably, the answer is yes. * Case 1-2: Basically, we don’t the reason not to include PDSCH group indicator in DCI format 1\_2 for such case configured with enhanced Type-2 CB.   Case 2: Same view with Lenovo that in case of Type-3 CB, HARQ-ACK feedback for all HARQ processes are reported regardless of priority. |
| vivo | We share similar views as QC that further optimizations can be discussed in Rel-17.  For case 2, type-3 codebook is organized in the perspective of HARQ process, and there is no need to restrict reporting only HARQ-ACK information for the PDSCH scheduled by DCI format 1\_1 and DCI format 1\_2 which signals the same priority. |
| Ericsson | Agree with case 1-1 and 1-2. For type 3 CB, the feedback should be reported regardless of the priority, the overhead is anyway there, so they send all NACK when the UE can actually multiplex the valid feedback. |
| Nokia, NSB | The sub-clause 9 says:  In the remaining of this Clause, a UE multiplexes UCIs with same priority index in a PUCCH or a PUSCH. A PUCCH or a PUSCH is assumed to have a same priority index as a priority index of UCIs a UE multiplexes in the PUCCH or the PUSCH.  This means that remaining clause consider only DCI formats of the same priority, if two CBs are configured. The other priority DCI formats are not considered, I hope this clarifies.  For the Case 1-2 and Case 2 lets continue discussion in R17 sub-agenda if NR-U URLLC sub-agenda is confirmed by plenary. |
| FL summary#2 | Based on the feedback, it is clear that a large majority of companies prefer to leave to Rel-17 any potential correction to the joint configuration of two HARQ-ACK codebooks (PDSCH-HARQ-ACK-CodebookList-r16) and NR-U features such as NNK1 value and enhanced type-2 codebook. It is possible that such joint configuration may work in Rel-16 depending on gNB scheduling. While some companies would be ok to define a behavior for DCI format 1\_2 as for DCI format 1\_0, other companies still prefer to leave this potential correction to Rel-17.  The only clear case of an incompatible configuration in the Rel-16 specs is when type-3 HARQ-ACK codebook and two HARQ-ACK codebooks are configured simultaneously, since contradicting rules would apply for the UE: the UE is supposed to report all HARQ processes in the type-3 codebook in the same PUCCH (or PUSCH), but those HARQ processes may be associated with different priorities. It seems to be the understanding of most companies that the UE should still report all HARQ processes in the type-3 HARQ-ACK codebook.  So resolution of issue C2 may be limited to one possible correction for Rel-16:  FL proposal:   * If a UE is configured with type-3 HARQ-ACK codebook and with PDSCH-HARQ-ACK-CodebookList-r16, the UE reports HARQ-ACK feedback for all HARQ processes in Type-3 HARQ-ACK codebook regardless of priority indication.   Companies are invited to comment on this latest proposal. |
| OPPO | We prefer not to make this agreement at the current stage. PDSCH-HARQ-ACK-CodebookList-r16 was not adequately discussed during NRU WI, and we are not completely sure about the potential issue. Moreover, we think this might go beyond the NRU CR scope. Therefore, we propose to postpone it. |
| QC | We prefer to focus on “treating DCI format 1\_2 same as DCI format 1\_0 in enhanced type-2 codebook”.  For type-3, we would like to understand the specification impacts first. Hence, we suggest to directly discuss the TPs (if any) from the supporting companies (which is similar to the approach we took for some other issues). Agreeing to the proposal may mean that in fact we start to optimize the combinations of these different features. Our understanding is that the goal here is that if two features can already work but small changes / clarifications to the spec is required, that can be discussed. |
| Nokia, NSB | 1) We strongly insist to treat DCI format 1\_2 as non-fall-back DCI, because it is non-fall-back DCI same as DCI format 1\_1, and introduce support for h, g, q in 1\_2 in R17 …. so at least here we would not be able to find compromise with QC at this point.  2) We prefer to Conclude that NN-K1 is currently supported with DCI format 1\_2 and TYPE-2 CB … or is QC still of different opinion?  3) For  FL proposal:   * If a UE is configured with type-3 HARQ-ACK codebook and with PDSCH-HARQ-ACK-CodebookList-r16, the UE reports HARQ-ACK feedback for all HARQ processes in Type-3 HARQ-ACK codebook regardless of priority indication.   We believe it requires at least specification clarification if agreed, but in principle this could work out of box. I agree with Mostafa that better to investigate broadness of specification change, before rushing into agreement. |
| MediaTek | On concluding that NNK1 is supported with DCI 1\_2 when Type2 CB is configured, we are ok with it.  Response to Nokia. On treating DCI format 1\_2 as fallback DCI, even we don't have a strong preference for it, we have a point different from Nokia. It depends on how we captures it the specification. If specification can generally capture how to handle a DCI format without fields of h, g, and q, then it will not put a restriction on DCI format 1\_2 if the fields of h, g, and q can be configured in DCI format 1\_2 in the future release. Moreover, even those fields can be configured in DCI format 1\_2 in the future release, it is possible that they are still absent in DCI format 1\_2. Then, we still need a mechanism to handle this case anyway. Consequently, to have a mechanism to handle DCI without fields of h, g, and q is better for forward compatibility.  On Type-3 CB, we share similar view with QC. R16 eURLLC defines some multiplexing and dropping rules for UCI reports with different priorities, and we don't know whether it is sufficient to avoid all possible ambiguities even the FL proposal is adopted. Thus, instead of rushing to a conclusion at this stage, we suggest to leave this issue to R17. |
| FL summary #3 | Given the additional feedback and the preference from a large majority of companies to leave optimizations and corrections on the joint configuration of URLLC and NRU to Rel-17, we could try to capture observations we reached in the discussion on joint configurations of URLLC and NR-U that seem to work without ambiguity, and others can won’t work based on Rel-16 specs, such as:  Examples of joint configurations/signaling that can work in Rel-16:   * Handling of NNK1 value with Type-2 CB and 2 HARQ-ACK codebook priorities, using DCI format 1\_1 and/or DCI format 1\_2 * Handling of NNK1 value with eType-2 CB and 2 HARQ-ACK codebook priorities using DCI format 1\_1/1\_0   Examples of joint configurations/signaling that cannot work in Rel-16:   * Handling of NNK1 value with eType-2 CB and 2 HARQ-ACK codebook priorities using DCI format 1\_1/1\_0 and DCI format 1\_2 * Reporting Type-3 CB when different HARQ processes have been scheduled with different PUCCH priorities   There seems to be no consensus on even enabling the two cases above that cannot work in Rel-16, as this is considered as optimization rather than simple correction.  Companies are invited to comment on the goal to capture observations such as the one above, and not targeting any TP for Rel-16 related to issue C2. |
| Nokia, NSB | Given the conclusion we made today on not making any corrections in R16 anymore, I think concluding on what works and what does not work would be useful for RAN. We support FL proposal. |
| QC | The second example (eType-2) seems to be not supported based on RRC configurations in 38.331 shown below (unless if we would like to optimize and inform RAN2 to change this, which goes against the conclusion)  PDSCH-HARQ-ACK-CodebookList-r16 ::= SEQUENCE (SIZE (1..2)) OF ENUMERATED {semiStatic, dynamic} |
| FL summary #4 | Conclusions were made in GTW session:  Conclusion:  No corrections for joint configurations of eURLLC features and NR-U for issues B6 in R1-2004745 and C2 in R1-2004746 (no TPs for these issues) in Rel-16 (Note: Joint configurations of eURLLC and NR-U is supported)  So let’s continue the discussion the reach observations on configurations that work or don’t work in Rel-16, with accurate descriptions.  Based on QC’s feedback, I moved the second bullet point to the list of configurations that are not supported. Since this is not supported irrespective of NNK1 value or DCI format, I removed those details from the bullet and merged it as case 2 with the first bullet point of non-supported cases. I made some revisions for clarity by referring to the RRC configuration parameters.  Examples of joint configurations/signaling that can work in Rel-16:   * Case 1: Handling of NNK1 value (dl-DataToUL-ACK-r1 with value -1) with Type-2 HARQ-ACK codebook and two HARQ-ACK codebook priorities (when UE is provided with PDSCH-HARQ-ACK-CodebookList-r16), using DCI format 1\_1 and/or DCI format 1\_2   Examples of joint configurations/signaling that cannot work in Rel-16:   * Case 2: Joint configuration of Enhanced Type-2 HARQ-ACK codebook and two HARQ-ACK codebook priorities (when UE is provided with PDSCH-HARQ-ACK-CodebookList-r16) * Case 3: Reporting Type-3 HARQ-ACK codebook when different HARQ processes have been scheduled with different PUCCH priorities (when UE is provided with PDSCH-HARQ-ACK-CodebookList-r16)   Are the 3 cases above accurate and agreeable as observations for Rel-16? |
| MediaTek | Regarding the RRC configurations in 38.331 not include eType-2 CB, we think it is still fine to provide conclusions from RAN1 spec’s perspective, and whether to optimize RRC signaling could be up to RAN2 decision. In this sense, we suggest the following conclusions:  For the examples of joint configurations/signaling that can work in Rel-16, we suggest to add one more example:  Examples of joint configurations/signaling that can work in Rel-16 from RAN1’s perspective:   * Case 1: Handling of NNK1 value (dl-DataToUL-ACK-r1 with value -1) with Type-2 HARQ-ACK codebook and two HARQ-ACK codebook priorities (when UE is provided with PDSCH-HARQ-ACK-CodebookList-r16), using DCI format 1\_1 and/or DCI format 1\_2 * Case 2: Handling of NNK1 value (dl-DataToUL-ACK-r1 with value -1) with eType-2 CB and 2 HARQ-ACK codebook priorities using DCI format 1\_1/1\_0 * Case 3: Reporting eType-2 CB when 2 HARQ-ACK codebook priorities are provided (when UE is provided with PDSCH-HARQ-ACK-CodebookList-r16)   Examples of joint configurations/signaling that cannot work in Rel-16 from RAN1’s perspective:   * ~~Case 2: Joint configuration of Enhanced Type-2 HARQ-ACK codebook and two HARQ-ACK codebook priorities (when UE is provided with PDSCH-HARQ-ACK-CodebookList-r16)~~ * Case 4: Reporting Type-3 HARQ-ACK codebook when different HARQ processes have been scheduled with different PUCCH priorities (when UE is provided with PDSCH-HARQ-ACK-CodebookList-r16) |

# Issue C3

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| C3 | Out-of-Order issue for NNK1 |

Companies are invited to provide detailed comments on the issue and on the TP proposed in R1-2004445 using the table below.

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| **Company** | **Summary of proposals and further companies’ views** |
| Qualcomm  (R1-2004445) | Non-numeric K1 may result in out-of-order operation. This can happen when a first DCI that indicates non-numeric K1 is detected but a second DCI that indicates a numeric K1 (and was supposed to indicate the timing for HARQ-Ack for the PDSCH scheduled by the first DCI) is missed.    **Proposal 2. HARQ-Ack for a PDSCH that is scheduled with a non-numeric K1 is multiplexed in the next PUCCH that carries HARQ-Ack and satisfies the UE PDSCH processing timeline for the PDSCH if UE has not detected the second DCI with numeric-K1 that points to an slot earlier than the PUCCH slot**.  ==TP for 38.213 Section 9.1.3===  --Unchanged part omitted------------------------  If a UE receives a first PDSCH scheduled by a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK*,  - if the UE detects a second DCI format, the UE multiplexes the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format, where  - if the UE is not provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one  - if the UE is provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in Clause 9.1.3.3  - if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in Clause 9.1.4.  - if there is a PUCCH or PUSCH transmission in a slot that carries HARQ-Ack and satisfies timing conditions in Clause 9.2.5, and the second DCI has not been detected that points to an earlier slot for HARQ-Ack transmission, the UE multiplexes the HARQ-ACK information for the first PDSCH in the PUCCH or PUSCH transmission in the slot.  --Unchanged part omitted------------------------ |
| Ericsson | Our understanding of the rel-15 behaviour is that the UE is not expected to send out of order HARQ. In the example from Qualcomm, if the UE misses PDCCH for PDSCH2, the UE is not expected to include the feedback in PUCCH2 when there is another PDSCH (SPS PDSCH) that points to an earlier PUCCH (PUCCH1).  The proposed changes will result in adding the feedback to PUCCH 1. But that does not solve any problem, since the size of the codebook to be included in PUCCH 1 is anyway erroneous due to the missed last PDCCH (PDCCH for PDSCH 2).  We do not support the proposal. |
| QC | Response to Ericsson: The proposal prevents from error propagation. Even if the payload size in PUCCH1 cannot be corrected in the example (since the last DCI is missed), the PUCCH2 will have the correct codebook size in the proposal. Without the proposal, not only PUCCH1 has a wrong codebook size, but also PUCCH2 will not be transmitted (as this is an error case in Rel. 15 and UE behavior is not defined).  In addition, the current condition “otherwise, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission” in current spec is never satisfied as there is always a second DCI (UE has to wait until infinity to get to the “otherwise” part). |
| Nokia, NSB | We suggest the following wording  …..  - if UE reports HARQ-ACK for DL SPS PDSCH scheduled after first DCI in a PUCCH or PUSCH for which timing conditions in Clause 9.2.5 are satisfied and does not detect the second DCI, the UE multiplexes the HARQ-ACK information for the first PDSCH in the PUCCH or PUSCH transmission in the slot.  - otherwise, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission. |
| ZTE | We think DL SPS PDSCH scheduling is the special case potentially causes the out of order issue and for the normal PDSCH scheduling the existing spec has no problem. In this sense, Nokia’s wording seems better. |
| MediaTek | Support the proposal from QC and the revised TP from Nokia, with further modifications:  If a UE receives a first PDSCH scheduled by a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK*,  - …..  - if the UE reports HARQ-ACK for a SPS PDSCH reception in a PUCCH or PUSCH transmission in a slot after the first DCI format for which timing conditions in Clause 9.2.5 are satisfied, and the UE does not detect a second DCI format before the PUCCH or PUSCH transmission, the UE multiplexes the corresponding HARQ-ACK information in the PUCCH or PUSCH transmission in the slot.  - otherwise, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission. |
| Samsung | We think UE is not expected to send HARQ-ACK of an out of order PDSCH. In the example provided by QC, assuming PDSCH 1, PDSCH 2(missed PDSCH) and PDSCH 3 are in the same PDSCH group and C-DAI=1,2,3 respectively, UE should transmit NACK in the corresponding HARQ-ACK bit location for C-DAI =1/2, i.e. UE does not transmit valid HARQ-ACK of PDSCH1.  The suggested wording by Nokia would lead to error case in some scenarios. For example, if the missed PDSCH is K1=2, i.e. gNB expects UE to report HARQ-ACK of PDSCH 1 and missed PDSCH in PUCCH 0 between SPS PDSCH and PUCCH1. Then, according to the proposal by Nokia, UE reports HARQ-ACK of PDSCH1 in PUCCH1.  So, we do not support the proposal. |
| LG | We have similar understanding with Ericsson on the OOO case in Rel-15 and also have some concerning/questioning points on the above proposal.  If HARQ-ACK for the PDSCH scheduled by NNK1 would be reported together with the HARQ-ACK for SPS PDSCH on a same PUCCH as proposed in above,  - Q1: how to determine the PUCCH resource? (since it may not be the PUCCH resource dedicated for HARQ-ACK of SPS PDSCH)  - Q2: how to generate the corresponding HARQ-ACK payload? (only for the PDSCH(s) scheduled by NNK1? or including all the C-DAI values before the PDSCH by NNK1?)  - Q3: If HARQ-ACK for the PDSCH scheduled by NNK1 would be allowed to report onto the early PUCCH as proposed in above, does it mean that HARQ-ACK for the PDSCH scheduled by NNK1 would be reported onto the earliest PUCCH after the PDSCH reception? (seems unnecessary to mention the second DCI) |
| vivo | We do not support the proposal and share the similar view as Ericsson and LG. Besides, the PUCCH resource configured for SPS PDSCH HARQ-ACK is of PUCCH format 0 or 1 according to NR Rel-15, so the payload is also very limited. |
| Lenovo, Motorola Mobility | We don’t support this proposal. We share similar concern with LG. |
| Intel | Assuming out-of-order HARQ-ACK transmission is anyway needs to be avoided, the case mentioned by QC can already be handled by current spec. UE behavior likes below  - To prepare for PUCCH 1, UE knows it must report HARQ-ACK for PDSCH 1 and the SPS PDSCH. However, a dynamic allocated PUCCH resource is not available (due to missing PDSCH with K1=3), UE cannot transmit the PUCCH.  - it is up to UE to pretend to not receive anything, so as to report only SPS HARQ-ACK on the SPS PUCCH resource  - at PUCCH 2, gNB could trigger retransmission of all early PDSCH transmissions including PDSCH 1, PDSCH with K1=3 (missed) and SPS PDSCH  - for Type2 codebook, bit ordering is by C-DAI in the group  - for Type3 codebook, bit ordering is by HARQ process number  In conclusion, we don’t think the proposal is needed. |
| OPPO | Firstly, we think this is a corner case. Secondly, the proposal also cause a new ambiguity of the CB size in PUCCH1.  We don’t support this proposal. |
| QC\_2 | Response to SS: Without the TP, UE is not expected to handle this scenario (we do not think “UE should transmit NACK in the corresponding HARQ-ACK bit location for C-DAI =1/2” would be current behavior). This results in PUCCH2 not being transmitted at all (UE behavior is not defined).  Response to LG: For Q1, PRI in the first DCI determines the PUCCH resource as usual (as if the first DCI pointed to PUCCH1 since this is the last DCI from UE point of view). For Q2, DAI is followed as usual. Depends if any other DCI points to this PUCCH1 or not (again, as if the first DCI pointed to PUCCH1). For Q3, yes, otherwise there is out-of-order issue.  Response to Intel: Regarding PUCCH resource when feedback of PDSCH1 is included in PUCCH1, please see our response to LG above. Regarding the second comment, we are not sure how “at PUCCH 2, gNB could trigger retransmission of all early PDSCH transmissions including PDSCH 1, PDSCH with K1=3 (missed) and SPS PDSCH” is done based on current spec. Does this comment refer to type 2 or enhanced type 2?  General response: We would like to point out that main goal here is not the suggestion of including the HARQ-Ack for PDSCH1 (NN-K1) in PUCCH1. Instead, the main goal is to prevent from propagating the error to PUCCH2. In that sense, it is equally acceptable to have a condition that the UE discards the HARQ-Ack in that case (instead of transmitting HARQ-Ack in PUCCH1). Hence, we think the following modified proposal can also solve the problem, which can be captured in the “otherwise” part of the current spec (as mentioned before, the current “otherwise” condition never kicks in in the current spec):  **Alternative Proposal: HARQ-Ack for a PDSCH that is scheduled with a non-numeric K1 is discarded if UE has not detected a second DCI with numeric-K1 that points to the next PUCCH that carries HARQ-Ack and satisfies the UE PDSCH processing timeline for the PDSCH**. |
| FL summary | Companies are invited to comment on Qualcomm’s alternative proposal, with the goal to clarify the UE behavior for discarding a PDSCH scheduled with a NNK1 value in order to avoid OOO HARQ reporting. |
| Nokia, NSB | We are fine with Updated QC proposal |
| Intel | Fine for updated QC proposal. I prefer to add one sub-bullet or one note saying that  - retransmission of HARQ-Ack for a PDSCH that is scheduled with a non-numeric K1 by enhanced dynamic codebook or one-shot feedback is not precluded.  This is to clarify that ‘discarded’ doesn’t mean completely drop the bit but only drop in next PUCCH. |
| OPPO | We see the concern from QC that ‘otherwise’ condition in the current spec is not clear. But we are not sure to understand the proposed solution. To our understanding, the alternative proposal says that the UE will drop the HARQ-ACK **if UE has not detected a second DCI with numeric-K1 that points to the next PUCCH that carries HARQ-Ack and satisfies the UE PDSCH processing timeline for the PDSCH**. But we don’t understand how the UE determines ‘has not detected’? One possible interpretation is that when the UE detects a next DCI that points to a PUCCH occasion that carriers the HARQ-ACK of the other group and the PUCCH occasion satisfy the PUSCH processing time condition, in this case the UE determines ‘has not detected’ and the UE will drop the HARQ-ACK of the NNK1 PDSCH? If our interpretation is correct, we don’t think this is a reasonable solution, because it would force the gNB to schedule the same group of the NNK1 PDSCH first. Otherwise, the HARQ-ACK will be dropped.  To us, a similar issue has been discussed in RAN2 and they have introduced a timer for the case when a first DCI schedules a PDSCH with NNK1, and the UE expects that a second DCI is sent within the timer duration. Thus, it would be reasonable that if the UE does not detect the second DCI within the timer duration, the UE will kick in the ‘otherwise’ condition. So to solve the issue raised by QC. We propose the following TP.  =============== proposed TP for 38.213 9.1.3=======================  If a UE receives a first PDSCH scheduled by a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from dlDataToUL-ACK,  - if the UE detects a second DCI format, the UE multiplexes the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format, where  - if the UE is not provided pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one  - if the UE is provided pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQACK information report for a same PDSCH group index as indicated by the first DCI format as described in Clause 9.1.3.3  - if the UE is provided pdsch-HARQ-ACK-OneShotFeedback-r16, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in Clause 9.1.4.  - otherwise, if the drx-RetransmissionTimerDL corresponding to the HARQ process number of the PDSCH scheduled by the first DCI format expires according to [TS38.331], the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission. |
| Samsung | We are fine with Updated QC proposal.  Response to QC’s previous comment to SS: The reason I think UE should transmit NACK in the corresponding HARQ-ACK bit location for C-DAI =1/2 is, if UE detects OOO, UE assumes it is an error case, so UE discards the received DCI. But when UE receives PDSCH 3 in the same PDSCH group and C-DAI=3, UE knows there’re two bits are missing before PDSCH 3, so UE reports NACKs for C-DAI=1/2. |
| LG | We have a bit different understanding on the handling of this OOO case concluded in Rel-15. Since UE is not expected to be scheduled as such OOO manner, it would be up to the UE whether the corresponding PDSCH is discard. With reasonable UE implementation, the UE would discard the PDSCH without corresponding HARQ-ACK feedback, and thus we think no TP is necessary.  And regarding the above new TP provided by OPPO, the issue with retransmission timer doesn’t seem to be only related to this PDSCH scheduled by NNK1 but related to normal PDSCH. So, we don’t see the necessity of the TP. |
| vivo | We have the same concern as OPPO. As comments from Intel, it is better to clarify what’s the meaning of ‘discarded’. |
| Ericsson | Agree with LG on the OOO behaviour. |
| QC | **Response to OPPO**: Once PUCCH1 is transmitted, UE already knows that the condition ‘has not detected’ is satisfied.  I am not following this part “One possible interpretation is that when the UE detects a next DCI that points to a PUCCH occasion that carriers the HARQ-ACK of the other group and the PUCCH occasion satisfy the PUSCH processing time condition, in this case the UE determines ‘has not detected’ and the UE will drop the HARQ-ACK of the NNK1 PDSCH?” First, I assume you meant PDSCH processing time (not PUSCH; unless if you are referring to UCI multiplexing). Second, what is “the other group”? Proposal is not specific to enhanced type 2 as the out-of-order issue is a general restriction.  Regarding “it would force the gNB to schedule the same group of the NNK1 PDSCH first”. For the case of enhanced type 2, if that results in out-of-order, should it be allowed? Are you suggesting that gNB on purpose schedules PDSCH/HARQ-Ack that results in out-of-order operation? In the example we gave, that is not the gNB intention, but because of the second DCI is missed, the issue occurs.  Regarding the drx-RetransmissionTimerDL, these are separate issues. What if UE is not configured with DRX? Also, it does not solve the problem of error propagation to PUCCH2.  **Response to LG/Ericsson**: In the absence of the TP, this is an error case, which means there is no UE behavior specified or even expected. It does not mean that only one HARQ-Ack bit is discarded. It means that the whole codebook in PUCCH2 is invalid. The issue here is that gNB cannot prevent this case (it is not a misconfiguration or wrong scheduling). gNB is not even aware of out-of-order situation that the UE is facing. Also, this is in no way a corner case as this can happen because of only one missing DCI when NN-K1 is used, and the impact is not limited to the PUCCH that the missing DCI is pointing to.  A TP is provided below for clarification (it is fine to focus on the proposal first, if that approach is preferred):  If a UE receives a first PDSCH scheduled by a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK*,  - if the UE detects a second DCI format, the UE multiplexes the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format, where  - if the UE is not provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one  - if the UE is provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in Clause 9.1.3.3  - if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in Clause 9.1.4.  - if there is a PUCCH or PUSCH transmission in a slot that carries HARQ-Ack and satisfies timing conditions in Clause 9.2.5, and the second DCI indicating the slot for HARQ-Ack transmission as described above is not detected, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission. |
| OPPO | **Respond to QC:**  Sorry Mostafa, the PUSCH processing time was a typo, I just wanted to copy your proposal and somehow I typed PUSCH…  From what I understand from your explanation, the problem is that the UE does not know when to enter the ‘otherwise condition’ and our proposal just gives the UE a clear way to determine the ‘otherwise condition’ happened and then the HARQ-ACK is dropped. Also, I believe in RAN2 they have defined the timer in particular for NNK1 case. When a DCI schedules a NNK1 PDSCH, the timer is started and the UE is expected to be scheduled by a second DCI with numerical K1 within the timer running time. Thus, we think that this timer might be used to resolve the issue you mentioned. But we don’t have strong opinion on this—only a proposal for discussion ☺.  Regarding the OOO issue, I fear that I didn’t fully get your point, so I will try to understand it better—in your figure, do you mean that if the DCI after PDSCH1 were not missed by the UE, the DCI should have pointed to the PUCCH1, in which the HARQ-ACK of PDSCH1 must be reported? |
| QC | **Response to OPPO**  Thanks Hao for the question. That is right. gNB did not mean to create the out-of-order issue (since it knows that it is an error case). The second DCI was supposed to point to PUCCH1. This results in not only PUCCH1 having a wrong codebook size, but also behavior for HARQ-Ack in PUCCH2 not being defined as the third DCI indicates to the UE that feedback for PDSCH1 should be transmitted on PUCCH2 (in the absence of the proposed TP). |
| FL summary#2 | Views are still very diverse in this discussion. Several companies think that a clarification of the UE behavior is not necessary since rules already exist in the specs to clarify that UE should not expect OOO scheduling irrespective of numerical K1 or NNK1 value. So the second proposal from Qualcomm did not reach consensus.  The third proposal from Qualcomm is to revise the “otherwise” condition:  if there is a PUCCH or PUSCH transmission in a slot that carries HARQ-Ack and satisfies timing conditions in Clause 9.2.5, and the second DCI indicating the slot for HARQ-Ack transmission as described above is not detected, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission.  I guess the intent of the proposal above is that the second DCI is not the one that points to the PUCCH or PUSCH that satisfies the timing conditions for the first DCI scheduling PDSCH reception. If so the wording could be improved, e.g.:  if there is a PUCCH or PUSCH transmission in a slot that carries HARQ-Ack and the timing conditions in Clause 9.2.5 for the first DCI format detection are satisfied for the slot, and the UE has not detected an applicable second DCI (as described above) indicating the slot, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission.  What are companies’ views on this latest proposal from Qualcomm (with or without my revisions)? |
| OPPO | **Response to QC:**  Regarding the OOO issue, we still don’t get why in enhanced type2 CB between two groups, QC sees it as an issue. To us, the implementation should support the OOO between PDSCH groups anyway. For example below, a UE is scheduled by a first DCI with PDSCH group 0 (with q=0) and points to PUCCH0, then later the UE is scheduled by a second DCI with PDSCH group 1 (with q=0) and points to PUCCH1, later the UE is scheduled by a third DCI with PDSCH group 1 (with q=1) and points to PUCCH2. If the UE fails the LBT on PUCCH0, the UE will report the HARQ-ACK of group 0 later than PUCCH1 anyway. We believe that the implementation to handle this case is same as in OOO case. For this reason, we don’t think the non-OOO restriction between PDSCH groups is needed as this case cannot be avoided.    From the above analysis, we think the ‘otherwise’ case is not necessary, and we make the following revised TP.  =============== proposed TP for 38.213 9.1.3=======================  If a UE receives a first PDSCH scheduled by a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from dlDataToUL-ACK,  - When the UE detects a second DCI format, the UE multiplexes the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format, where  - if the UE is not provided pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one  - if the UE is provided pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQACK information report for a same PDSCH group index as indicated by the first DCI format as described in Clause 9.1.3.3  - if the UE is provided pdsch-HARQ-ACK-OneShotFeedback-r16, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in Clause 9.1.4. |
| QC | **Response to OPPO:**  OOO operation is not allowed in Rel. 16 except in the case of multi-DCI based multi-TRP (two values of CORESETPoolIndex), which has its own UE capability signalling. For the case of single TRP, eURLLC WI extensively discussed OOO in Rel. 16 and concluded that it is not supported. In all cases (except mDCI based mTRP), including enhanced type-2, OOO is not supported.  The figure you illustrated above is not OOO because the first PDSCH is processed and the feedback for the first PDSCH is already prepared to be transmitted in PUCCH0, and in PUCCH2, HARQ-Ack for the first PDSCH is simply retransmitted. It does not impact UE pipelining for processing two OOO PDSCHs (which is the reason that Rel. 15 has the OOO restriction).  On the other hand, the figure below for the case of enhanced type 2 is in fact OOO (which is not allowed, i.e., error case). This happens because of NN-K1. In the figure, it is assumed that the second DCI indicates a different group (g=1) but does not indicate q=1 (otherwise, there is no OOO issue as the second DCI determines that feedback for PDSCH1 is included in PUCCH1). Again, the issue is not specific to enhanced type-2 (it is specific to NN-K1). I hope this clarifies. |
| LG | Regarding QC’s concern, I understood that the OOO event might a bit more happen under NR-U situation compared to licensed band operation, due to the potential combination of NNK1 indication and DCI missing. But, still my current thinking is that it could be handled by a reasonable UE implementation, and I’d like to hear other companies’ opinion on this. BTW, if a corresponding TP is necessary, it might be better to formulate as the following way.  ============================================================  If a UE receives a first PDSCH scheduled by a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK*,  - if the UE detects a second DCI format and a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI indicates a slot with the first PUCCH or PUSCH transmission carrying HARQ-ACK after the first PDSCH reception that satisfies the timing conditions in Clause 9.2.5, the UE multiplexes the corresponding HARQ-ACK information in the PUCCH or PUSCH transmission, where  - if the UE is not provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one  - if the UE is provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in Clause 9.1.3.3  - if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in Clause 9.1.4.  - otherwise, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission.  ============================================================  On the other hand, regarding the example in the above OPPO’s figure, I agree with QC that such situation doesn’t seem to be considered as the OOO case since it is seen as just a retransmission of the previous HARQ-ACK feedback, and it would not be involved with the PDSCH processing. |
| OPPO | **Response to QC and LG**  I agree with you that the figure I provided was not OOO case, as I said in my previous response. It was my intention to give a non-OOO case to show that there is not much of difference from OOO, at least I have difficulty in seeing the difference from implementation point of view. @Mostafa and Sukchel, sorry if I mis-understood something.  The upper figure is not OOO, but the lower figure is OOO. Let’s see what the difference is. For upper case, the UE prepares the CB of g=0 for PUCCH0 and he cannot transmit it, then the UE holds the CB of g=0 until he receives the third DCI and transmits the CB of g=0 in PUCCH2.    For the lower case, the UE prepares the CB of g=0 for PUCCH2, when he detects the last DCI. If the processing time between the PDSCH3 and PUCCH2 is enough, what is the problem for reporting CB of g=0 in PUCCH2? Given that PDSCH1 is always before PDSCH3, I don’t see there is an issue for insufficient processing time for PDSCH1. |
| QC | TP provided by LG looks fine to us. One minor suggestion:  if the UE detects a second DCI format and a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI indicates a slot with the earliest PUCCH or PUSCH transmission carrying HARQ-ACK after the first PDSCH reception that satisfies the timing conditions in Clause 9.2.5, the UE multiplexes the corresponding HARQ-ACK information in the PUCCH or PUSCH transmission, where  @Hao: OOO is not necessarily about PDSCH processing time (N1). It is about UE complexity with respect to pipelining. There have been extensive discussions on the impact of OOO to UE processing and pipelining in Rel. 16 URLLC. The conclusion was:  **Conclusion:**   * For Rel. 16 URLLC, no support of out-of-order/overlap PDSCH/HARQ and out-of-order/overlap PUSCH operation.   In the example you had, first PDSCH is already processed and HARQ-Ack bit is determined and generated. In the example I gave, UE does not know when feedback for PDSCH1 is going to be reported and HARQ-Ack for it is not determined / generated yet (because of NN-K1).  When you say “I don’t see there is an issue for insufficient processing time for PDSCH1”, do you think that the following case is also supported? |
| OPPO | @Mostafa, thank you for further clarifications. Please note that I am not disputing that OOO is not an issue for all the cases. But I am a bit confused with the OOO for inter-group case. For your example above, do these two PDSCHs belong to the same group, if so I agree that we should not support this case. But I feel puzzled that why we cannot support it if they belong to different groups. The CBs are generated separately with dedicated C-DAI/T-DAI. They are not dependent at all.  But I noticed that you mentioned the reason of ‘pipelining’. Please correct me if I am wrong. Does it mean that even though these two PDSCHs from two different groups are scheduled, they will be processed in the same pipeline, and for an earlier PUCCH2 reporting, the PDSCH2 is supposed to be processed earlier than PDSCH1, but since PDSCH1 is buffered in the pipeline already, the processing ordering cannot be changed? If my understanding is correct, it seems that this is really related to a particular implementation structure. Then I tend to agree with LG that why we cannot open for more diverse implementation? But instead, we restrict to a particular implementation structure? |
| QC | @ Hao, thanks for your comments. I do not understand how “PDSCH group” plays a role in UE complexity with respect to processing.  For different PDSCH groups, you mentioned “The CBs are generated separately with dedicated C-DAI/T-DAI”, but in the example above (the latest one above assuming regular type 2, i.e., no PDSCH group), CBs are also generated separately with dedicated C-DAI/T-DAI since they are in different slots/PUCCH resources and A/N belong to different codebooks. Then, why do you think the case above is different in terms of UE complexity for regular type 2 vs enhances type 2? What is different between the two? It seems that you agree that the example above is not supported in Rel. 15. For the same reason, it is not supported in enhanced type 2 unless if you think that enhanced type 2 makes it easier from UE complexity point of view.  When I referred to pipelining, I did not refer to a particular UE implementation choice. I was referring to the reason that OOO is not supported in the first place, and also referring to the discussions that took place in eURLLC AI. |
| FL summary #3 | I have questions for clarification. QC wrote “UE does not know when feedback for PDSCH1 is going to be reported and HARQ-Ack for it is not determined / generated yet (because of NN-K1)”. This is a possibility, and the gNB must ensure the PDSCH processing time requirements are met with respect to the second DCI that provides a numerical K1. But the UE could have determined/generated the HARQ-ACK bit for the PDSCH scheduled with NNK1 earlier (which would be consistent with the assumption of a pipelined implementation, and I assume the UE would want to pass the result to its higher layers as soon as possible). Why would the UE wait for decoding the PDSCH until it receives a numerical K1 value? Wouldn’t it be even more complex to wait from a UE implementation perspective?  Looking at Hao’s example, even if the UE fails to transmit the PUCCH due to LBT failure, in my understanding this PUCCH occasion should be considered as the first transmission of the HARQ-ACK information, and a later PUCCH would correspond to a re-transmission.  What are other companies’ views on LG’s TP copied below? (note that the wording below may need to be adjusted according to the discussion on issue C1 if “first PDSCH reception” needs to be avoided):  - if the UE detects a second DCI format and a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI indicates a slot with the first PUCCH or PUSCH transmission carrying HARQ-ACK after the first PDSCH reception that satisfies the timing conditions in Clause 9.2.5, the UE multiplexes the corresponding HARQ-ACK information in the PUCCH or PUSCH transmission, where  - if the UE is not provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one  - if the UE is provided *pdsch-HARQ-ACK-Codebook = enhancedDynamic-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in Clause 9.1.3.3  - if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in Clause 9.1.4.  - otherwise, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission. |
| OPPO | @Mostafa, I see your point and I agree that ‘PDSCH group’ does not play role here. Sorry for the mis-leading.  However, I still believe that the case for NNK1 is a bit different from what has been discussed in Rel.15 or eURLLC. If I may, I would like to reuse the above three examples to explain why I think they are different, and we here name these three examples as case 1, case 2 and case 3 (figures reinserted below)    case 1    Case 2    Case 3  As you can see from the analysis below, the case 1 and case 2 still respect the rule that who prepares the uplink earlier, would transmit the PUCCH earlier. I see the difference coming from that the UE won’t prepare the uplink when he receives a PDSCH indicated with NNK1. But for case 3, I agree that it is indeed OOO. Please let me know what is wrong with my analysis for case 2. Thanks in advance. |
| Lenovo, Motorola Mobility | We generally agree with LG’s proposed TP. Meanwhile, there are some terms not clear to us. E.g., how to understand “the first PUCCH or PUSCH transmission carrying HARQ-ACK after the first PDSCH”? What is “the first” referring? Does it imply the earliest PUCCH occasion after the reception of the first PDSCH or the PUCCH occasion indicated by HARQ timing field in the second DCI format? What is the consequence if removing “the first” if the PUCCH occasion is indicated by the second DCI? |
| QC | **Regarding the TP:** TP from LG looks fine to us. One suggestion that we also mentioned before is to replace “first” with “earliest”.  **Regarding the question from David / Hao**: Even when PDSCH processing time is enough (as shown in Case 3 using Hao’s numbering), OOO is not allowed. Yes, UE could start processing the PDSCH w/o waiting for second DCI, but does it mean that OOO restriction should be relaxed for this case? In our understanding, NN-K1 and/or enhanced type 2 CBs should be used in accordance with the OOO restriction. We would like to ask the following question: If in Case 2, instead of NN-K1, the first DCI pointed to PUCCH2, it makes it the same as Case 3 (plain vanilla OOO). What makes it ok when another DCI (instead of the first DCI) points to PUCCH2 for transmission of HARQ-Ack of PDSCH1?  In the Case 3 with the “PDSCH proc.” and “UL prep” shown in Hao’s Figure, why UE does not do the blue “UL prep” step after the green “UL prep” if anyway it can do it in the Case 2? With the same reasoning, why you are not arguing that OOO should be allowed even in Case 3? Isn’t Case 2 more difficult than Case 3 since there are only additional steps involved for determining timing for HARQ-Ack for the first PDSCH (as opposed to Case 3, where the timing is known much earlier as it is indicated in the same DCI that scheduled the PDSCH)?  When it comes to retransmission of a HARQ-Ack (e.g. in Case 1), PDSCH processing is not involved at all, and seems that everyone agrees that it is ok (same for Type-3, where HARQ-Ack for a previous PDSCH can be retransmitted). |
| OPPO | @Mostafa: thanks for follow up comments, really appreciated ☺  For case 3, the UE knows the PUCCH resource when he receives PDSCH0 (numerical K1), thus the UE can start to do the blue ‘UL prep’ after the PDSCH0 decoding. To me, it would also make sense that an advanced UE could postpone the blue ‘UL prep’ after preparing the green ‘UL prep’ to resolve the OOO issue. But I know that it was the case for R15 and I would not like to dispute this. On the other hand, for case 2, the situation is different. The UE CANNOT prepare UL when he receives PDSCH0 (due to NNK1), it has to wait until it receives PSDCH2 (with numerical K1). In this case, we are sure that the UE will prepare the blue ‘UL prep’ after the green ‘UL prep’, thus there is no OOO issue.  In summary, from our understanding, for case 2, the UE cannot prepare UL for PDSCH0 until after receiving PDSCH2. But for case 3, the UE can start to prepare UL when receiving PDSCH0, which might lead to OOO issue, but the OOO issue can be removed if advanced UE postpone the blue ‘UL prep’ after the green ‘UL prep’—which by the way is not the scope of my intention. My intention was only to talk about NNK1 case. |
| QC | @ Hao: Thank you for the follow-up.  I am not sure if I follow your conclusion from “The UE CANNOT prepare UL when he receives PDSCH0 (due to NNK1)”. Are you suggesting that because UE CANNOT prepare UL earlier in the case of NN-K1, it should be easier for UE to support OOO?  Let me try another way: If you agree with the following two observations, then isn’t it a logical conclusion that OOO cannot be supported in Case 2?   * Observation 1: OOO is not supported in Case 3 * Observation 2: It would be more difficult for UE to support OOO in Case 2 compared to Case 3   + This is because there are additional steps involved in Case 2 for determining timing for HARQ-Ack for the first PDSCH (as opposed to Case 3, where the timing is known much earlier as it is indicated in the same DCI that scheduled the PDSCH) |
| OPPO | @Mostafa: thanks for sharing views.  My observations are different.   * Observation 1: in case 2, UE prepares UL for PUCCH1 first and UL for PUCCH2 second, then UE transmits PUCCH1 first then transmits PUCCH2 second; therefore we don’t see it as an OOO case. As shown in the figure, there is no crossed arrows.      * Observation 2: in case 3, UE might prepare UL for PUCCH0 first and UL for PUCCH1 second, then the UE transmits PUCCH1 first and PUCCH0 second. In case UE prepares the UL in this order, there will be an OOO issue. But for advanced UE, it can reorder the UL preparation ordering to resolve the OOO issue. |
| QC | @ Hao: Thanks for the follow-up.  We see one issue with your observations: You are assuming a more advanced UE in Case 2 comparing to the “advanced UE” you mentioned in Case 3, which you agree that is not supported. However, the specification is not written for this advanced UE. Otherwise, OOO restriction would have been relaxed for this advanced UE in Rel. 15 or in Rel. 16. |
| OPPO | @Mostafa: thanks for follow up  To me, the UE in case 2 is a normal UE instead of an advanced UE. I would like to ask why you think in case 2 the UE is an advanced UE? Is it because the UE does not prepare an UL after PDSCH0 processing but prepares an UL for PUCCH2 after decoding PDSCH2? The reason why I think it is a normal UE is that in any case, the UE cannot start to prepare the uplink after decoding PDSCH0. So it has to store the AN of PDSCH0 in a buffer, until when the UE can start to prepare the uplink, the UE will read back the AN of PDSCH0 for generating the CB. In this case, at least to me, it does not make much difference between putting this AN bit in green ‘UL prep’ or in blue ‘UL prep’. It is the same UE capability because the UL preparation has already been postpone after PDSCH0 decoding. This is the point that I didn’t get. |
| Intel | To Sukchel, could you check if your TP performs correctly in following figure? I think the two PDSCHs and the related PUCCHs are not OOO. However, there is still enough PDSCH processing time between PDSCH 2 and PUCCH 1.  - there is no OOO problem  - PUCCH 2 is not first PUCCH  - delay between PDSCH 2 and PUCCH 1 > processing time  - HARQ-ACK for PDSCH 2 with NNK1 shall be transmitted on PUCCH2    If my understanding is correct, HARQ-ACK for PDSCH 2 with NNK1 shall be transmitted on PUCCH2. However, the proposed TP will drop HARQ-ACK for PDSCH 2? |
| FL summary #4 | Thanks for the additional clarifications brought by Hao and Mostafa. One issue I see is that we can’t really talk about OOO condition until the PUCCH timing is provided for a PDSCH scheduled with NNK1. I agree with Hao’s observation that the UE cannot start to prepare the uplink after decoding PDSCH0 in case 2.  In this sense, Sukchel’s TP may not work as intended since the next DCI that provides the earliest PUCCH may be for another PDSCH group, so this next DCI is not the second DCI expected for the first PDSCH scheduled with NNK1 value. In the order of received DCIs, the second DCI expected by the UE may be the 3rd DCI received by the UE. I think that was the common understanding when we agreed the TP at RAN#100-e.  In the original example from Qualcomm we indeed have an OOO condition from the UE perspective since the UE missed a DCI. But from the gNB perspective this is a HARQ re-transmission which doesn’t qualify as an OOO condition.    Perhaps this case just remains unspecified as an error case. |
| LG | **Regarding Yingyang’s comment:**  Although whether handling is necessary for the OOO case due to NNK1 value or even whether the case raised by QC indeed belongs to the OOO is still uncertain, I would try to modify my TP with assumption that the case raised by QC is the OOO and needs to be handled.  Given the above assumption, your comment seems correct, in other words, my previous TP doesn’t seem to be sufficient. In this sense, probably the following update (in yellow) could address your case.  - if the UE detects a second DCI format and a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI indicates a slot with the earliest one among PUCCH or PUSCH transmission(s) carrying HARQ-ACK corresponding to the PDSCH received after the first PDSCH reception that satisfies the timing conditions in Clause 9.2.5, the UE multiplexes the corresponding HARQ-ACK information in the PUCCH or PUSCH transmission, where |
| QC | One clarification regarding OOO discussion: The discussions between Hao and myself was mainly on UE complexity, why OOO is not supported in Rel. 15/16, and how NN-K1 makes it easier or harder for the UE to support OOO. We do not think anyone is proposing to change the following part of the specification in 38.214 specifically for NN-K1. Please correct me if I am wrong:  “In a given scheduled cell, the UE is not expected to receive a first PDSCH in slot *i*, with the corresponding HARQ-ACK assigned to be transmitted in slot *j*, and a second PDSCH starting later than the first PDSCH with its corresponding HARQ-ACK assigned to be transmitted in a slot before slot *j*.”  We also agree with FL that the following figure is not OOO from gNB perspective, but it is indeed OOO from UE perspective due to missing DCI. The intention of the TP is to prevent from this misunderstanding between UE and gNB and avoid error propagation to PUCCH2. As a side note, even if OOO was allowed in the specifications (which is not), there is still the issue of error propagation to PUCCH2 (gNB does not expect feedback for PDSCH1 in PUCCH2).    @Hao: You asked “I would like to ask why you think in case 2 the UE is an advanced UE?” My comment was referring to your earlier response that you mentioned only an advanced UE can support Case 3, which logically means that Case 2 is also only supported by an advanced UE (even more advanced). As commented earlier, we think that the specification is not written for this advanced UE.  **Regarding the TP**: To address the issue brought up by Yingyang, do we also need to include the case that the second DCI (with numeric K1) does not schedule PDSCH (e.g. SPS release, one-shot trigger w/o scheduling PDSCH, Scell dormancy DCI) as shown below? i.e. To address the case in Yingyang’s example if you replace the third PDSCH with a e.g. SPS release  - if the UE detects a second DCI format and a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI indicates a slot with the earliest one among PUCCH or PUSCH transmissions that  - carry HARQ-ACK corresponding to a PDSCH received after the first PDSCH reception or  - triggered by the second DCI format, and  - satisfy the timing conditions in Clause 9.2.5,  the UE multiplexes the corresponding HARQ-ACK information in the PUCCH or PUSCH transmission, where |

# Conclusions

TBD

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