**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

|  |  |
| --- | --- |
| 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

|  |  |
| --- | --- |
| **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? |

|  |  |  |
| --- | --- | --- |
| **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

|  |  |
| --- | --- |
| 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:

|  |  |  |
| --- | --- | --- |
|  | 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:

|  |  |
| --- | --- |
| **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. |

# Issue C3

|  |  |
| --- | --- |
| 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.

|  |  |
| --- | --- |
| **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. |

# Conclusions

TBD

# References

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