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

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

**Agenda Item: 7.2.2.2.3**

**Source: Moderator (Huawei)**

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

**Document for: Discussion and Decision**

# Introduction

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

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

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

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

# Issue A5

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

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

Proposal:

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

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| **Company** | **Comments on the proposal above** |
| Nokia, NSB | We would prefer to keep language as close to specification, for example, instead of   * nHARQ-ACK should be defined for the cases where   + UE is not provided PDSCH-CodeBlockGroupTransmission for any cell   + UE is provided PDSCH-CodeBlockGroupTransmission for  <   We could agree   * nHARQ-ACK should be defined for the cases where   + A UE is not provided *PDSCH-CodeBlockGroupTransmission* for each of the  serving cells, or for PDSCH receptions scheduled by a DCI format that does not support CBG-based PDSCH receptions, or for SPS PDSCH reception, or for SPS PDSCH release, and if   Furthermore, we would like to clarify   * Type 2 CB rule for is used separately for each PDSCH group, and SPS PDSCH is considered separately from the two PDSCH groups and is always counted in |
| QC | We can first focus on TB-based HARQ-Ack when feedback for both groups are included.  For the following cases, we can simply refer to section 9.1.3.1:   * For the case that feedback for only one group is included * For the case UE is provided PDSCH-CodeBlockGroupTransmission: Since the assumption is that TB-based vs CBG-based HARQ-Ack generation follows Section 9.1.3.1 (except that the minor part related to issue A-7), it is not clear if we need to explicitly describe the nHARQ-ACK determination in this case. |
| Samsung | P1. For “nHARQ-ACK should be defined for the cases”, the same cases as Rel-15 should be supported for ,   1. If a UE is not provided *PDSCH-CodeBlockGroupTransmission* for each of the  serving cells, or for PDSCH receptions scheduled by a DCI format that does not support CBG-based PDSCH receptions, or for SPS PDSCH reception, or for SPS PDSCH release,   (2) If a UE  - is provided *PDSCH-CodeBlockGroupTransmission* for  serving cells; and  - is not provided *PDSCH-CodeBlockGroupTransmission*, for  serving cells where  P2. Agree that “Type 2 CB rule for is used separately for each PDSCH group, and SPS PDSCH is considered separately from the two PDSCH groups”.  P3. Agree that “ is given by , when available, for the (g+1)mod2”  P4. Agree that nHARQ-ACK should include the case of q=1 and q=0, but one common equation would be sufficient, e.g. ， nHARQ-ACK, (g+1)mod 2 equals 0 if q=0  To avoid duplicated description in the standard, it is sufficient to add a summation formula in section 9.1.3.3, e.g.  with some clarifications for SPS PDSCH and , and simply refer to section 9.1.3.1 for per PDSCH group handling (to address P1 and P2) |
| ZTE | We agree with the proposals in principle.  For the TP, we can simply refer to section 9.1.3.1 for UE is provided PDSCH-CodeBlockGroupTransmission or not and the can be separately defined for each PDSCH group. |
| vivo | Agree with the FL’s proposal in principle.  For the determination of , when the last non-fallback DCI is for group 1 and triggers HARQ-ACK reporting for group 0, and there is at least one DCI format 1\_0 detected after the last non-fallback DCI, which points to the same PUCCH occasion,  may not be given by , instead, it could be based on DCI format detection by UE.  When q=0, nHARQ-ACK could be simply refer to section 9.1.3.1, with pointing out the necessary modification. |
| Intel | P1: OK with a correction. The second sub-bullet should be “≤”  P2: Agree  P3: Yes if scheduled group in last DCI is group 0. On the other hand, if scheduled group is 1, comments from vivo is valid for consideration.  P3: Agree, a common wording to simplify the spec is preferred |
| Ericsson | Agree in principle, while keeping the same wording as in the spec and referring to 9.1.3.1 when only one group is requested. |

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

# Issue A7

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

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

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

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

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

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| **Company** | **Comments on the alternatives above** |
| Nokia, NSB | We prefer Alt2 because it reduces CB size, however, it is not clear to us what does “at least one DCI format” in Alt2 means. Is it at least one DCI at PDCCH monitoring occasion m=0 or after? |
| QC | We prefer Alt1 as it is more robust against missing DCIs. We would be fine with Alt2 as well to close this issue. |
| Samsung | We prefer Alt 1 as it is more robust. |
| ZTE | We prefer Alt.1 as it is more robust. Alt2 may have some problem if the DCI is miss detected. |
| MediaTek | Prefer Alt 1 due to robustness |
| vivo | Alt1 is slightly preferred for us, because it is more robust against DCI miss-detection, though it may result in more overhead. |
| Lenovo, Motorola Mobility | We prefer Alt 1 for robustness |
| Sharp | We prefer Alt1 for less misalignments between gNB and UE. |
| Intel | Alt 1 is preferred, since Alt 2 may results in wrong codebook size if the only one DCI of the other sub-codebook is missed. |
| Ericsson | We prefer ALT2, we do not need to optimize for the case of all DCI being missed. |

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

# Issue A18

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

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

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| **Company** | **Summary of proposals and further companies’ comments** |
| MediaTek  (R1-2003658) | In NR, DCI format 1\_0 is possible to be used for indicating a DL SPS release. However, if UE detects a DCI format 1\_0 indicating a DL SPS release, it is not clear in current specification how UE handle the DCI format 1\_0 since only defines behavior for PDSCH reception scheduled by DCI format 1\_0. We believe that the missing UE behaviour should be also completed in TS38.213 clause 9.1.3.3.  **Proposal 2: Text proposal 2 is adopted in TS38.213 clause 9.1.3.3 to complete UE behavior to DCI format 1\_0 indicating a SPS PDSCH release in enhanced dynamic HARQ-ACK codebook.**  ====**Text Proposal 2 Starts**==== 9.1.3.3 Type-2 HARQ-ACK codebook grouping and HARQ-ACK retransmission \*\*\* Unchanged text is omitted \*\*\*  If a UE detects DCI formats with respective PDSCH-to-HARQ\_feedback timing field values indicating a same PUCCH transmission occasion and none of the DCI formats that the UE detects after a last PUCCH transmission occasion for includes a New\_Feedback indicator field for , and at least one of the DCI formats is DCI format 1\_0, the UE generates HARQ-ACK information only for PDSCH receptions scheduled by detections of DCI format 1\_0 and SPS PDSCH releases indicated by detections of DCI format 1\_0 by detections of DCI format, as described in Clause 9.1.3.1 or 9.1.3.2 for multiplexing in the PUCCH transmission occasion.  If a DCI format indicating a slot for a PUCCH transmission occasion does not include a New\_Feedback indicator field, a PDSCH reception scheduled by the DCI format or a SPS PDSCH release indicated by the DCI format is associated with PDSCH group 0 and a value of *h*(*g*) associated with the DCI format is set only if *h*(*g*) is provided by another DCI format that provides a value of *h*(*g*) for PDSCH group 0 and indicates the slot for the PUCCH transmission occasion.  \*\*\* Unchanged text is omitted \*\*\*  ===== **Text Proposal 2 Ends**==== |
| Qualcomm | This is editorial, and there may be easier ways, e.g. not mention “PDSCH reception” |
| Nokia, NSB | We prefer MTK clarification |
| QC | Fine with the TP in principle. Our preference is to simplify the text and not mention PDSCH. This is also aligned with other parts of the spec (note that in the previous part of the spec, the DCI format is associated with group 0, and not the scheduled PDSCH: e.g., “and to detections of DCI formats that do not provide a value of and and are associated with a same value of , of ”)  If a UE detects DCI formats with respective PDSCH-to-HARQ\_feedback timing field values indicating a same PUCCH transmission occasion and none of the DCI formats that the UE detects after a last PUCCH transmission occasion for includes a New\_Feedback indicator field for , and at least one of the DCI formats is DCI format 1\_0, the UE generates HARQ-ACK information only in response to detections of DCI format 1\_0, as described in Clause 9.1.3.1 or 9.1.3.2 for multiplexing in the PUCCH transmission occasion.  If a DCI format indicating a slot for a PUCCH transmission occasion does not include a New\_Feedback indicator field, the DCI format is associated with group 0 and a value of *h*(*g*) associated with the DCI format is set only if *h*(*g*) is provided by another DCI format that provides a value of *h*(*g*) for group 0 and indicates the slot for the PUCCH transmission occasion. |
| Samsung | Fine with MTK’s proposal. |
| ZTE | We are fine with the TP. |
| vivo | It is just an editorial issue. We are fine with the TP from MTK, and the TP from QC can also be acceptable, as long as all necessary cases for HARQ-ACK of DCI format 1\_0 are covered |
| Lenovo, Motorola Mobility | MTK’s proposal is fine with us. |
| Sharp | We are Okay with the proposed TP and we also think that the expressions in Qualcomm’s TP are clear and more concise. Anyway, it is editorial. |
| Intel | Fine with TP from MTK. |
| Ericsson | Fine with the TP |

# 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.