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

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

**Agenda Item: 7.2.2.2.3**

**Source: Moderator (Huawei)**

**Title: Feature lead summary#1 on email discussion 100b-e-NR-unlic-NRU-HARQ-03 (SPS)**

**Document for: Discussion and Decision**

# Introduction

This document provides updated proposals on issue A11. Companies are invited to provide their views on the two questions from the FL using the table in section 2.

[100b-e-NR-unlic-NRU-HARQ-03] Email discussion/approval on handling of SPS with enhanced dynamic codebook and with NNK1 by 4/24; if necessary, followed by endorsing the corresponding TPs by 4/30 – David (Huawei)

# Issue A11

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| A11 | SPS with enhanced dynamic codebook and with NNK1Issue 1: Whether there is a problem with reusing the pseudo-code of section 9.1.3.1 because it will result in reporting 2 HARQ-ACK bits for SPS PDSCH in one PUCCH when HARQ-ACK feedback both PDSCH groups is reported?Issue 2: Handling of case when an SPS configuration is activated with a DCI that indicates non-numerical K1. Interpretation of NFI, DAI, q in activated DCI for SPS PDSCH |

FL analysis: for issue 1, the problem seems to be that clause 9.1.3.3 asks the UE to follow the procedure of clause 9.1.3.3 twice when first and second HARQ information is generated, which means that UE will append HARQ-ACK bits for SPS PDSCH receptions twice (at the end of each group).

FL proposal: companies provide views on the following questions

* Q1: Can we simply clarify that the HARQ-ACK bits corresponding to SPS PDSCHs are appended to the end of a dynamic HARQ-ACK codebook for nrofHARQ-Processes configured for the SPS configuration, i.e. when the UE generates first and second HARQ-ACK information in 9.1.3.3 the following handling of HARQ-ACK bits for SPS PDSCH receptions in 9.1.3.1 is only done once after generating the first and second HARQ-ACK information?

Set 

while 

if a single SPS PDSCH reception is activated for a UE and the UE is configured to receive SPS PDSCH in a slot  for serving cell , where  is the PDSCH-to-HARQ-feedback timing value for SPS PDSCH on serving cell 



= HARQ-ACK information bit associated with the SPS PDSCH reception

end if

;

end while

* Q2: Can a DCI format 1\_1 indicate a NNK1 and activate a SPS configuration (CRC scrambled with CS-RNTI and NDI=0)?
* Q3: Can we clarify that in a DCI activating SPS PDSCH, the NFI, DAI, q fields are only interpreted for the PDSCH scheduled by the DCI, and are not interpreted for the SPS PDSCHs?

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

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| **Company** | **Comments** |
| OPPO | Q1: supportQ2: Open, but slightly not preferredQ3: yes, these fields should be reserved. |
| Nokia, NSB | Q1: We believe the best would be to add condition in 9.1.3.3 stating that SPS PDSCH CB is not appended for the triggered non-scheduled group. Q2: We think that support for NN-K1 in DL SPS activation is a corner case, because UE activates DL SPS to avoid need for transmitting DCIs. There may be more issues than benefit from supporting it.Q3: We have the same view as FL, but we think that the current spec is clear on this. Reporting HARQ-ACK for DL SPS activation in TYPE2 is business as usual and SPS PDSCH is appended to the CB. All clear. |
| ZTE | Q1: Fine with the proposalQ2: No, we share the same view as NokiaQ3: Yes |
| MediaTek | Q1: The issue only happens when the first and second HARQ-ACK information are multiplexed in a same PUCCH occupation (i.e., q = 1). One alternative to address this issue is stating that UE generates HARQ-ACK bits of SPS PDSCH receptions only for PDSCH group 1 (g = 1) when q = 1. Then, the HARQ-ACK bits for SPS will be naturally mapped at the end of enhanced HARQ-ACK codebook.Q2: NoQ3: Agree with FL |
| Sharp | Q1: Fine with FL’s proposal.Q2: No. The main purpose of NNK1 mechanism is to indicate the UE to report the corresponding HARQ-ACK information in the next COT. Since when the COT is obtained is unknown at the time of indicating NNK1, some SPS PDSCHs (if scheduled) probably fall out of the next COT.Q3: Yes. We have the same view as FL and Nokia. The current spec has descriptions corresponding to SPS activation DCI and SPS PDSCH in 9.1.3.3 and 9.1.3.1, respectively. |
| Samsung | Q1: We’d like to ask for the clarification of “nrofHARQ-Processes configured for the SPS configuration”. Whether the *nrofHARQ-Processes* is determined by the number of SPS PDSCHs with in a slot , i.e. exactly the same as Rel-15 without HARQ-ACK retransmission of SPS PDSCHs? If yes, we support FL’s proposal. Q2: No. Share the same view Nokia. Q3: Share the same view with Nokia and FL.  |
| LG | Q1: Support that the HARQ-ACK bits corresponding to SPS PDSCHs are appended to the end of a dynamic HARQ-ACK codebook. In case when only one group is requested, the HARQ-ACK bits for SPS PDSCHs start after that for the group. In case when both two groups are requested, the HARQ-ACK bits for SPS PDSCHs start after that for the second group 1.Q2: Similar view with other companies by considering two concerning points below:- The motivation to introduce NN-K1 was to address UE processing time for the PDSCH scheduled to the end of a COT, but periodic DCI-less SPS PDSCH doesn’t seem to be suitable with such motivation.- The reception of SPS activation DCI by UE is currently confirmed to gNB by receiving the corresponding HARQ-ACK PUCCH from the UE, but there would be no confirmation from the UE if SPS activation DCI indicates NN-K1.Q3: same view with other companies since the first PDSCH scheduled by SPS activation DCI is treated as a dynamic PDSCH with associated DCI. It seems the current spec is already clear, and thus no further clarification/correction would be necessary. |
| vivo | Q1: Basically support FL's proposal. The appended HARQ-ACK for SPS PDSCH can be only based on the PUCCH transmission occasion $i(g)$, so there is at most one bit, without regard to *nrofHARQ-Processes* configured for the SPS configuration.Q2: Not supportive. This case may bring some issues, with ambiguous benefits.Q3: Yes. |
| Ericsson | Q1: YesQ2: We slightly prefer this option. But OK since majority of companies are not supportive. Q3: Yes |
| Lenovo, Motorola Mobility | Q1: We support placing HARQ-ACK information bit for SPS PDSCH at the end of the dynamic HARQ-ACK codebook regardless of one or two PDSCH groups requested for HARQ-ACK feedback. Q2: NO. Q3: Yes.  |
| QC | Q1: Yes. When UE is configured with multiple SPS configurations (Rel. 16 feature), multiple bits are appended to the end of the codebook, but the same principle is applicable to that case as well. Q2: We prefer to specify the case that DCI that activates the SPS can indicate NN-K1. The reason is the use case that HARQ-Ack for multiple SPS PDSCHs can be sent all at once. For NRU, one motivation is to save on UL overhead to avoid unnecessary UL transmission to feedback Nack when the SPS PDSCH is not transmitted (SPS is activated, but for some instances, e.g. a burst of instances, SPS PDSCH is not sent due to LBT failure at the gNB side or when there is no data to transmit). Some response to some of the comments are provided below:* Response to Nokia: Even with the enhancement, DCI does not need to be sent often, only when needed or every nrofHARQ-Processes \* periodicity
* Response to Sharp: The reason for the proposal is to address the same issue. When SPS PDSCH is outside COT, gNB does not send the PDSCH. Hence, UE does not need to send Nack for every instance.
* Response to LG: For the first point, please see our comment above. For the second point, gNB has the flexibility to request HARQ-Ack for the first SPS PDSCH if it sends a DCI after activation. If it can wait, it can send it sometime after that (e.g. after the second SPS PDSCH). If it can wait further, it can send the DCI after the first nrofHARQ-Processes SPS PDSCHs. So, gNB has full flexibility.

Q3: Yes. Current spec seems to be already clear once we clarify the point in Q1.  |
| Intel | Q1: since  is checked in the proposed pseudo code, there is no retransmission of HARQ-ACK for SPS PDSCH. Is it correct understanding? it is better to make a decision on this operation first and then the TP. Q2: NO. if supported, it means that always another PDSCH scheduling should be scheduled to transmit HARQ-ACK info, or relying on one-shot feedback. Both ways cause limitations and are not desired. Q3: Yes |
| FL summary | **Q1: Can we simply clarify that the HARQ-ACK bits corresponding to SPS PDSCHs are appended to the end of a dynamic HARQ-ACK codebook for nrofHARQ-Processes configured for the SPS configuration, i.e. when the UE generates first and second HARQ-ACK information in 9.1.3.3 the following handling of HARQ-ACK bits for SPS PDSCH receptions in 9.1.3.1 is only done once after generating the first and second HARQ-ACK information?**Yes: OPPO, ZTE, Mediatek, Sharp, Samsung, LG, vivo, Ericsson, Lenovo, Qualcomm* 1 bit: vivo
* Multiple bits: Qualcomm

No: Mediatek (report in group 1 when q=1), Nokia (report by appending SPS PDSCH bits after the HARQ-ACK bits of the group signaled by SPS activation DCI?)FL summary: a large majority of companies support clarifying that the HARQ-ACK bit for SPS PDSCH (in case of a single SPS PDSCH reception is activated) is appended at the end of the enhanced type-2 codebook after both groups (if both groups are reported) or after the group that is reported. There may be different views on handling the cases where multiple SPS PDSCH receptions are activated (introduced in Rel-16).@ Intel, Samsung: no enhancement for SPS was agreed in the WI phase, so I believe it is a correct interpretation that there is no re-transmission of HARQ-ACK bit for a SPS PDSCH. The informal conclusion has been to reuse the Rel-15 SPS procedures. Now we are just discussing corrections.Question to Mediatek: your proposal mean that the HARQ-ACK bit for a SPS PDSCH is reported as part of a group, which is a fixed to group 1 only when q=1, so this depends on signaling in one or more DCIs. When a single group is reported, are you proposing that the SPS PDSCH belongs to a group or belongs to no group? In the case where 2 groups are requested in the same PUCCH, with your proposal there could be cases where SPS PDSCH HARQ-ACK cannot be reported (see the second PUCCH in the example below):C:\Users\d00441999\AppData\Roaming\eSpace_Desktop\UserData\d00441999\imagefiles\3B62CBB8-B2BF-4976-ADBE-82B996FCD697.pngQuestion to Nokia: I am not sure that I understand your proposal (“add condition in 9.1.3.3 stating that SPS PDSCH CB is not appended for the triggered non-scheduled group”). What is the “triggered non-scheduled group? Is the proposal to append SPS PDSCH HARQ-ACK bits after the HARQ-ACK bits of the group of the PDSCH scheduled by the SPS activation DCI (and the SPS PDSCH HARQ-ACK don’t belong to a group)? If this understanding is correct, when the scheduled group is group 0 and two groups are reported in the same PUCCH, then the HARQ-ACK bit for a SPS PDSCH would not be added at the end of the reported HARQ-ACK codebook but in the middle of the two groups.FL proposal 1: the HARQ-ACK bit(s) corresponding to SPS PDSCH is(are) appended to the end of a dynamic HARQ-ACK codebook with PDSCH grouping, without belonging to any group:* if a single SPS PDSCH reception is activated, the loop of HARQ-ACK information for the case of single SPS PDSCH reception activated from clause 9.1.3.1 is done only once after generating the first and second (if any) HARQ-ACK information of clause 9.1.3.3, and the corresponding HARQ-ACK bits are appended after the first and second (if any) HARQ-ACK information bits.
* if multiple SPS PDSCH receptions are activated, the loop of HARQ-ACK information for the case of single SPS PDSCH reception activated from clause 9.1.3.1 and the clause for the case of multiple SPS PDSCH receptions activated from clause 9.1.3.1 are done only once after generating the first and second (if any) HARQ-ACK information of clause 9.1.3.3, and the corresponding HARQ-ACK bits are appended after the first and second (if any) HARQ-ACK information bits.

**Q2: Can a DCI format 1\_1 indicate a NNK1 and activate a SPS configuration (CRC scrambled with CS-RNTI and NDI=0)?**Yes: QualcommNo: Nokia, ZTE, Mediatek, Sharp, Samsung, LG, vivo, Lenovo, IntelNo strong preference: Ericsson, OPPOFL summary: a large majority of companies do not support optimizing SPS for NR-U that allows signaling NNK1 value in a DCI format that activates a SPS configuration. FL proposal 2: a DCI format 1\_1 cannot simultaneously indicate a NNK1 value and activate a SPS configuration (CRC scrambled with CS-RNTI and NDI=0).**Q3: Can we clarify that in a DCI activating SPS PDSCH, the NFI, DAI, q fields are only interpreted for the PDSCH scheduled by the DCI, and are not interpreted for the SPS PDSCHs?**Yes: OPPO, ZTE, Mediatek, Sharp, Samsung, LG, vivo, Ericsson, Lenovo, Qualcomm, IntelNo: FL summary: All companies agree with the clarification, which does not require a TP unless we agree to interpret some field (among NFI, DAI, q, PDSCH group index) for a SPS PDSCH.Does any company think that a TP would be required for Q3, assuming we agree on Q1? |
| Lenovo, Motorola Mobility | The two new FL proposals are fine with us.We prefer a TP for Q3. |
| Intel | The two new FL proposals are fine with us.A TP for Q3 is not needed and there is no confusion. Based FL proposal 1, say it is agreeable, HARQ-ACK for SPS PDSCH is anyway appended to the end of the codebook, which is not impacted by the value of NFI, DAI, q or group index.  |
| MediaTek | Respond to Question asked by FL: we agree with FL that the proposal is problematic. We support the two new FL proposals. If spec can clearly clarify that SPS PDSCH reception doesn’t belong to any group, then TP for Q3 is not needed. |
| LG | On FL proposal 1 for Q1:Seems supportive to us.On FL proposal 2 for Q2:Seems supportive to us, and same clarification would also be necessary for SPS release DCI, one-shot HARQ-ACK codebook triggering DCI, and Scell dormancy indication DCI. It would be desirable that NNK1 value is not allowed to be indicated by those DCIs as well.On FL summary for Q3:No TP would be required. |
| Nokia, NSB | Q1:   9.1.3.1 is called for scheduled group g of the PUCCH, then all good. If 9.1.3.1 is called also for non-scheduled group, we would say: If $h^{\left(g+1\right)mod2}\left(g\right)=∅$ or $h^{\left(g+1\right)mod2}\left(g\right)=h(\left(g+1\right)mod2)$, generate second HARQ-ACK information for PUCCH transmission occasion $i(\left(g+1\right)mod2)$ in a slot, as described in Clause 9.1.3.1 by excluding HARQ-ACK for DL SPS PDSCH , where …As a consequence, SPS codebook can end up in the middle, but that is not issue, as its size is semi-static. To us this would result in minimum spec change, but if majority thinks that P1 is technically better or has even less spec change, we are OK to go with majority view.Q2: OK P2Q3: we stated our view already |
| QC | Q1: Looking at the comment from Nokia above, it seems way easier to go with that approach. Also, it seems that the same approach is done in Rel. 15 for TB-based vs CBG-based sub-codebook appending:…Please correct me if my understanding is not right. Then, is there any issue with just agreeing to the TP above provided by Nokia and be done with it?Q2: We are fine to go with majority view here. Good to also capture the cases mentioned by LG so that we do not have to come back to those which do not have a good use case (unlike the case of SPS activation with NN-K1, which is very useful but maybe late at this stage).Q3: TP is not required. |
| Ericsson | Q1: We are fine with FL proposal. Nokia TP is general look OK, but maybe we can check if the placement of the “by excluding HARQ-ACK for DL SPS PDSCH” is correct. It seems in this case, works when 2 groups are reported, while the TP should consider the case for both 1 gorup and 2 groups. Maybe the change better be added afterwards. We can check more afterwards.Q2: Agree with FL proposal.Q3:We don’t think TP is needed. |
| Sharp | Q1: Agree with FL proposal 1 on what should be done. Regarding Nokia’s specific TP, although SPS codebook’s size is semi-static, it seems difficult for gNB to determine SPS codebook’s position when it is in the middle of the whole HARQ-ACK information, because the sizes of the first HARQ-ACK codebook and the second HARQ-ACK codebook are dynamic.Q2: Agree with FL proposal 2.Q3: TP is not necessary.  |
| Samsung  | Q1: Agree with FL proposal. Share the same view Sharp that gNB may not know the correct bit location for SPS HARQ-ACK, if SPS HARQ-ACK is in the middle of the codebook, especially when T-DAI/NFI for other PDSCH group is not configured. Q2: Agree with FL proposal.Q3: TP is not needed.  |
| vivo | Q1: From our understanding, no enhancement for SPS was agreed in the WI phase, so we believe here is based on the R15 mechanism for SPS PDSCH, i.e., single SPS configuration with at least 10ms periodicity. We just wonder whether enhancement for SPS PDSCH, e.g. multiple SPS configurations, small priority can be directly introduced on unlicensed band in this release? If yes, we have introduced so many new features in different WIs. Some features may can be directly used on unlicensed band without any issue, but some (e.g. HARQ-ACK with different PHY priority) may be not. Do we need to discuss each issue if it is identified by anyone tomorrow?Q2: Agree with the FL's proposal.Q3: A TP is not necessary. |

Summary of proposals from submitted Tdocs

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| **Company** | **Summary of proposals** |
| Vivo(R1-2001654) | HARQ-ACK for SPS PDSCH, if any, is always placed at the end of enhanced HARQ-ACK codebook to be transmitted, no matter whether the transmitted HARQ-ACK codebook contains only the first HARQ-ACK information, or both the first HARQ-ACK information and the second HARQ-ACK information. |
| OPPO(R1-2001761) | Appending the HARQ-ACK bit corresponding to SPS PDSCH to the group-based HARQ-ACK bits in enhanced type-2 HARQ-ACK codebookReuse Rel-15 mechanism for SPS PDSCH in Type-2 HARQ-ACK codebook as much as possible* SPS PDSCH doesn’t have group ID.
* If only the HARQ-ACK bit corresponding to SPS PDSCH is transmitted in slot n, PUCCH format 0/1 is used. Unless using one-shot HARQ-ACK feedback, HARQ-ACK only for SPS PDSCH cannot be retransmitted.
* If other group-based HARQ-ACK bits collide with the HARQ-ACK bit corresponding to SPS PDSCH, all HARQ-ACK bits are multiplexing in one PUCCH, and the HARQ-ACK bit corresponding to SPS PDSCH is mapped to the end of HARQ-ACK codebook. Furthermore, if the multiplexed group-based HARQ-ACK is triggered for retransmission, the HARQ-ACK bit corresponding to SPS PDSCH should be simultaneously retransmitted.

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| Qualcomm(R1-2002532) | When an SPS configuration is activated with a DCI that indicates non-numeric K1, the number of HARQ-Ack bits corresponding to SPS PDSCHs that are appended to the end of a dynamic HARQ-Ack codebook is nrofHARQ-Processes that is configured for the SPS configuration. |

# Conclusions

# References

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