**3GPP TSG RAN WG1 #105-e R1-210xxxx**

**e-Meeting, May 10th – 27th, 2021**

**Agenda Item:** 7.2.5

**Source:** Moderator (LG Electronics)

**Title:** Summary #1 of [105-e-NR-L1enh-URLLC-05]

**Document for:** Discussion and decision

# Introduction

According to discussion at the preparation phase, the following email thread is allocated by Chairman for further discussion:

[105-e-NR-L1enh-URLLC-05] Email discussion/approval on remaining issues on SPS enhancements – Duckhyun (LG):

* Issue #1: SPS PDSCH release and SPS receptions with slot aggregation
* Issue #3: *CSI-PUCCH-ResourceList* where SPS HARQ-ACK multiplexed
* Issue #2: Capture the agreement on SPS release that is not supported (*to be discussed after decision made on issue #1*)
* Discussion and decision by May 24, TPs by May 27

To address the identified issues of the above email thread, suggestions and questions for the issues are provided in Section 2. In section [3], the outcome from [105-e-NR-L1enh-URLLC-05] are provided including all the agreements and all the endorsed TPs.

# Issues in RAN1#105-e

* 1. Issue #1 SPS PDSCH release and SPS receptions with slot aggregation

The issue #1 is about SPS PDSCH release and SPS PDSCH receptions when slot-aggregation is applied. In this meeting, some contributions show their preference based on UE behaviors discussed in RAN1#104-e, as like following

UE behavior 1: Nokia

UE behavior 2: ZTE, LGE, Huawei/Hisilicon

For convenience, the description of UE behaviors are brought from final summary for others in RAN1#104-e.

|  |
| --- |
| **UE behavior 1:**  Based on Samsung’s proposal, UE can receive SPS received freely in the slot where doesn’t include last occasion of SPS PDSCH. However, if UE receives SPS release in a slot other than first slot, UE drop previous receptions and clean HARQ process which is not desirable.    **Figure 2. UE behavior 1 based on [2] with 1 slot periodicity and 4 slot aggregation.**  **UE behavior 2:**  Based on CATT comment, propose UE behavior is in the light of the current UE behavior without slot-aggregation. UE can receive SPS release only before end of the reception of any of corresponding SPS occasion. But it has limited opportunity for SPS release comparing to above.    **Figure 2. UE behavior 2 based on CATT’s comment with 1 slot periodicity and 4 slot aggregation.** |

In principle, both UE behaviors are under the last conclusion. Thus, the same PUCCH resource are used for SPS release and SPS receptions.

UE behavior 1 can be regarded as an extension of current UE behavior. In UE behavior 1, all SPS occasion of a TB are considered to determine the end of the reception. In other words, the end of last SPS occasion is considered

UE behavior 2 is to apply current specification strictly. UE can receive SPS release only before end of the reception of any of corresponding SPS occasion.

Pros and cons between UE behaviors

* Behavior 1
  + if PDSCH is configured with e.g. 4 or 8 repetitions, with behaviour 2 it may not be possible to ensure SPS release and SPS PDSCH mapped to the same PUCCH especially if operating with a relatively small set of k1 values or operating with sub-slot PUCCH.   
    
  + This will drop previous receptions and clean the HARQ process, which is waste of UE power both from the perspective of SPS release DCI monitoring and SPS PDSCH reception.
* Behavior 2
  + Same principle with single SPS PDSCH case.
  + It is simpler for the UE implementation
  + It would restrict gNB scheduling
  + There is no use case that would benefit from sending the release DCI later than the first repetition.

From above point of view, FL makes following questions.

**Q1-1: Please share your preference between UE behaviors. It would be appreciated to indicate your preference first with “Behavior 1” or “Behavior 2”.**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | Behavior 2. |
| Nokia, NSB | Behaviour 1.  As mentioned above, with behaviour 2 it may not be possible to ensure SPS release and SPS PDSCH mapped to the same PUCCH (Question 1-4) when PDSCH is configured with 4 or 8 repetitions. This would basically restrict the usage of back-to-back SPS PDSCH with repetitions.  On the ‘waste of power’ argument, the release will not happen very often anyway, so this is a minor disadvantage not really limiting the functionality. |
| vivo | Behavior 2 |
| HW/HiSi | Behavior 2.  From the UE perspective we prefer behavior 2. We think that the UE should not be required to decode the PDSCH when it will be released anyway. |
| Qualcomm | Behavior 2. |
| Samsung | Behavior 1.  We share similar view as Nokia. |
| ZTE | Behavior 2. |
| Ericsson | Behavior 2  But Figure 2 does not correctly describe behavior 2. SPS release can be in any of 0,1,2,3 (i.e., not just 0), as long as the SPS release is before the end of SPS PDSCH transmission in the given slot. |

**Q1-2: If Behavior 1 is adopted, is it necessary to make specification changes?**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| Nokia, NSB | Yes. |
| vivo | Yes |
| HW/HiSi | Yes |
| Qualcomm | Yes. |
| Samsung | Yes, but minimum. We suggest the following.  If a UE is configured to receive SPS PDSCHs in a slot for SPS configurations that are indicated to be released by a DCI format, and if the UE receives the PDCCH providing the DCI format in the slot where the end of a last symbol of the PDCCH reception is not after the end of a last symbol of any of the last occasions of SPS PDSCH receptions, if the last occasion is in the slot, and if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH receptions would be multiplexed in a same PUCCH, the UE does not expect to receive the SPS PDSCHs, does not generate HARQ-ACK information for the SPS PDSCH receptions, and generates a HARQ-ACK information bit for the SPS PDSCH release. |
| ZTE | No need, but we are open to make the specification more clear especially for slot-aggregated SPS receptions. |
| Ericsson | Yes |

**Q1-3: If Behavior 2 is adopted, is it necessary to make specification changes?**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | No need for spec change.  The current spec describes as “the end of a last symbol of the PDCCH reception is not after the end of a last symbol of any of the SPS PDSCH receptions” To our understanding, the wording of “any of” is exactly UE behavior 2. |
| Nokia, NSB | Yes.  We disagree with the FL comment that “UE behavior 2 is to apply current specification strictly”; In our view “any of the SPS PDSCH receptions” in current specs doesn’t mean the first SPS occasion. |
| Vivo | May be no need for spec change and a conclusion is enough. But we are open for specification change. |
| HW/HiSi | Yes (or conclusion could work). |
| Qualcomm | We are fine with either a conclusion or specification change to further clarify the UE behavior. |
| Samsung | Yes |
| ZTE | No need, but we are open to make the specification more clear especially for slot-aggregated SPS receptions. |
| Ericsson | No need of spec change  By definition, UE behavior 2 is based on existing spec. |

**Q1-4: If Behavior 2 is adopted, what is your views on whether or how to solve the issue of limited K1 value? (i.e., no proper K1 value in a set or largest K1 value cannot cover the PUCCH for SPS PDSCH with slot-aggregation)**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | The issue of limited K1 value can be avoided by gNB configuration. |
| Nokia, NSB | We think the question should be for behavior 2, as the limitation as shown in the last Fig. above only applies for behavior 2 (i.e. for behavior 1 you could transmit the release DCI also in a later ‘repetition’ slot to align with the PUCCH occasion of the HARQ-ACK of the SPS configuration).  So the question should be instead:  **Q1-4: If Behavior 2~~1~~ is adopted, what is your views on whether or how to solve the issue of limited K1 value? (i.e., no proper K1 value in a set or largest K1 value cannot cover the PUCCH for SPS PDSCH with slot-aggregation)** |
| vivo | At this late stage, simple solution with minimum specification impacts should outweigh the solutions for flexibility. We don’t think behavior1 should be adopted |
| FL | I corrected the question according to Nokia, NSB. Thanks! |
| HW/HiSi | We agree with oppo, this can be avoided by gNB configuration. |
| Qualcomm | This can be avoided by gNB configuration. |
| ZTE | It is an error case to be avoid by implementation. |
| Ericsson | No need to address |

* 1. Issue #2 Capture the agreement on SPS release that is not supported

In RAN1#101e and RAN1#104bis, the following agreement and conclusion as drawn.

|  |
| --- |
| **Agreement (RAN1#101e)**  It is not supported that a SPS release PDCCH in a slot is received after the end of the SPS PDSCH reception in the slot for the same SPS configuration corresponding to the SPS release PDCCH if HARQ-ACKs for the SPS release and the SPS reception would map to the same PUCCH.   * FFS: if HARQ-ACKs for the SPS release and the SPS reception mapping to different PUCCHs   **Conclusion (RAN1#104bis)**  The following is not supported:   * The case that SPS release is received in a slot where SPS PDSCH is configured to be received for the SPS configuration corresponding to the SPS release if the HARQ-ACK for the SPS release and the SPS reception mapping to different PUCCHs. |

In [1, 2], there are proposals to capture previous agreements on SPS release timing that is not supported.

**Proposals from [1]:**

1. Adopt the text proposal to capture the agreement on SPS release that is not supported.

|  |
| --- |
| ---------------------------------Start of Text Proposal to TS 38.213 v16.5.0----------------------- 9.1 HARQ-ACK codebook determination ...  If a UE is configured to receive SPS PDSCHs in a slot for SPS configurations that are indicated to be released by a DCI format, and if the UE receives the PDCCH providing the DCI format in the slot where the end of a last symbol of the PDCCH reception is not after the end of a last symbol of any of the SPS PDSCH receptions, and if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH receptions would be multiplexed in a same PUCCH, the UE does not expect to receive the SPS PDSCHs, does not generate HARQ-ACK information for the SPS PDSCH receptions, and generates a HARQ-ACK information bit for the SPS PDSCH release.  < Unchanged parts are omitted >  If a UE is configured to receive SPS PDSCH(s) in a slot for SPS configuration(s), the UE does not expect to receive a PDCCH providing a DCI format in the slot to indicate SPS PDSCH release of the these SPS configuration(s), where the end of a last symbol of the PDCCH reception is after the end of a last symbol of any of the SPS PDSCH reception(s), if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH reception(s) would be multiplexed in a same PUCCH.  If a UE is configured to receive SPS PDSCH(s) in a slot for SPS configuration(s), the UE does not expect to receive a PDCCH providing a DCI format in the slot to indicate SPS PDSCH release of the these SPS configuration(s), if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH reception(s) would map to different PUCCHs.  < Unchanged parts are omitted >  --------------------------------- End of Text Proposal to TS 38.213 v16.5.0----------------------- |

Proposals from [2]:

In the following, we present a TP addressing the RAN1#101e agreement and the RAN1#104bis-e conclusion above based on our proposal 4.1 to support behavior 1, based on the following logic:

* The first added paragraph excludes the case of the release to be received after the last symbol for SPS PDSCHs in a slot (and for SPS repetition, this restriction only applies to the last SPS PDSCH occasion of the SPS repetition bundle) based on the RAN1#101-e agreement.
* As the first paragraph excludes these cases already, the related restrictions (for simplicity) can be removed from the second paragraph handling the case of same PUCCH for SPS HARQ and release indication.
* The third paragraph is added to reflect to the RAN1#104bis-e conclusion to not support different PUCCH for SPS HARQ and release indication.

**Proposal 4.2: Adopt the following TP to Sec. 9.1 of TS 38.213 to support behavior 1 as well as reflecting earlier RAN1 agreements and conclusion:**

|  |
| --- |
| 9.1 HARQ-ACK codebook determination \*\*\* Unchanged text is omitted \*\*\*  The UE is not expected to receive a DCI format in a slot to release SPS PDSCHs configured to be received in the same slot if the end of the last symbol of the PDCCH reception is after the end of a last symbol of any of the SPS PDSCH receptions for SPS configurations not subject to *pdsch-AggregationFactor* or any of the last occasions of SPS PDSCH receptions for SPS configurations subject to *pdsch-AggregationFactor* as described in Sec. 5.1.2.1 of [6].  If a UE is configured to receive SPS PDSCHs in a slot for SPS configurations that are indicated to be released by a DCI format, and if the UE receives the PDCCH providing the DCI format in the slot ~~where the end of a last symbol of the PDCCH reception is not after the end of a last symbol of any of the SPS PDSCH receptions~~, and if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH receptions would be multiplexed in a same PUCCH, the UE does not expect to receive the SPS PDSCHs, does not generate HARQ-ACK information for the SPS PDSCH receptions, and generates a HARQ-ACK information bit for the SPS PDSCH release.  The UE is not expected to receive a DCI format in a slot to release SPS PDSCHs configured to be received in the same slot if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH receptions would be multiplexed in a different PUCCH.  \*\*\* Unchanged text is omitted \*\*\* |

Since the first paragraph in [2] is related to issue #1, I would like to suggest to make TP after the decision of issue #1 together with its outcome.

Regarding proposal in [1] and third paragraph in [2], it seems fine to discuss in advance at least for saving our times.

**Q2-1: Please share your view whether below TP 2 is acceptable or not.**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | We are fine with the second paragraph in TP2.  For the first paragraph in TP 2, we think the wording is related to issue 1 so it is preferred to find the right wording after the decision of issue #1 together with its outcome. |
| Nokia, NSB | We agree with the intention, although prefer to agree on the TP after agreeing on issue #1  Nevertheless, we think TP2 could be simplified as follows:  Last part of the first paragraph in red could be removed (“~~, if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH reception(s) would be multiplexed in a same PUCCH~~”) 🡨 The release timeline restriction applies regardless of the PUCCH mapping. |
| Vivo | Generally ok with the TP |
| HW/HiSi | The first paragraph in the proposal below is about the timeline between the release DCI and the SPD PDSCH. But it only covers the case without repetition. We suggest to discuss it after we have concluded issue #1.  For the second paragraph we are fine with the TP. |
| Qualcomm | Generally OK with the TP. The wording of the first paragraph could be tuned to include the case of PDSCH repetition, and to simplify as suggested by Nokia.  For the second paragraph, we are fine. |
| Samsung | We don’t think the TP is necessary.  The agreements should be interpreted as a conclusion. We don’t have description such as “… is not supported ” in 38.213. |
| ZTE | Fine with the intention of second paragraph on the issue of mapping to different PUCCHs. For the first paragraph, we can come back after the issue#1 has conclusion or agreement. |
| Ericsson | Support  Regarding the 1st paragraph and Issue #1, we understood the agreement from RAN1#101e covers repetition also, i.e., the agreement does not contain any limitation of “no repetition”   |  | | --- | | **Agreement (RAN1#101e)**  It is not supported that a SPS release PDCCH in a slot is received after the end of the SPS PDSCH reception in the slot for the same SPS configuration corresponding to the SPS release PDCCH if HARQ-ACKs for the SPS release and the SPS reception would map to the same PUCCH.   * FFS: if HARQ-ACKs for the SPS release and the SPS reception mapping to different PUCCHs | |

**TP 2:**

|  |
| --- |
| ---------------------------------Start of Text Proposal to TS 38.213 v16.5.0----------------------- 9.1 HARQ-ACK codebook determination …  If a UE is configured to receive SPS PDSCHs in a slot for SPS configurations that are indicated to be released by a DCI format, and if the UE receives the PDCCH providing the DCI format in the slot where the end of a last symbol of the PDCCH reception is not after the end of a last symbol of any of the SPS PDSCH receptions, and if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH receptions would be multiplexed in a same PUCCH, the UE does not expect to receive the SPS PDSCHs, does not generate HARQ-ACK information for the SPS PDSCH receptions, and generates a HARQ-ACK information bit for the SPS PDSCH release.  < Unchanged parts are omitted >  If a UE is configured to receive SPS PDSCH(s) in a slot for SPS configuration(s), the UE does not expect to receive a PDCCH providing a DCI format in the slot to indicate SPS PDSCH release of the these SPS configuration(s), where the end of a last symbol of the PDCCH reception is after the end of a last symbol of any of the SPS PDSCH reception(s), if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH reception(s) would be multiplexed in a same PUCCH.  If a UE is configured to receive SPS PDSCH(s) in a slot for SPS configuration(s), the UE does not expect to receive a PDCCH providing a DCI format in the slot to indicate SPS PDSCH release of the these SPS configuration(s), if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH reception(s) would map to different PUCCHs.  < Unchanged parts are omitted >  --------------------------------- End of Text Proposal to TS 38.213 v16.5.0----------------------- |

* 1. Issue #3 CSI-PUCCH-ResourceList where SPS HARQ-ACK multiplexed

In the last meeting, this issue has been discussed but haven’t concluded yet. This is latest proposal in the last meeting.

**Latest Proposal 3-1 in RAN1#104bis-e:**

**For the multiplexing among overlapping channels with same a given priority index, if a UE is provided subslotLengthForPUCCH for the HARQ-ACK codebook of the given priority index, UE does not expect that the HARQ-ACK corresponding only to SPS PDSCH(s) in one sub-slot is moved to a different sub-slot after multiplexing.**

* **Note: It is up to the editor to decide whether/how to capture the proposal in the spec if agreed.**

Here are related proposals for this issue.

**Proposal from [4]:**

Proposal 1: For the multiplexing among overlapping channels with same a given priority index, if a UE is provided subslotLengthForPUCCH for the HARQ-ACK codebook of the given priority index, UE would not move the HARQ-ACK corresponding only to SPS PDSCH(s) in one sub-slot to a different sub-slot after multiplexing with the description of the current spec.

Proposal from [5]:

**Proposal 2: For the multiplexing among overlapping channels with same a given priority index, if a UE is provided *subslotLengthForPUCCH* for the HARQ-ACK codebook of the given priority index, UE does not expect that the HARQ-ACK corresponding only to SPS PDSCH(s) in one sub-slot is moved to a different sub-slot after multiplexing.**

Proposal from [6]:

**Proposal 4: Conclude that,**

**For the multiplexing among overlapping channels with a given priority index, if a UE is provided *subslotLengthForPUCCH* for the HARQ-ACK codebook of the given priority index, UE does not expect that the HARQ-ACK corresponding only to SPS PDSCH(s) in one sub-slot is moved to a different sub-slot after multiplexing.**

Based on the companies’ proposals, there is common understanding that that UL multiplexing procedure must keep the original sub-slot but it is unclear whether specification changes is not necessary. Thus, it would be good to try latest proposal and discuss about specification impact.

**FL Proposal 3: take below as a conclusion.**

**Proposed Conclusion:**

**For the multiplexing among overlapping channels with same a given priority index, if a UE is provided subslotLengthForPUCCH for the HARQ-ACK codebook of the given priority index, UE does not expect that the HARQ-ACK corresponding only to SPS PDSCH(s) in one sub-slot is moved to a different sub-slot after multiplexing.**

**Q3-1: Please share your view whether FL proposal 3 is acceptable or not.**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | Support. |
| Nokia, NSB | Support |
| vivo | Support |
| HW/HiSi | Support |
| Qualcomm | Support. |
| Samsung | Not support.  The same issue also happens for SR PUCCH. For example, as shown in the figure below, SR PUCCH#2 is a positive SR, CSI PUCCH #0 is the initial CSI PUCCH, when CSI PUCCH #0 multiplexed with SR PUCCH #3 the result PUCCH is CSI PUCCH#1 due to payload change. CSI PUCCH#1 overlaps with SR PUCCH#2.    **Figure 1**  Another example is given below, CSI PUCCH #0 multiplexed with SR PUCCH #2 the result PUCCH is CSI PUCCH#1, the latency of SR is increased.    **Figure 2**  We think these cases should also be avoided. Therefore, we prefer our original proposal form R1-2102136.  ***Proposal: The PUCCH resources in CSI-PUCCH-ResourceList should be configured within a same sub-slot. Adopt the following TP.***  TS 38.213  **9 UE procedure for reporting control information**  …  If a UE is provided two *PUCCH-Config*  - if the UE is provided *subslotLengthForPUCCH* in the first *PUCCH-Config*, the PUCCH resource for any SR configuration with priority index 0 or any CSI report configuration in any *PUCCH-Config* is within the *subslotLengthForPUCCH* symbols in the first *PUCCH-Config*, if the UE is provided by *multi-CSI-PUCCH-ResourceList*, PUCCH resources in *multi-CSI-PUCCH-ResourceList* should be configured within the same *subslotLengthForPUCCH* symbols.  - if the UE is provided *subslotLengthForPUCCH* in the second *PUCCH-Config*, the PUCCH resource for any SR configuration with priority index 1 in any *PUCCH-Config* is within the *subslotLengthForPUCCH* symbols in the second *PUCCH-Config*  … |
| ZTE | Support |
| Ericsson | Support |

**Q3-2: Is it necessary to make specification changes for the above proposal? It would be appreciated to indicate your preference first with Yes or no.**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| OPPO | No specification change.  To our understanding, if a UE is provided subslotLengthForPUCCH for a given priority index, the multiplexing of SPS HARQ-ACK and CSI in section 9.2.5.2 (the following text) should be performed on sub-slot level, that is, the highlighted “slot” in the following text should be re-interpreted as sub-slot. In such a case, the SPS HARQ-ACK information would not be moved to a different sub-slot after multiplexing with CSI. Therefore, the current specification is clear and no needs for further clarification.  **9.2.5.2 UE procedure for multiplexing HARQ-ACK/SR/CSI in a PUCCH**  If a UE has one or more CSI reports and zero or more HARQ-ACK/SR information bits to transmit in a PUCCH where the HARQ-ACK, if any, is in response to a PDSCH reception without a corresponding PDCCH  - if any of the CSI reports are overlapping and the UE is provided by *multi-CSI-PUCCH-ResourceList* with  PUCCH resources in a slot, for PUCCH format 2 and/or PUCCH format 3 and/or PUCCH format 4, as described in Clause 9.2.1, where the resources are indexed according to an ascending order for the product of a number of corresponding REs, modulation order , and configured code rate ;  - if , the UE uses PUCCH format 2 resource , or the PUCCH format 3 resource , or the PUCCH format 4 resource  - else if …… |
| Nokia, NSB | No  We don’t see a need for a specs change, the conclusion could be sufficient. |
| Vivo | Conclusion may be enough. We are open to make specification changes for the proposal. |
| HW/HiSi | No spec change needed. |
| Qualcomm | Some clarifications in the specification would be preferred, since such conclusion **can not** be inferred from anywhere in the specification. |
| ZTE | Reach conclusion first. Fine to make specification more clear. |
| Ericsson | While spec change may not be necessary, it’s useful to clarify in the spec and avoid confusion. |

# Final outcome from [105-e-NR-L1enh-URLLC-05]

From the discussion in [105-e-NR-L1enh-URLLC-05],

# References

1. R1-2104215, Maintenance of PDCCH and SPS for Rel-16 NR URLLC, Ericsson
2. R1-2104312, Rel-16 URLLC/IIoT maintenance of PDCCH, Scheduling/HARQ and SPS enhancements, Nokia, Nokia Shanghai Bell
3. R1-2104321, Remaining issues on SPS enhancement in Rel-16 URLLC, ZTE
4. R1-2104801, Maintenance on SPS enhancements, OPPO
5. R1-2105418, Remaining issues of other aspects for URLLC/IIOT, LG Electronics
6. R1-2105531, Remaining issues on UCI enhancements and SPS, Huawei, HiSilicon
7. R1-2105851, Release of UL grant type 2 PUSCH or SPS PDSCH configurations, ASUSTeK