**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. |
| CATT | Behavior 2.  The description of behavior 2 is not accurate. The intention is to restrict SPS PDSCH release in the first slot of SPS PDSCH repetitions as illustrated in Figure 2.  If Behavior 1 is allowed, if the release DCI is sent in the last slot of SPS repetition, both HARQ-ACK for SPS release and SPS PDSCH would occupy the same HARQ-ACK bit. Then if UE missed the release DCI but correctly decoded the SPS PDSCH, UE would send ACK to the gNB and gNB may think that release DCI is correctly received by the UE. |
| DOCOMO | Behavior 2 |
| Apple | Behavior 2 |

**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 |
| CATT | Yes |
| DOCOMO | 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. |
| CATT | No. We think a conclusion is sufficient. |
| DOCOMO | Spec change is not necessary |
| Apple | We are fine to take a conclusion on this. |

**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 |
| CATT | Up to gNB. |
| DOCOMO | Can be avoided by gNB configuration |

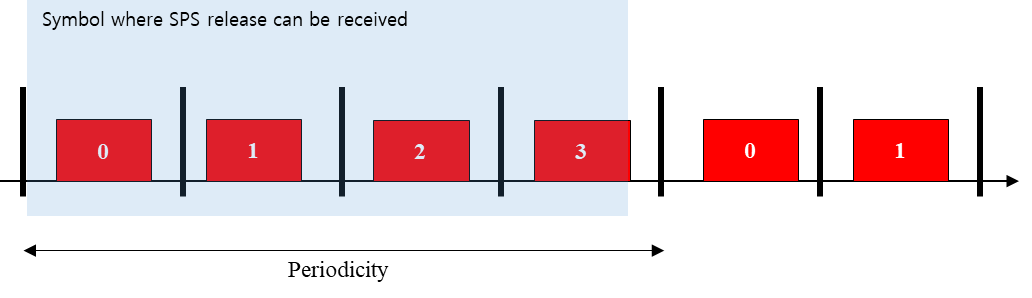
* + 1. Update#1 on Issue #1 (5/24)

From provided comment so far, it seems necessary to clarify the description of UE behavior.

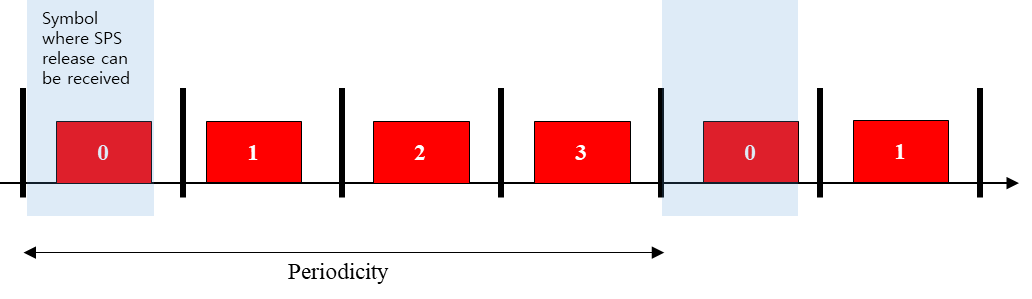
UE behavior 1 can be regarded as an extension of current UE behavior. In UE behavior 1, all SPS occasion of a TB are considered to determine the end of the reception. In other words, the end of last SPS occasion is considered

UE behavior 2 is to apply current specification to the repetition bundles over multiple slots, i.e, UE can receive SPS release only before end of the reception of any of corresponding SPS occasion in multiple slot. It eventually means UE can receive SPS release only before end of the reception of the first SPS occasion. I think it is an understanding of most proponent of behavior 2.

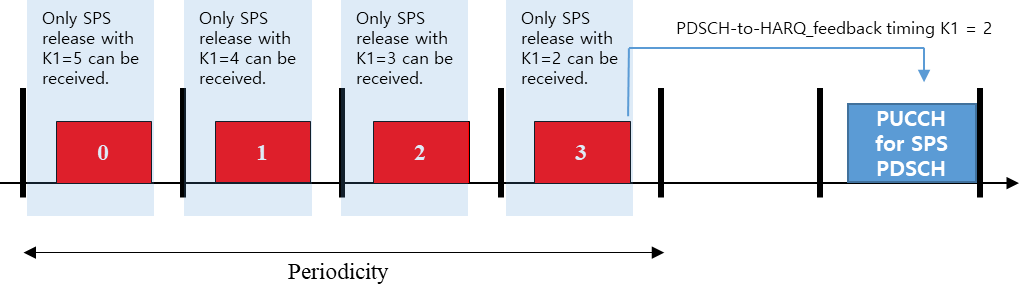
UE behavior 2’ is made from Ericsson’s comment. This is to apply current specification more strictly, i.e., make timeline of SPS release for each slot having SPS occasion.



**UE behavior 1**



**UE behavior 2**



**UE behavior 2’ (from Ericsson’s comment)**

From answers on Q1-1, there seems a majority view on Behavior 2 (supported by 8 companies), comparing to Behavior 1((supported by 2 companies) or 2’(supported by 1 company)

From answers on Q1-2, most of companies think Behavior 1 needs specification changes.

From answers on Q1-3, 3 of companies prefer to make specification changes for behavior 2. 7 companies prefer to keep current specification. Among those companies, 4 companies are open to discuss.

From answers on Q1-4, most of companies think the drawback of behavior 2 could be avoided by gNB configuration.

Based on above majority views, FL made following proposals.

**FL Proposal 1-1: Take below as a conclusion (Support Behavior 2).**

**Proposed Conclusion:**

**For SPS PDSCH release and SPS PDSCH reception with slot-aggregation, If a UE is configured to receive SPS PDSCHs over multiple slots for a TB by SPS configurations that are indicated to be released by a DCI format, UE can receive the PDCCH providing the DCI format only before end of the first occasion of corresponding SPS receptions.**

* **Note: The UE stops the PDSCH decoding and does not generate HARQ-ACK feedback information for the SPS PDSCH reception as in current specification.**

**Q1.1-1: Please share your view whether the intention of FL Proposal 1-1 is acceptable or not.**

The wording of the proposal may not be preferable (I tried to bring the text from current description). Please share your suggestion if any.

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| HW/HiSi | We agree with behavior 2. But think the proposed conclusion does not reflect behavior 2. Or understanding would be that the SPS PDSCH release DCI only can be received before the end of the first occasion.  Maybe the conclusion could be written like this:  **For SPS PDSCH release and SPS PDSCH reception with slot-aggregation, If a UE is configured to receive SPS PDSCHs over multiple slots for a TB by SPS configurations that are indicated to be released by a DCI format, UE can receive the PDCCH providing the DCI format only before end of the first occasion of corresponding SPS receptions. ~~occasion~~.** |
| vivo | HW’ update seems clearer. |
| ZTE | We support behavior 2, and agree with the proposal 1-1. As FL explained, the any occasion includes the first occasion, then I can accept the proposal. But the revision from Huawei seems clearer. So I support the update from Huawei. |
| Nokia, NSB | We still prefer behaviour 1 or 2’ (as proposed by E//), but are willing to compromise for the sake of progress.  If Huawei and other companies think that ‘**any of corresponding SPS occasion**’ should be replaced with ‘the first occasion’ in the proposed conclusion, then similar edit should also be made to the current specs for clarity. |
| Qualcomm | We support HW/HiSi’s update (and behavior 2). |
| DOCOMO | We agree with the proposed conclusion and also support the modification from Huawei |
| Feature lead | @all:  Thanks for the comments so far. It seems Huawei’s modification is fine. I update the proposal accordingly.  @Nokia, NSB: Thank you for being flexible! |
| Samsung | We can compromise with Huawei’s update, but, we share similar view as Nokia, spec clarification is necessary. |
| CATT | We agree with Huawei’s update which is our understanding of behavior 2. |
| OPPO | Fine with Huawei’s modification. |

* + 1. Update#2 on Issue #1 (5/26)

Based on companies input, there seems no objection on latest proposal with Huawei’s modification especially if there will be specification changes accordingly.

**FL Proposal 1-1: Take below as a conclusion (Support Behavior 2).**

**Proposed Conclusion:**

**For SPS PDSCH release and SPS PDSCH reception with slot-aggregation, if a UE is configured to receive SPS PDSCHs over multiple slots for a TB by SPS configurations that are indicated to be released by a DCI format, UE can receive the PDCCH providing the DCI format only before end of the first occasion of corresponding SPS receptions.**

* **Note: The UE stops the PDSCH decoding and does not generate HARQ-ACK feedback information for the SPS PDSCH reception as in current specification.**

To reflect above conclusion, there was a discussion whether to make specification changes. Half of companies thinks the specification impact is not necessary and other half of companies think that the changes is necessary or are open to discuss.

Considering current specification, it could be read as timeline condition checks any of the SPS receptions only in a slot. For Behavior 2, UE should check the first occasion among SPS occasions over multiple slots, for SPS configuration where *pdsch-AggregationFactor* is provided.

|  |
| --- |
| 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. |

Since some companies already show their interpretation by comments, e.g., UE behavior 2’, FL suggests companies to consider to make specification changes for reflecting UE behavior 2.

**Q1.2-1: If you have strong concern to make specification changes, please provide your opinion and explanation.**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| HW/HiSi | We agree to update the specification. |
| OPPO | We are fine to modify the specification. |
| ZTE | Support to modify the specification. |
| Nokia/NSB | TP/CR is needed |
| Ericsson | OK to modify spec |
| Samsung | TP is necessary. |
| vivo | We are fine to modify the specification |

There are some text proposals for issue #1 and #2 in contributions. Based on TP in [2] and discussion on issue #2, following TP has been drafted. Please check following TP.

**Q1.2-2: Please share your view whether below text proposal is acceptable or not. Please let us know if you have any suggestion on the text proposal.**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| HW/HiSi | We are not sure if the text in green describes behavior 2 for SPS PDSCH repetition correctly.  The following sentence “of the first occasions of corresponding SPS PDSCH receptions for SPS configurations subject to *pdsch-AggregationFactor* as…” seems to describe the intended behavior correctly for the first occasion. But it is then said nothing about what is happening in other occasions than the first. Behavior 2 means that the UE is not expected to receive any release DCI during the other occasions, but this does not seem clear to me from the proposed text. Could the TP be misunderstood that a release DCI can be received any time during the remaining occasions?  Maybe following wording could describe the Behavior 2 clearer?:  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* and any of the first occasions of corresponding SPS PDSCH receptions for SPS configurations subject to *pdsch-AggregationFactor* as described in Sec. 5.1.2.1 of [6]. For slots containing SPS occasions other than the first, the UE is not expected to receive a DCI format to release the same SPS PDSCH.    The remainder of the TP starting from “*If a UE is configured…”* seems ok. |
| ZTE | Support. The expression is by “UE is not expected”, the any of the occasion includes the first occasion. If UE is not expected … after…any of the occasion, it equals UE is not expected … after…the first occasion, as the first occasion is the earliest occasion. |
| Feature lead | Based on given comments, I update TP. To address ZTE’s and Huawei’s concern, “for TBs” has been added to clarify a range of SPS occasions.  This is another draft based on Huawei’s modification. It would be appreciated to provide your opinion for both of them.  If a UE is configured to receive SPS PDSCHs in a slot for SPS configuration that are indicated to be released by a DCI format, the UE is not expected to receive the DCI format in the 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 subject to *pdsch-AggregationFactor*, the UE is not expected to receive the DCI format in a slot containing SPS occasions other than the first. |
| Nokia, NSB | Support the TP.  We are with ZTE’s clarification//answer to problem raised by HW/HiSi, and therefore, we don’t think the additional sentence by FL is needed.  Minor editorial change needed here (the / these):    < 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), if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH reception(s) would map to different PUCCHs.  < Unchanged parts are omitted > |
| HW/HiSi [2] | A question for clarification about the answer that ZTE provided to our concern.  @ZTE: When you say “*the any of the occasion includes the first occasion. If UE is not expected … after…any of the occasion*”, isn’t there a risk that the current wording that the “any” only refers to the case without PDSCH repetition?  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*** and any of the first occasions of corresponding SPS PDSCH receptions for SPS configurations subject to *pdsch-AggregationFactor* as described in Sec. 5.1.2.1 of [6] |
| ZTE2 | Echo to HW’s question. The issue we discussed is related PDSCH repetition. My previous answer is targeting to this issue only. As your note, in the case without repetition, any of the occasion is the individual sample, and the only one is also the first one. And every individual one will be treated as the first one here. So literally, my interpretation can also be applied to the case you mentioned. But anyway, I am open to your version above, it is more straightforward, if most of companies think this is OK, I can accept. |
| Ericsson | Due to TDD, it is not correct to limit SPS release to first occasion. It should be the first occasion that SPS PDSCH is expected to be received, i.e., move to next occasion if earlier occasions were not expected to be received for some reason. For example, the TP is edited as follows:  For SPS configurations subject to *pdsch-AggregationFactor*, the UE is not expected to receive the DCI format in a slot containing SPS occasions other than the first slot where the SPS PDSCH reception is expected. |
| Feature lead | To address Ericsson’s concern, add a reference for TS 38.214. Please check updated TP. |
| vivo | Support the TP. we don’t think the additional sentence “for TBs”by FL is needed. |
| Samsung | Regarding the behavior 2 of Issue#2, E/// brought up an issue in case of TDD. It is not clear to us whether it is allowed to transmit PDCCH in slot 1 in the figure below, at least it seems to be possible for this case but for some other cases (all UL slot) not.  cid:image009.png@01D75309.7B47E7C0  We also spot another issue for Behavior 2 in case of joint release for SPS PDSCHs with repetition.    Considering the figure below, where can gNB send the PDCCH in this case?  cid:image001.png@01D75307.A4E7F360  It seems we don’t have such issue for Behavior 1, we suggest to postpone the discussion of the TP to the next meeting and give companies some time to think about it. |
| HW/HiSi | We support the TP below. |

**Draft of Text proposals for issue #1 and #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 according to Clause 5.1 of [6] for TBs for SPS configurations that are indicated to be released by a DCI format, the UE is not expected to receive the DCI format in the 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 occasion for TBs.  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), 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. Final status of issue #1 and #2

From the discussion in [105-e-NR-L1enh-URLLC-05], following were made:

|  |
| --- |
| **Conclusion**  For SPS PDSCH release and SPS PDSCH reception with slot-aggregation, if a UE is configured to receive SPS PDSCHs over multiple slots for a TB by SPS configurations that are indicated to be released by a DCI format, UE can receive the PDCCH providing the DCI format only before end of the first occasion of corresponding SPS receptions.   * Note: The UE stops the PDSCH decoding and does not generate HARQ-ACK feedback information for the SPS PDSCH reception as in current specification. |

To reflect above conclusion and previous agreements haven’t been captured in specification, initial TP were made by FL based on Nokia’s contribution.

For TP for issue #1, following discussion point has been provided.

* Point 1: (By Huawei/Hisilicon) TP should address SPS occasions in multiple slots and UE is not expected to receive any release DCI during in a slot where UE is required to receive SPS occasion other than first SPS occasion.
* Point 2: (By Ericsson) TP should address TDD operation, to consider only valid SPS occasion.
* Point 3: (By Ericsson) It is desirable to consider SPS collision handling in Clause 5.1 in TS 38.214
* Point 4: (By Samsung) It should be clear whether it is allowed to transmit PDCCH in slot where SPS occasion is omitted.
* Point 5: (By Samsung) It would be necessary to discuss pros and cons of UE behavior 2 if time permitted.

To resolve above concerns, some modification on initial TP were discussed by companies. To address point 1, the word “TBs” was added. To address point 2 and 3, the reference for Clause 5.1 of TS 38.214 and Clause 11.1 of TS 38.213 was added. To address point 4, “that are required to be received” was added to some places.

For TP for issue #2, there has been no objection form update #2, bottom red part.

This is latest TP during email discussions. It is highly appreciated to consider this text proposal for the next meeting.

**Text proposals for issue #1 and #2 :**

|  |
| --- |
| ---------------------------------Start of Text Proposal to TS 38.213 v16.5.0-----------------------    **9.1              HARQ-ACK codebook determination**  …  If a UE is required to receive SPS PDSCHs in a slot according to Clause 5.1 of [6] and Clause 11.1 for SPS PDSCH transmission occasions of TBs for SPS configurations that are indicated to be released by a DCI format, the UE is not expected to receive the DCI format in the 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 transmission occasions that are required to be received of TBs.    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), 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 #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 | |
| CATT | We prefer to discuss the TP after concluding issue #1. |
| DOCOMO | We are fine with the 2nd paragraph, and prefer to discuss the 1st paragraph after concluding issue#1 |

**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. Update#1 on Issue #2 (5/24)

Regarding TP2, most companies suggested to discuss on the first paragraph after the discussion on issue #1. For second paragraph, most of companies seems fine.

Regarding the comment from Samsung, I feel sympathy with this. However, if we recall this prolonged discussion, I have to admit that the current spec without the description of excluded case have made problems. As Feature lead, I suggest to take TP 2 with only first paragraph for now.

@Samsung,

Could you live with TP below?

**Please share your view if you have strong concern on the TP 2 with update #1.**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| HW/HiSi | Could you please clarify, from your description above on the update on issue #3,most companies seem fine with the second paragraph and the discussion of the first one should be postponed. The TP2 below seems to be the other way around? The second paragraph is deleted and the first is kept and discussed?  Could you please clarify what we have missed here? |
| ZTE | Same comment with Huawei, Maybe the second paragraph is missing? |
| Nokia, NSB | Same comment as HW/HiSi & ZTE. Only a single paragraph seems to be not sufficient. |
| Samsung | As quite a few companies suggested to postpone the discussion in the 1st round, we don’t think it is necessary to discuss the TP for now. |
| Qualcomm | Same comment as HW/HiSi and others. The second paragraph seems to be missing.  For the TP2 below, as Nokia suggested in the first round, we can remove the “if HARQ-ACK information…” condition. |
| DOCOMO | Same comment with other companies |
| Feature lead | Sorry for inconvenience. It was my confusion during edit. I fixed the TP by changing paragraph. If you don’t mind, please share view again via email or draft folder. |
| CATT | Which TP are we discussing now?  @FL: I fixed again |

**TP 2 with update #1:**

|  |
| --- |
| ---------------------------------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), 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. Update#2 on Issue #2 (5/26)

Please see update #2 on issue #1.

* 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 |
| CATT | We support the proposal and can include SR to address Samsung’s comments. |
| DOCOMO | Support |
| Apple | We support taking a conclusion and including the issue raised by Samsung on SR in the conclusion as well. |

**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. |
| CATT | We think spec change is not necessarily needed but we are also open to spec change. |
| DOCOMO | We don’t see the necessity of spec change |
| Apple | It seems taking a conclusion to cover CSI/HARQ and CSI/SR can be beneficial. |

* + 1. Update#1 on Issue #3 (5/24)

For issue 3, most of companies support to have the conclusion without specification changes.

For the issue raised by Samsung’s comment in Q3-1, some companies suggest to include SR into the conclusion.

Actually the issue related to SR transmission is not a scope of this discussion, Since it is not related to SPS anymore. That was why we address only “the HARQ-ACK corresponding only to SPS PDSCH(s)” in the previous meeting.

If it is common understanding for general UL multiplexing procedure and if it is acceptable to treat the issue here, it would be good to solve the issues together. Here is a modified proposal to include general PUCCH resource applied to subslotLengthForPUCCH. If it is not acceptable, I would like to suggest to take previous proposal and treat SR issue as a separated discussion.

**FL Proposal 3 with update#1: 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 PUCCH transmission ~~the~~ ~~HARQ-ACK codebook of~~ with the given priority index, UE does not expect that ~~the HARQ-ACK corresponding only to SPS PDSCH(s)~~ the PUCCH transmission in one sub-slot is moved to a different sub-slot after multiplexing.**

Clean version:

**For the multiplexing among overlapping channels with same a given priority index, if a UE is provided subslotLengthForPUCCH for the PUCCH transmission with the given priority index, UE does not expect that the PUCCH transmission in one sub-slot is moved to a different sub-slot after multiplexing.**

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

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| HW/HiSi | For the situation where no HARQ-ACK would be transmitted in a slot, only SR and CSI. In this case SR would follow the slot. Is this conclusion misleading in the sense that SR should use sub-slot? |
| vivo | Do not support. For the multiplexing of SR and CSI, or CSI and CSI, they are multiplexed in slot level, and can be in a different sub-slot after multiplexing. |
| ZTE | Same concern with Huawei and vivo, I am fine with the original version. |
| Nokia, NSB | Agree with the comments by HW/HiSi, vivo & ZTE.  The restriction would only need to apply if HARQ-ACK is multiplexed. |
| Samsung | We would like to given another example to address HW and other companies’ concern.    The SR in sub-slot 6 is moved to sub-slot 0, the case has HARQ-ACK involved, we think it should be handled per sub-slot. If PUCCHs in sub-slot 0 is performed first, there will be no CSI overlapping with HARQ-ACK if PUCCHs in sub-slot 6 is not considered.  We insist on our initial TP, it is simple and clean.  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* |
| Qualcomm | We share the same view as HW/Hisi, Vivo, ZTE, Nokia, that the restriction would only apply to HARQ-ACK. CSI and SR in Rel-16 are both slot based transmission, and as such we don’t think any limitation is necessary.  To Samsung, the example brought up above has HARQ-ACK information, and therefore by the previous version of the conclusion, it should be determined as an error case. And if the HARQ-ACK is not present in the example, then SR should be allowed to multiplex from subslot 6 to subslot 0. |
| DOCOMO | We prefer previous version |
| Samsung2 | Thanks Qualcomm for clarification, however, it seems we have different understanding. With the previous version of the conclusion, we don’t think the above figure should be considered as an error case. First of all, the HARQ-ACK is not moved to another sub-slot. Second, we didn’t limit the HARQ-ACK only corresponding to SPS PDSCH(s), dynamic scheduled HARQ-ACK can also exist in the above example.  To Qualcomm, could you clarify a bit why the figure above should be considered as an error case? |
| Feature lead | @all:  As mentioned above by Huawei/Hisilicon, Vivo, ZTE, Nokia, NSB and Qualcomm, it is clear that there are slot-based PUCCH resource and sub-slot-based PUCCH resource. I think now we have clear understanding that a result of UL multiplexing should be in the same sub-slot when a sub-slot PUCCH is involved in the UL multiplexing. To reflect that, previous version is enough. So I propose to agree the previous proposal below at least.  **FL Proposal 3**  **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.**  Meanwhile, The issue Samsung mentioned is related to the pseudo code in 9.2.5, which is for determine final PUCCH resource in a single slot. To perform both sub-slot-based and slot-based UL multiplexing, some discussion would be necessary. For example,   * How to run pseudo code? Per sub-slot basis or per slot basis or both? * Is it necessary that all PUCCH resource is confined in the same sub-slot for sub-slot-level UL multiplexing?   However, it is separated discussion which may not related to SPS enhancement. I would like to suggest to discuss this issue in the next meeting, otherwise, I would try following.  **Q3-1-2: Can the general sub-slot issue be handled under this discussion? If so, Please share your view on the following proposal.**  **FL Proposal 4**  **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 to multiplex the HARQ-ACK information corresponding to the HARQ-ACK codebook with other PUCCH transmission(s) in the different sub-slot(s).z** |
| Samsung 3 | clearly the understanding of the issue is not aligned. Further discussion is necessary. We cannot accept the proposals for now.    We acknowledge that the issue is not only related to SPS, we first spot the issue in the last meeting, at that time we only thought of SPS case and the issue was discussed under this agenda. However, during the discussion of this meeting, we figured out SR is also related to this issue and should not be separately discussed, it is a same/similar issue. We don’t see the reason why the issue should be separately discussed for SR and SPS.    Also, based on Qualcomm’s latest reply in email, Qualcomm acknowledged the example we mentioned in the 2nd round is valid. We would like to encourage other companies to further think of the issue.  If companies agree the given example is valid, we think this case should be handled per sub-slot instead of slot since HARQ-ACK gets involved. When dealing the set Q in sub-slot 0, there is no CSI PUCCH#1, the multiplexing of set Q in sub-slot 6 may be handled after HARQ-ACK PUCCH#2 is transmitted, clearly, the result CSI PUCCH#1 may not be multiplexed with HARQ-ACK PUCCH#2. We think this case should be avoided. |
| CATT | We think the example provided by Samsung is valid. To address the case, is the following updated proposal agreeable?  **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) or SR in one sub-slot is moved to a different sub-slot after multiplexing.**  @FL: Based on companies’ understanding above, SR is slot-based PUCCH. For may understanding, the reason to confine SR within sub-slot is just for case when SR is multiplexed into sub-slot HARQ-ACK codebook. Thus, if HARQ-ACK is not involved, there seems no reason to limit SR not to move to another sub-slot. |
| OPPO | Fine with the both FL proposal 3.  We acknowledge that the example from Samsung for SR is valid and agree with FL that this issue is somehow related with the pseudo code in 9.2.5. For FL proposal 4, we have a clarification question: does proposal 4 means the scheduling/configuration in sub-slot 0/6 (in Samsung’s example) should be avoided by gNB or it means that in this case the pseudo code in 9.2.5 should be performed per sub-slot basis such that CSI PUCCH #0 is used to transmit CSI and SR?  @FL: I feels that there is no clear understanding how the pseudo code in 9.2.5 run with sub-slot HARQ-ACK. So it is up to further discussion. The main purpose of proposal 4 is for gNB to guarantee no inter-sub-slot UL multiplexing if sub-slot HARQ-ACK is involved, no matter what UE behavior is determined in future. I think it is all we can do here with limited time for a new issue. |
| Samsung 4 | Regarding Issue #3, we would like to further clarify a bit.  In our understanding, there are two sub-issues under Issue#3,        Issue #3-1: Whether it is allowed to multiplex SPS HARQ-ACK into another sub-slot ?        Issue #3-2: Whether it is allowed to multiplex SR into another sub-slot ?  Both sub issues are related to multiplexing with CSI, therefore, we think they can be discussed together. A unified solution is preferred.  For Issue #3-1, we acknowledged the issue during last meeting, solutions for this sub-issue continued in this meeting.  For Issue #3-2, we spot the issue at the beginning of this meeting. For simplicity, we brought up this issue with the following two examples without HARQ-ACK involved, however, HW and a few companies believe that multiplexing of SR and CSI is performed per slot, the issue is not valid. We cannot agree because similar cases exist when there is HARQ-ACK.  cid:image011.png@01D751B2.DFF84FA0  Figure 1  cid:image012.png@01D751B2.DFF84FA0  Figure 2  In the 2nd round reply, we further clarified the issue with the example in Figure 3.  cid:image013.png@01D751B2.DFF84FA0  Figure 3  The example in Figure 3 has HARQ-ACK in each sub-slot, in our understanding, this case should be handled per sub-slot. Hopefully, we are aligned here. If HW and other companies still think it is performed per slot, please help clarify.  In our understanding, PUCCH mux for each sub-slot is performed in a time order. When dealing the set Q in sub-slot 0, there is no CSI PUCCH#1, the multiplexing of set Q in sub-slot 6 may be handled after HARQ-ACK PUCCH#2 is transmitted, in this situation, the result CSI PUCCH#1 may not be multiplexed with HARQ-ACK PUCCH#2. The CSI and SR cannot be transmitted. Therefore, we think this case should be avoided.  Further, we don’t think multiplexing of SR and CSI in sub-slot 6 can be performed in advanced, there can be overlapping HARQ-ACK in sub-slot 6 as shown in Figure 4. DCI can comes after HARQ-ACK in sub-slot 0. UE does not know whether there will be overlapping HARQ-ACK in sub-slot 6 when transmitting HARQ-ACK in sub-slot 0.  cid:image015.png@01D751B2.DFF84FA0  Figure 4  We think it is necessary to further discuss Issue#3-2, if companies think this issue is not valid, could you please further clarify.  Hopefully companies can better understand our concern. |

* + 1. Update#2 on Issue #3 (5/26)

Regarding Issue #3, few more concern has been raised. Concerns are related to whether to handle UL multiplexing per slot or sub-slot. Samsung show some figures for these issue. To sum up, there could be three sub-issues.

* Issue #3-1: Whether it is allowed to multiplex SPS HARQ-ACK into another sub-slot?
* Issue #3-2: Whether it is allowed to multiplex SR into another sub-slot?
* Issue #3-3: Whether it is allowed to multiplex SPS HARQ-ACK in a sub-slot with other PUCCH transmission in different sub-slot?

First of all, some of issues are related to the pseudo code in 9.2.5, which is for determine final PUCCH resource in a single slot. To perform both sub-slot-based and slot-based UL multiplexing, some discussion may be necessary. However, this could be out of scope of this discussion and SPS enhancement. For example,

* How to run pseudo code? Per PUCCH basis or per sub-slot basis or per slot basis or per both slot and sub-slot?
* Is it necessary that all PUCCH resource is confined in the same sub-slot for sub-slot-level UL multiplexing?

Regarding issue #3-1, the following proposal get majority supports. Samsung proposes to handle issue #3-1 and other issues together and also propose unified solution. Meanwhile, some companies thinks that UE can multiplex SR into another sub-slot so other issue may be not valid.

**FL Proposal 3**

**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.**

Regarding issue #3-2, there are different understanding on this issue. Here is a list of options to solve the problem. .

* Option 1: No handling, since SR is slot-based PUCCH even if *subslotLengthForPUCCH* is configured.
* Option 2 (Samsung’s proposal): PUCCH resources in multi-CSI-PUCCH-ResourceList should be configured in one sub-slot.
* Option 3 (CATT’s modification): add “SR” to FL proposal 3 so that the conclusion covers both SPS HARQ-ACK and SR.

**Text proposals for Option 2**

|  |
| --- |
| 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* |

**Proposal for Option 3:**

**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) or SR in one sub-slot is moved to a different sub-slot after multiplexing.**

As feature lead, my suggestion is to discuss issue #3-1/2 together including option of “no handling”. Thus, there could be following alternatives.

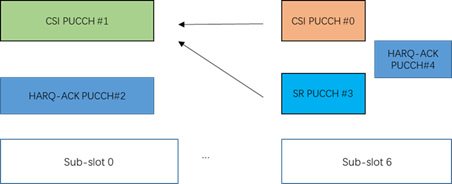
* Alt.1: Take FL proposal 3 as a conclusion for issue #3-1. No handling for issue #3-2.
* Alt.2: Take CATT’s proposal (option 2, add “SR” to FL proposal 3) for both issue #3-1 and issue #3-2.
* Alt.3: Take Samsung’s proposal for both issue #3-1 and issue #3-2.

**Q3.2-1: Please indicates your preference on alternatives above. It is highly appreciated to provide reasons in detail.**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| HW/HiSi | Our preference is Alt1.  3-2 should not be handled, because this is addressed already in Rel-15. |
| OPPO | We think issue #3-2 is related with issue #3-3 (the following case from Samsung is valid). In addition, we agree with FL that this is general sub-slot issue and not SPS-specific problem, it is related to the pseudo code in 9.2.5. So we slightly prefer to handle these issues (#3-1~#3-3) together and try to reach some consensus on the interpretation of the pseudo code for determining the final PUCCH resource.  We are fine to handle these issues under this discussion or under the email thread of UCI enhancements. |
| ZTE | Alt.1. Intend to separate the discussion of 3-1 and 3-2. |
| Feature lead | I removed Option 4 in issue #3-2 since it was for issue #3-3. Sorry for confusions. |
| Nokia, NSB | Alt. 1, and agree with ZTE that the discussions on 3-1 and 3-2 could be handled separately. |
| Ericsson | Alt 1  We are not convinced of the issue raised by Samsung Figure 4. In our understanding, if CSI PUCCH#0 overlaps with SR PUCCH#3, SR is multiplexed with CSI and sent on PUCCH#0, i.e., it does not move to another (sub)slot. See spec text below.  38.213 section 9.2.5.1 |
| Samsung | Our first choice is Alt 3. Our intention is to have a unified solution for the similar issues. Considering some companies are not convinced by the validity of the other issue, we can compromise to take Alt1 as well if the majority view is Alt 1.  We only have this issue for LP PUCCHs, some editorial suggestion as below,  **For the multiplexing among overlapping LP PUCCHs~~channels~~ ~~with same a given priority index~~, if a UE is provided subslotLengthForPUCCH for the LP PUCCH-Config~~HARQ-ACK~~ ~~codebook~~, UE does not expect that the HARQ-ACK corresponding only to SPS PDSCH(s) [and/or SR] in one sub-slot is moved to a different sub-slot after multiplexing.**  Regarding the spec mentioned by E///, we have different understanding.  The spec doesn’t say the CSI PUCCH doesn’t change after UCI multiplexing, in our understanding a resource can be either the 1st or 2nd CSI PUCCH resource provided in *multi-CSI-PUCCH-ResourceList.* The description is the same as multiplexing of HARQ-ACK and SR. After multiplexing, the payload can change, UE may reselect a PUCCH resource according to the total payload. See spec below for comparison.  38.213 section 9.2.5.1  If a UE would transmit a PUCCH with  HARQ-ACK information bits in a resource using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 in a slot, as described in Clauses 9.2.1 and 9.2.3,  bits representing a negative or positive SR, in ascending order of the values of *schedulingRequestResourceId* anda *schedulingRequestResourceId* associated with *schedulingRequestID-BFR-SCell*, are appended to the HARQ-ACK information bits and the UE transmits the combined  UCI bits in a PUCCH using a resource with PUCCH format 2 or PUCCH format 3 or PUCCH format 4 that the UE determines as described in Clauses 9.2.1 and 9.2.3.  If a UE would transmit a PUCCH with  CSI report bits in a resource using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 in a slot,  bits representing corresponding negative or positive SR, in ascending order of the values of *schedulingRequestResourceId* and a *schedulingRequestResourceId* associated with *schedulingRequestID-BFR-SCell*, are prepended to the CSI information bits as described in Clause 9.2.5.2 and the UE transmits a PUCCH with the combined  UCI bits in a resource using the PUCCH format 2 or PUCCH format 3 or PUCCH format 4 for CSI reporting.  In our understanding, CSI PUCCH resource is determined based on the spec in 9.2.5.2 as below,  38.213 9.2.5.2  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  and , , the UE transmits a PUCCH conveying HARQ-ACK information, SR and CSI report(s) in a respective PUCCH where the UE uses the PUCCH format 2 resource , or the PUCCH format 3 resource , or the PUCCH format 4 resource  - else the UE uses the PUCCH format 2 resource , or the PUCCH format 3 resource , or the PUCCH format 4 resource  and the UE selects  CSI report(s) for transmission together with HARQ-ACK information and SR, when any, in ascending priority value as described in [6, TS 38.214] |
| vivo | Alt 1  SR can be multiplexed in a PUCCH in another sub-slot only when it multiplexed with CSI reports in a PUCCH resource provided by multi-CSI-PUCCH-ResourceList. But it does matter. SR can CSI is slot-based, sub-slot procedure is applied when it includes HARQ-ACK according to the discussion in UCI session. |

Regarding issue #3-3, Samsung also raised concern that HARQ-ACK PUCCH #2 in sub-slot 0 can be multiplexed with SR PUCCH#3 and CSI PUCCH #0 in sub-slot 6 in the following case. In the email discussion, Qualcomm think that it is not an error case since HARQ-ACK codebook doesn’t move into different sub-slot and SR PUCCH can be multiplexed into different sub-slot.



FL think this is general sub-slot issue and not SPS-specific problem. But it is also true that it could be related to issue #3-2, since some alternatives prohibit such cases. Here is question for issue #3-3.

**Q3.2-2: Can the general sub-slot issue be handled under this discussion? If so, issue #3-3 is valid?**

**Please indicates your views. It is highly appreciated to provide reasons in detail.**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| HW/HiSi | No, the discussion here should be limited to SPS PDSCH HARQ-ACK |
| OPPO | We think issue 3-3 is valid and fine to handle these issues under this discussion or under the email thread of UCI enhancements. |
| ZTE | No, if we want to make a conclusion this time, we should not expand the discussion scope here. Issue 3-3 can be further discussed in UCI session. |
| Nokia/NSB | Agree with ZTE & HW, not discussed here. Could be discussed in some future UCI session. |
| Ericsson | We don’t think issue # 3-3 is valid. See our response to Q3.2-1. |
| vivo | With FL Proposal 3, we don’t think issue #3-3 is valid. “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.” Here, we think the “multiplexing” includes multiplexing with CSI, we find no other case that the SPS HARQ-ACK will be multiplexed in another sub-slot with FL Proposal 3. |

**Q3.2-2: if issue #3-3 is valid, Can following proposal 4 solve the problem? If so, it is acceptable?**

**FL Proposal 4**

**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 to multiplex the HARQ-ACK information corresponding to the HARQ-ACK codebook with other PUCCH transmission(s) in the different sub-slot(s).**

**Please indicates your views. It is highly appreciated to provide reasons in detail.**

**Comment:**

|  |  |
| --- | --- |
| Company | Comment |
| HW/HiSi | We think that issue 3-3 is not valid. |
| OPPO | As commented above, we slightly prefer to first reach some consensus on the interpretation of the pseudo code in 9.2.5. |
| Ericsson | We don’t think issue # 3-3 is valid. See our response to Q3.2-1. |
| vivo | We don’t think issue # 3-3 is valid. See our response to Q3.2-2. |
|  |  |

* + 1. Final status of issue #3

Regarding Issue #3, few more concern has been raised after update #2. Concerns are related to whether to handle UL multiplexing per slot or sub-slot. Samsung show some figures for these issue. To sum up, there could be three sub-issues.

* Issue #3-1: Whether it is allowed to multiplex SPS HARQ-ACK into another sub-slot?
* Issue #3-2: Whether it is allowed to multiplex SR into another sub-slot?
* Issue #3-3: Whether it is allowed to multiplex SPS HARQ-ACK in a sub-slot with other PUCCH transmission in different sub-slot?

Regarding issue #3, there are 3 alternatives for two sub-issues #3-1 and #3-2. Given companies’ view so far, Alternative 1 has majority support (5 of 6). And Samsung, proponent of Alt. 3, also can compromised with Alt. 1.

Samsung also suggest to modify proposal 3, to apply the proposal only to low priority. Since CSI PUCCH only has low priority, the issue #3-1 could be addressed even if the proposal includes low priority only.

**Original FL Proposal 3**

**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.**

**Modified FL proposal 3 based on Samsung’s comment**

**For the multiplexing among overlapping schannels with priority 0 s~~ame a given priority index~~, if a UE is provided subslotLengthForPUCCH in first PUCCH-Config ~~for the HARQ-ACK codebook~~, 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.**

During the email discussion, Qualcomm responded to the modification as following:

|  |
| --- |
| **From Qualcomm’s comment in the email thread:**  For Proposal 3, we prefer the original formulation. It’s true that Rel-16 spec only supports low priority P/SP-CSI report on PUCCH. However, there is no harm in making the statement more general to cover both high priority and low priority either. The original formulation is more forward compatible in case in later releases, high priority CSI on P/SP-PUCCH is introduced. |

It is highly recommended for companies to provide views on issue #3-1/2 in the next meeting, with consideration on Samsung and Qualcomm’s comment.

Regarding sub-issue #3-3, there is no clear majority view on whether the issue #3-3 is valid. At least for proponent of issue #3-3, it is encouraged to provide detailed explanation and response for comment by opponent in the table Q3.2-2 for the next meeting.

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

From the discussion in [105-e-NR-L1enh-URLLC-05], following were made:

**Conclusion**

For SPS PDSCH release and SPS PDSCH reception with slot-aggregation, if a UE is configured to receive SPS PDSCHs over multiple slots for a TB by SPS configurations that are indicated to be released by a DCI format, UE can receive the PDCCH providing the DCI format only before end of the first occasion of corresponding SPS receptions.

* Note: The UE stops the PDSCH decoding and does not generate HARQ-ACK feedback information for the SPS PDSCH reception as in current specification.

# 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