**3GPP TSG RAN WG1 #104-e R1-210xxxx**

**e-Meeting, Jan. 25th – Feb. 5th, 2021**

**Agenda Item:** 7.2.5

**Source:** Moderator (LG Electronics)

**Title:** Summary of [104-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:

[104-e-NR-L1enh-URLLC-05] Email discussion/approval on remaining issues on SPS enhancements – Duckhyun (LG) by Feb 3

* Issue 3: SPS PDSCH release and SPS receptions with slot aggregation
* Issue 4: PUCCH resource for SPS PDSCH HARQ-ACK and SR

To address the identified issues of the above email thread, suggestions and questions for the issues are provided in Section 2. In section 3-4, the outcome from [104-e-NR-L1enh-URLLC-05] are provided including all the agreements and all the endorsed TPs.

Other submitted issues are listed up in the summary in preparation phase [4]. It would be appreciated that companies can provide input/feedback in the next meeting in order to facilitate the discussion.

# Issues in RAN1#104-e

* 1. Issue #3 SPS PDSCH release and SPS receptions with slot aggregation

In [1][3], TP and CR is provided for the case of SPS PDSCH release and SPS repetitions. According to [3], When a SPS PDSCH is configured with aggregation factor, some of the SPS PDSCH occasions within the repetition may end before the end of the release PDCCH while some others may end after the end of the release PDCCH, as shown below. In this regard, the figure may be effectively considered as a SPS PDSCH which ends in slot nD=3 and should be supported.



**1st TP from [3]:**

|  |
| --- |
| 9.1 HARQ-ACK codebook determination\*\*\* Unchanged text is omitted \*\*\*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.\*\*\* Unchanged text is omitted \*\*\* |

According to [1], current specification doesn’t care about slot aggregation so that restrict SPS PDSCH reception even when there is no HARQ-ACK bit collision in the type-1 HARQ-ACK codebook. To solve this problem, [1] propose following TP:

**2nd TP from [1]:**

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| 9.1 HARQ-ACK codebook determination\*\*\* Unchanged text is omitted \*\*\*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 with same value of $b\_{r,k,n\_{D}}$ 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 text is omitted \*\*\* |

**From FL:**

As mention in the previous meeting, what makes problem is that the SPS PDSCH and SPS release are mapped to same UCI bit in the same PUCCH. In the figure brought by [3], if they are mapped to same PUCCH, those HARQ-ACK are mapped to different UCI bits due to different K1 value. Though the specification changes may be necessary to clarify previous agreement, but it is not clear whether to consider the last occasion of SPS PDSCH.

This issue is related to previous CR. We defined the problem “HARQ-ACK bit overlapping between SPS PDSCH and SPS release” and dropped SPS PDSCH HARQ-ACK to solve the problem. Though current text had make a problem with slot aggregation, however, the principle still valid with slot aggregation. Thus, I would recommend to clarify and reflect our principle into specification text.

Meanwhile, since current text already four if statement, I wouldn’t like to recommend to add more conditioning text. If both text proposal are in the light of our previous principle and work, I suggest to adopt second text proposal.

**FL recommendation: Adopt following TP for TS 38.214 Clause 9.1**

**Proposed text proposal:**

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| --- |
| 9.1 HARQ-ACK codebook determination\*\*\* Unchanged text is omitted \*\*\*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 into same value of $b\_{r,k,n\_{D}}$ 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 text is omitted \*\*\* |

**Comment:**

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| --- | --- |
| Company | Comment |
| Samsung | Not support. $b\_{r,k,n\_{D}} $is only for Type-1 HARQ-ACK codebook. The timeline restriction applies to both Type-1 and Type-2 HARQ-ACK codebooks.Further, even for Type-1 HARQ-ACK codebook, the proposed TP may not work for joint release as the SPS PDSCHs could map to different $b\_{r,k,n\_{D}}$. Take the following case as an example,The SPS PDSCHs #0 and #1 would be multiplexed with$ b\_{r,k,n\_{D}}=0$, SPS PDSCHs #2 and #3 would be multiplexed with$b\_{r,k,n\_{D}}=1$. The release PDCCH would be multiplexed at the location of SPS config#0, i.e.$b\_{r,k,n\_{D}}=0.$ Then the condition in the proposed TP by LG does not hold. Therefore, the intended behavior that UE should only generate one A/N for the release PDCCH and not receive the SPS PDSCHs is not specified.1st TP from [3] should be adopted. BTW, there is a typo for the reference [2] which should be [3] instead.  |
| CATT | Basically we do not see the motivation to send a release DCI in the subsequent slot(s) when slot aggregation is configured for SPS. If it is allowed, then 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 if the HARQ-ACKs are multiplexed in a same HARQ-ACK codebook. In this case, 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. Although both HARQ-ACK for release DCI in other slots except the last slot of SPS repetition and HARQ-ACK for SPS PDSCH can be transmitted in a same HARQ-ACK codebook, in order to have a unified solution and considering that the use case is unclear, we propose to not support that as well. In summary, for SPS PDSCH repetition, it is proposed that the release DCI can only be transmitted in the first slot of SPS PDSCH repetitions and the timeline requirement in the slot applies.  |
| Nokia, NSB | Do not support the current proposed TP – agree with the comments by Samsung, namely: 1. The timeline applies to both Type 1 & Type 2 CB
2. The issue of the bit mapping only applies to Type 1 CB
3. Multiplexing in the same $b\_{r,k,n\_{D}} $only solves the problem for single SPS release (but not joint SPS release)
 |
| OPPO | We share view with CATT |
| HW/HiSi | Do not support the TP.The UE should stop all the remaining PDSCH receptions after it has received the release DCI, including the repetition in the same slot with the release DCI. We don’t think it is reasonable for the UE to decode the SPS PDSCH after it detects the release DCI. According to our understanding the current TP seems to enforce this? Or do we miss anything here? |
| ZTE | Samsung’s proposal is preferable. |
| Qualcomm | Do not support the TP. Neither first TP from [3] and second TP from [1] are needed. For [1], we don’t see a use case for the network to send the release DCI at the last slot of the repetition (since UE still needs to decode the previous SPS PDSCH repetitions, but does not send any HARQ-ACK feedback...).  |
| Apple | It seems further discussion is needed. One question on the text from Samsung (copied below):Does the text marked in yellow refer to SPS receptions for different SPS configurations?Not sure what the text marked in cyan (“the last occasion is in the slot”) establishes. 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. |
| Ericsson | Do not support the TPs.We have similar view as CATT that the scenario shown (at the start of section 2.1) is not useful to support. If the scheduler decides to release the SPS (green box), then this SPS PDSCH transmission including all repetitions (all blue boxes) would contain no data. It does not make sense that the UE is required to decode and HARQ-ACK this SPS PDSCH. On the other hand, we have concern about CATT suggestion: “the release DCI can only be transmitted in the first slot of SPS PDSCH repetitions”. This does not work for group release DCI, if the SPS configurations in the group do not start their repetitions in the same slot.Overall, we don’t see either TP is needed. |
| vivo | Do not support the TP.Agree with CATT and QC, we don’t think it makes sense that gNB send the release DCI in a slot other than the first slot of SPS PDSCH repetitions. |

* + 1. Update #1 on issue #3

Based on companies’ input, we may need further discussion on this issue.

If we recall the discussion on SPS PDSCH and SPS PDSCH release. Based on the comment, I think we have two option based on samsung’s proposal and CATT’s comment. To make it easier and discuss UE behavior rather than wording, I bring few figures based on my understanding. Please inform if there is any misunderstanding.



**Figure 1. Current UE behavior with 1 slot periodicity**

Current spec allow for UE to receive SPS release only in blue box, and UE drop SPS PDSCH HARQ-ACK if SPS release is indicated.

**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.**

Given situation, I would like to suggest to discuss and down-select on between two UE behaviors before drafting TP.

**Q1: between UE behavior 1 and 2, Which is preferred?**

**Comment:**

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| Company | Comment |
| Samsung | We prefer behavior 1 for the following reasons.1. With no aggregation factor, we had agreed that PDCCH can be received in the same slot as PDSCH subject to the timeline condition, Figure 1. To provide the same gNB flexibility, it should be supported to receive the PDCCH in any slots among the repetition, i.e. slot-level granularity.
2. One import scenario is when the numerology of the PDSCH is larger than the PDCCH, in which case, the restriction on gNB flexibility would be unnecessarily large if PDCCH is required to be only received before the end of the first PDSCH repetition.
3. The PDSCH processing time is from the last repetition, so in case of receiving the PDCCH in a slot other than the last one, there is no need to apply the timeline restriction between the PDCCH and the PDSCH in the slot.
 |
| HW/HiSi | We prefer behavior 2We agree with QC from the first round comments, that there is no use case to send the release DCI later than the first repetition.Regarding the concern that was raised for joint release, we think the system is not broken, since separate releases can be used instead. |
| CATT | We prefer behavior 2.As commented in the 1st round discussion, we do not see the motivation to send a release DCI in the subsequent slot(s) when slot aggregation is configured for SPS.For joint release, we share the same view with Huawei that separate release can be used if gNB wants. |
| Ericsson | In our understanding, UE behavior 1 is supported by current specification. For the SPS PDSCH with repetition, the goal is that the UE can receive the release PDCCH and HARQ-ACK is sent for the release. We expect the SPS PDSCH is empty.Current specification satisfies this need in our understanding. For the PDCCH in Behavior 1 figure, if release PDCCH is in the same slot as repetition #0/1/2 (**even if the PDCCH ends after the SPS PDSCH repetition of the same slot**), the HARQ-ACK for release and SPS PDSCH reception do not map to the same PUCCH, hence no problem. ***Agreement (RAN1#101)****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.* In summary, our view is still that the Behavior 1 (or, figure in [3]) is already supported, and no spec change is needed. |
| ZTE | Share the similar view with Ericsson. Neither TP is needed. gNB could avoid the unnecessary SPS PDSCH occasions if gNB wants to release the corresponding SPS PDSCH. |
| Qualcomm | We support behavior 2. We don’t see the use case to send release DCI in a slot other than the first 1, if gNB do not intend to transmit data using the SPS PDSCH occasion.We have scenarios other than “*HARQ-ACKs for the SPS release and the SPS reception would map to the same PUCCH*”, but concluded in 102\_e GTW session that other scenarios (e.g., HARQ-ACK for SPS release and SPS reception map to different PUCCH when SPS PDSCH and SPS release are received in the same slot) will not be supported. As such, we don’t agree that Behavior 1 is already supported. |
| Nokia, NSB | We prefer behavior 1 since it provides more flexibility to the gNB for releasing a SPS PDSCH.This question is closely related to Q2. As Ericsson pointed out, UE behavior 1 is currently supported since the ‘different PUCCH case for SPS PDSCH and its release’ is currently not prohibited in the standard. Clearly, this may not be the case anymore if some restrictions were introduced related to Q2.  |
| Samsung 2 | To CATT Regarding the DCI missing error case, it can be simply avoided by gNB implementation. If gNB transmit the SPS PDSCH repetitions in previous slot, we don’t think it is reasonable for gNB to transmit the release DCI in the last slot of repetitions. If gNB does not transmit SPS PDSCH repetitions, gNB can transmit the SPS release DCI in any slot. There won’t be any misunderstanding.To Ericsson: According to the agreement, the behavior 1 is NOT supported if the A/N of the release PDCCH and the SPS PDSCH(s) are mapped to the same PUCCH. If the PDCCH is received after the end of the PDSCH in the second slot, it is not supported according to the agreement. A/N of the PDCCH and PDSCH could be still mapped to the same PUCCH even if the PDCCH is received in the slot of repetition #0, #1, and #2, depending on the K1 values. Also, we think the scenario under Q1 and the proposed TPs is for mapping to the same PUCCH and should be addressed first. In our view, the use case is network flexibility to release the SPS PDSCH configuration without additional latency, similar to the case of no PDSCH aggregation. Requiring gNB to transmit the PDCCH before the first repetition, puts unnecessary restriction especially when the numerology of PDCCH is smaller than PDSCH. In the following, gNB would need to transmit the PDCCH before the dashed line which is in some cases even impossible depending on numerology difference and configured CORESET length and the PDSCH duration (e.g. if in the PDSCH duration is 3 OS, even a length-1 CORESET cannot end the PDCCH before the PDSCH)We would like to hear companies’ feedback. |

In addition to above, depending on K1 set and a slot where SPS release is received, it is difficult to use same PUCCH for both SPS PDSCH and SPS release. Though the different PUCCH case is not supported according to RAN1#103 deceision, however, current specification doesn’t prohibit the case using different PUCCH case. Thus,

**Q2: Current specification is prohibiting “using different PUCCH case for SPS PDSCH and its release in the same slot”? if not, are specification changes needed?**

**Comment:**

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| Company | Comment |
| Samsung | We don’t have the understanding that current Spec. prohibits the case of different PUCCHs when the PDCCH and PDSCH are in the same slot. Specification change seems unnecessary.  |
| CATT | We do not think it is precluded. We are open to discuss whether specification change is needed or not. |
| Ericsson | Current spec does not preclude the case of HARQ-ACK on different PUCCH. Thus it is allowed by current spec. This is fine in our view, and no spec change is needed. |
| ZTE | Maybe “in the same slot” should be clarified first, the same slot is for DL transmission or of PUCCHs? If it means the DL transmission such as SPS PDSCH or its release, spec doesn’t exclude the different PUCCH for SPS PDSCH and its release. If the same slot is for PUCCHs, from our understanding, I share the same feeling of FL that spec doesn’t allow the behavior “using different PUCCH case for SPS PDSCH and its release in the same slot”, if the HARQ-ACKs for SPS PDSCH and its release have the same priority. And there is no strong motivation to set the different priorities to HARQ-ACKs for SPS PDSCH and its release. |
| Qualcomm | In our view, the current spec does preclude the scenario in which “HARQ-ACK for SPS PDSCH and its release are mapped to different slot when the release and the SPS PDSCH occur in the same slot”. As correctly pointed out by the FL, this is a RAN1 conclusion to not support such cases.  |
| Nokia, NSB | Current spec does not preclude the case of HARQ-ACK on different PUCCH. If there was a conclusion to not support this, then clearly some spec changes would be needed; however, we don’t recall that such conclusion was made (would be good if Qualcomm could point out the conclusion). |
| Qualcomm 2 | To Nokia:We have reached the following two agreements in 101\_e with several FFSs. Then in 102\_e, the FFS points in these agreements were discussed, but we can not reach any consensus to support these scenarios (including HARQ-ACK for SPS PDSCH and SPS release map to different PUCCHs). Finally, during 102\_e GTW, we made a conclusion that this issue will not be further discussed in Rel-16, and hence the only case that is supported in Rel-16 is the one that corresponds to the 101\_e agreement: i.e., 1) SPS release PDCCH must be received before the end of SPS PDSCH reception, and 2) HARQ-ACK for SPS release and HARQ-ACK for PDSCH should be mapped to the same PUCCH in the same slot. We are open to make spec changes to further clarify this issue. **Agreement*** At least, support the case that in a slot SPS release PDCCH is received before the end of the SPS PDSCH reception for the same SPS configuration corresponding to the SPS release PDCCH
	+ 1 bit HARQ-ACK is generated for SPS release and a UE does not expect to receive the SPS PDSCH if HARQ-ACKs for the SPS release and the SPS reception would map to the same PUCCH.
	+ FFS whether and how to support the HARQ-ACK for the SPS release and the SPS reception mapping to different PUCCHs
* FFS whether and how to support the case that SPS release PDCCH is received after the end of the SPS PDSCH for the same SPS configuration

**Agreement** 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

If other scenarios were supported by the spec, we will need to discuss several opening issues, including 1) the UE behavior when the SPS release is received before and after the SPS PDSCH in the slot, 2) UE behavior when HARQ-ACK for SPS release is scheduled before and after the SPS PDSCH, 3) how to avoid out of order issues, and others. This is clearly violating the previous RAN 1 conclusion/decision.  |

* + 1. Update #2 on issue #3

From companies’ input, I collect preferences on UE behavior 1 and 2.

* UE behavior 1: Samsung, Ericsson (No TP needed), ZTE(No TP needed), Nokia(No TP needed)
* UE behavior 2: Qualcomm, CATT, Huawei/HiSilicon

Since there is no clear majority view on this issue but there is also no common understanding on the current specification. Thus, it should be preceded to have common understanding and conclusion if needed. Based on companies’ input, issue #3 seems highly related to how current spec is interpreted.

The current specification only address the case:

* Cond 1: Both SPS PDSCH and corresponding SPS release are received in the same slot.
* Cond 2: Satisfy timeline (SPS release reception should be earlier than end of the SPS PDSCH reception.)
* Cond 3: The HARQ-ACK information of SPS release and SPS PDSCH reception would map to same PUCCH

If the current specification support only above case and UE follow the specification literally, UE behavior would be like following. Please note that HARQ-ACK feedback timing of SPS release is determined by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the DCI format carrying SPS PDSCH release.



**Figure 3. Strict interpretation of current specification**

According to current specification, if both SPS PDSCH and corresponding SPS release are received in the same slot, SPS release should map to same PUCCH and satisfy timeline in order to get received. Thus, even we keep current specification, the least flexibility of SPS release reception can be guaranteed.

The main decision point would be whether the current spec supports a scenario other than above case. In RAN1#102-e, following proposal has been made but not agreed in the GTW session.

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| **(in RAN1#102-e) Updated Proposal 1-1:****Support the case that SPS release PDCCH is received in a slot where SPS PDSCH is configured to be received for the same SPS configuration corresponding to the SPS release PDCCH if the HARQ-ACK for the SPS release and the SPS reception mapping to different PUCCHs*** + **the UE receives the SPS PDSCH and generates HARQ-ACK information for the SPS release and the SPS reception if SPS release PDCCH is received after the end of the SPS PDSCH reception**
	+ **FFS whether to receive SPS PDSCH if SPS release PDCCH is received before the end of the SPS PDSCH reception**
	+ **FFS the case of SPS PDSCH repetition over multiple slots.**
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The main reason not to support the above case, is that some companies think additional scenario is not essential and there was no objection to support only the agreed scenario (i.e., the current specification). Based on the situation, discussing other scenario would open and repeat previous discussion which has been closed. As a FL, that situation cannot be recommended. To finalize issue, I would like to have a conclusion to have common understanding on the specification.

**FL Proposal:**

**Take following as a conclusion in RAN1#104-e:**

* **There is no consensus to support the case that SPS release PDCCH is received in a slot where SPS PDSCH is configured to be received for the same SPS configuration corresponding to the SPS release PDCCH if the HARQ-ACK for the SPS release and the SPS reception mapping to different PUCCHs**

Please share your view orsuggestion if you have a strong concern on the proposal and its wording.

**Comment:**

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| --- | --- |
| Company | Comment |
| CATT | For the case shown in Figure 3, we would like to further clarify.If release DCI ends no later than the end of the first SPS PDSCH repetition, it is clear that UE does not receive SPS PDSCH, and does not generate HARQ-ACK for the SPS PDSCH, and generate HARQ-ACK for SPS PDSCH release.If release DCI is transmitted in the last slot, the same A/N bit location is used for both SPS PDSCH release and SPS PDSCH reception. In this case, there may be misalignment between gNB and UE if UE missed the release DCI but successfully decoded the SPS PDSCH. Therefore, we think this case should be precluded.If the release DCI is transmitted in the slot(s) other than the first and the last slot, and release DCI ends no later than the end of the SPS PDSCH repetition in the same slot, it is not clear whether the following spec texts cover the case so that UE does not generate HARQ-ACK information for the SPS PDSCH in the other slot(s), i.e. UE does not report NACK according to the quoted texts specified in 38.213 clause 9.1.2, but to report HARQ-ACK corresponding to the release DCI.*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.*TS38.213 clause 9.1.2:*The UE reports NACK value(s) for HARQ-ACK information bit(s) in a HARQ-ACK codebook that the UE transmits in a slot not indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in a corresponding DCI format.*  |
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* 1. Issue #4 PUCCH resource for SPS PDSCH HARQ-ACK and SR

According [2], when a SPS PDSCH HARQ-ACK PUCCH overlaps with a SR PUCCH, the SPS PDSCH HARQ-ACK PUCCH is used as the result PUCCH in general. However, in the current spec, PUCCH resource determination of *SPS-PUCCH-AN-List* only includes case of SPS PDSCH HARQ-ACK, the case of SPS PDSCH HARQ-ACK and SR is not included.

**Proposed changes from [2]:**

***Proposal 1: The UCI should include SPS PDSCH HARQ-ACK and SR, if any, when determining a PUCCH resource in SPS-PUCCH-AN-List. The following TP should be adopted.***

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| --- |
| If the UE is provided *SPS-PUCCH-AN-List* and transmits $O\_{UCI}$ UCI information bits that include only HARQ-ACK information bits in response to one or more SPS PDSCH receptions and SR, if any, the UE determines a PUCCH resource to be - a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the first entry in *sps-PUCCH-AN-List* if $O\_{UCI}\leq 2$, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the second entry in *sps-PUCCH-AN-List*, if provided, if $2<O\_{UCI}\leq N\_{1,SPS}$ where $N\_{1,SPS}$ is either provided by *maxPayloadSize* obtained from the second entry in *sps-PUCCH-AN-List* or is otherwise equal to 1706, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the third entry in *sps-PUCCH-AN-List*, if provided, if $N\_{1,SPS}<O\_{UCI}\leq N\_{2,SPS}$ where $N\_{2,SPS}$ is either provided by *maxPayloadSize* obtained from the third entry in *sps-PUCCH-AN-List* or is otherwise equal to 1706, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the fourth entry in *sps-PUCCH-AN-List*, if provided, if $N\_{2,SPS}<O\_{UCI}\leq N\_{3,SPS}$ where $N\_{3,SPS}$ is equal to 1706. |

**From FL:**

For my understanding, it is true that PUCCH for SPS can carry S R if they overlap in time. Adding “and SR, if any” would be simple solution for this problem.

**FL recommendation: Adopt above TP for TS 38.213 Clause 9.2.1**

**Comment:**

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| --- | --- |
| Company | Comment |
| Samsung | Support the proposal. |
| CATT | Fine with the TP. |
| Nokia, NSB | Support the TP / proposal |
| OPPO | Support the proposal. |
| HW/HiSi | Support the TP |
| ZTE | Already covered by specification, no need to change. See 38.213 g40 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 one of the SRs is a positive LRR, the value of the  bits indicates the positive LRR. An all-zero value for the  bits represents a negative SR value across all $K$ SRs. |
| Qualcomm  | Fine with the TP. To ZTE: The spec cited above does explain that UE picks up a PUCCH resource as described in 9.2.1. However, the TP is still needed for the UE to select a PUCCH resource based on the **total payload** of HARQ-ACK +SR, which is the same principle as the procedure in 9.2.3. Without the TP, the current spec implies that, the UE determines the PUCCH resource only based on the SPS HARQ-ACK payload, which is not correct.  |
| Apple | The TP is okay. |
| Ericsson | Support the TP. |
| Sharp | Agree with the TP. And propose adding one following change with red to describe that a PUCCH resource is provided based on HARQ-ACK information bits if $O\_{UCI}\leq 2$, as what described for PUCCH resource sets in Rel-15.If the UE is provided *SPS-PUCCH-AN-List* and transmits $O\_{UCI}$ UCI information bits that include only HARQ-ACK information bits in response to one or more SPS PDSCH receptions and SR, if any, the UE determines a PUCCH resource to be - a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the first entry in *sps-PUCCH-AN-List* if $O\_{UCI}\leq 2$ including 1 or 2 HARQ-ACK information bits and a positive or negative SR on one SR transmission occasion if transmission of HARQ-ACK information and SR occurs simultaneously, or |
| vivo | Support the change from SharpIn the section of 9.2, it is captured that “UCI bits include HARQ-ACK information bits, if any, SR information bits, if any, LRR information bit, if any, and CSI bits, if any.” So,OUCI includes HARQ-ACK and SR. When SR is considered, for the first sub-bullet, it is not correct that $O\_{UCI}\leq 2$. We can refer to the description in 9.2.1 and update the TP. |

* + 1. Update #1 on issue #4

Based on companies’ input, proposed TP with modification by sharp could be agreeable. (Hope ZTE’s concern has been resolved thanks to Qualcomm’s comment.) Please check modified TP as commented by sharp.

**Modified TP by sharp:**

**Proposed changes from [2]:**

**FL Proposal 1:Adopt above TP for TS 38.213 Clause 9.2.1**

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| If the UE is provided *SPS-PUCCH-AN-List* and transmits $O\_{UCI}$ UCI information bits that include only HARQ-ACK information bits in response to one or more SPS PDSCH receptions and SR, if any, the UE determines a PUCCH resource to be - a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the first entry in *sps-PUCCH-AN-List* if $O\_{UCI}\leq 2$ including 1 or 2 HARQ-ACK information bits and a positive or negative SR on one SR transmission occasion if transmission of HARQ-ACK information and SR occurs simultaneously, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the second entry in *sps-PUCCH-AN-List*, if provided, if $2<O\_{UCI}\leq N\_{1,SPS}$ where $N\_{1,SPS}$ is either provided by *maxPayloadSize* obtained from the second entry in *sps-PUCCH-AN-List* or is otherwise equal to 1706, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the third entry in *sps-PUCCH-AN-List*, if provided, if $N\_{1,SPS}<O\_{UCI}\leq N\_{2,SPS}$ where $N\_{2,SPS}$ is either provided by *maxPayloadSize* obtained from the third entry in *sps-PUCCH-AN-List* or is otherwise equal to 1706, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the fourth entry in *sps-PUCCH-AN-List*, if provided, if $N\_{2,SPS}<O\_{UCI}\leq N\_{3,SPS}$ where $N\_{3,SPS}$ is equal to 1706. |

Please share your view orsuggestion if you have a concern on TP and its wording.

**Comment:**

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| Company | Comment |
| Samsung | Our initial intention is to keep the spec simple, but we can live with the updated TP. |
| HW/HiSi | We are ok with the updated TP, even though the original one was simpler. |
| CATT | Fine with the updated TP. |
| Ericsson | After comparing the updated TP and corresponding spec text for dynamic PDSCH, we suggest remove “and SR, if any”. There is no mentioning of SR in spec text for dynamic PDSCH (see blow). This then allows multiplexing of HARQ-ACK/SR/SI in a PUCCH (existing spec), not just multiplexing of HARQ-ACK/SR.“ 38.213 V16.4.0, section 9.2.1:If the UE transmits $O\_{UCI}$ UCI information bits, that include HARQ-ACK information bits, the UE determines a PUCCH resource set to be - a first set of PUCCH resources with *pucch-ResourceSetId* = 0 if $O\_{UCI}\leq 2$ including 1 or 2 HARQ-ACK information bits and a positive or negative SR on one SR transmission occasion if transmission of HARQ-ACK information and SR occurs simultaneously, or…If the UE is provided *SPS-PUCCH-AN-List* and transmits $O\_{UCI}$ UCI information bits that include only HARQ-ACK information bits in response to one or more SPS PDSCH receptions, the UE determines a PUCCH resource to be …”We are fine with adding “including 1 or 2 HARQ-ACK …” in the updated TP. |
| ZTE | If most companies think this should be fixed, we can accept majority view. |
| Qualcomm | We are fine with the updated TP. (The newly added part are the same as the corresponding spec text for dynamic HARQ-ACK.)  |
| vivo | After double check the current spec, we agree with Ericsson’s view to remove “and SR, if any”. |
| Nokia, NSB | Agree with Ericsson & vivo, to align with the description in the parts for DG PDSCH, the ‘~~and SR, if any~~’ should be removed from the TP.  |
| Ericsson | Considering the confusion between spec text for HARQ-ACK with corresponding DCI, and spec text for HARQ-ACK without corresponding DCI, I suggest adding “with associated *PUCCHResourceSet*” as shown below. Overall, we recommend the following TP:“ 38.213 V16.4.0, section 9.2.1:If the UE transmits $O\_{UCI}$ UCI information bits, that include HARQ-ACK information bits with associated *PUCCHResourceSet*, the UE determines a PUCCH resource set to be - a first set of PUCCH resources with *pucch-ResourceSetId* = 0 if $O\_{UCI}\leq 2$ including 1 or 2 HARQ-ACK information bits and a positive or negative SR on one SR transmission occasion if transmission of HARQ-ACK information and SR occurs simultaneously, or…If the UE is provided *SPS-PUCCH-AN-List* and transmits $O\_{UCI}$ UCI information bits that include only HARQ-ACK information bits in response to one or more SPS PDSCH receptions, the UE determines a PUCCH resource to be - a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the first entry in *sps-PUCCH-AN-List* if $O\_{UCI}\leq 2$ including 1 or 2 HARQ-ACK information bits and a positive or negative SR on one SR transmission occasion if transmission of HARQ-ACK information and SR occurs simultaneously, or…” |
| Samsung 2 | Firstly, we would like to align our understanding regarding the PUCCH resource for multiplexed SPS PDSCH HARQ-ACK and CSI.In Rel-15, there is only 1 bit SPS PDSCH HARQ-ACK and the CSI PUCCH resource is used for the multiplexed UCI.

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| 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] - else, the UE transmits the  bits in a PUCCH resource provided by *pucch-CSI-ResourceList* and determined as described in Clause 9.2.5 |

In Rel-16, we haven’t discussed this issue yet. We agree with E/// that the SPS PDSCH HARQ-ACK PUCCH resource should be used for the multiplexed UCI. If this is the common understanding, we propose the following TP to avoid misunderstanding,

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| If the UE is provided *SPS-PUCCH-AN-List* and transmits $O\_{UCI}$ UCI information bits that include ~~only~~ HARQ-ACK information bits only in response to one or more SPS PDSCH receptions, the UE determines a PUCCH resource to be - a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the first entry in *sps-PUCCH-AN-List* if $O\_{UCI}\leq 2 $including 1 or 2 HARQ-ACK information bits and a positive or negative SR on one SR transmission occasion if transmission of HARQ-ACK information and SR occurs simultaneously, or |

 |
| Qualcomm | We prefer to keep the original formulation in FL Proposal 1 with the addition “and SR, if any” in the main sentence. For the SPS HARQ-ACK multiplexed with P/SP-CSI on PUCCH, we think that the current spec implies that the SPS HARQ-ACK is always multiplexed on the CSI resource.  |
| Samsung 3 | We are fine with either “~~only~~ HARQ-ACK information bits only” or adding “and SR, if any”. |

* + 1. Update #2 on issue #4

Based on the email discussion, there was an issue about the spec description. According to current specification, it is not supported to multiplex CSI information into SPS HARQ-ACK PUCCH. Since the related specification has been made in Rel-15, so it may not consider a case of multiple SPS configuration. However, the specification can work with multiple SPS configuration in same principle. At the same time, it is clear that SR UCI bit(s) can be multiplexed into SPS HARQ-ACK PUCCH. To cover those case, following changes has been proposed from the discussion.

* Option 1: Adding “and SR, if any”
	+ It has minimal specification impact and least ambiguity
* Option 2: Move only as “~~only~~ HARQ-ACK information bits only in response to one or more”
	+ It addresses least condition of SPS HARQ-ACK PUCCH so It has flexibility for spec changes on other pats
	+ But it could make ambiguity with current specification.

To finalize issue #4, I suggest to take option 1 (same as previous proposal) in order to have least ambiguity on the specification.

**FL Proposal :Adopt above TP for TS 38.213 Clause 9.2.1**

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| If the UE is provided *SPS-PUCCH-AN-List* and transmits $O\_{UCI}$ UCI information bits that include only HARQ-ACK information bits in response to one or more SPS PDSCH receptions and SR, if any, the UE determines a PUCCH resource to be - a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the first entry in *sps-PUCCH-AN-List* if $O\_{UCI}\leq 2$ including 1 or 2 HARQ-ACK information bits and a positive or negative SR on one SR transmission occasion if transmission of HARQ-ACK information and SR occurs simultaneously, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the second entry in *sps-PUCCH-AN-List*, if provided, if $2<O\_{UCI}\leq N\_{1,SPS}$ where $N\_{1,SPS}$ is either provided by *maxPayloadSize* obtained from the second entry in *sps-PUCCH-AN-List* or is otherwise equal to 1706, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the third entry in *sps-PUCCH-AN-List*, if provided, if $N\_{1,SPS}<O\_{UCI}\leq N\_{2,SPS}$ where $N\_{2,SPS}$ is either provided by *maxPayloadSize* obtained from the third entry in *sps-PUCCH-AN-List* or is otherwise equal to 1706, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the fourth entry in *sps-PUCCH-AN-List*, if provided, if $N\_{2,SPS}<O\_{UCI}\leq N\_{3,SPS}$ where $N\_{3,SPS}$ is equal to 1706. |

Please share your view orsuggestion only if you have a strong concern on the proposal and its wording.

**Comment:**

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| Company | Comment |
| CATT | Fine with the TP. |
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# Final outcome from [102-e-NR-L1enh-URLLC-IIoTenh-01]

# Text proposals

From the discussion in the email thread, following has been agreed:

# References

1. R1-2100899 Remaining issues of other aspects for URLLC/IIOT LG Electronics
2. R1-2101178 Maintanence on SPS PDSCH Samsung
3. R1-2101179 Draft CR on SPS release for PDSCH with aggregation Samsung
4. R1-210xxxx, Summary on Others for URLLC and IIOT, Moderator (LG Electronics)