3GPP TSG RAN WG1 #108-e R1-22abcde

e-Meeting, February 21 – March 3, 2022

**Agenda item: 7.1**

**Source: Moderator (Nokia)**

**Title: [108-e-NR-CRs-02] Issue#3 SPS PDSCH activation and PUCCH resource selection for the 1st SPS PDSCH**

**WI: NR\_newRAT-Core**

**Document for: Discussion and Decision**

# 1 Introduction

This document is a summary of the discussion related to the RAN1#108 AI 7.1 issue #2 handled in the following email thread:

[108-e-NR-CRs-02] Issue#3 SPS PDSCH activation and PUCCH resource selection for the 1st SPS PDSCH by March 1 – Karri (Nokia)

* Relevant tdocs: [R1-2201027](file:///C%3A%5CUsers%5CDocs%5CR1-2201027.zip), [R1-2201028](file:///C%3A%5CUsers%5CDocs%5CR1-2201028.zip), [R1-2201385](file:///C%3A%5CUsers%5CDocs%5CR1-2201385.zip), [R1-2202116](file:///C%3A%5CUsers%5CDocs%5CR1-2202116.zip), [R1-2201656](file:///C%3A%5CUsers%5CDocs%5CR1-2201656.zip)

The following Tdocs address the issue

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| **TDoc#** | **Tdoc title** | **Source** |
| [R1-2201027](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2201027.zip) | SPS PDSCH activation and PUCCH resource selection for the 1st SPS PDSCH | Nokia, Nokia Shanghai Bell |
| [R1-2201028](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2201028.zip) | Draft 38.213 CR on SPS PDSCH activation and PUCCH resource selection for the 1st SPS PDSCH | Nokia, Nokia Shanghai Bell |
| [R1-2201385](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2201385.zip) | Clarification on PUCCH resource determination for the first SPS PDSCH | ZTE |
| [R1-2202116](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2202116.zip) | Clarification on HARQ-ACK PUCCH resource for SPS PDSCH | Qualcomm Incorporated |
| [R1-2201656](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2201656.zip) | Clarification on HARQ-ACK for SPS PDSCH (Originally submitted to AI 7.2.5) | Ericsson |

# 2 Summary of the issue raised in the Tdoc

Exact proposals of the documents:

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| **TDoc#** | **Proposal** |
| [R1-2201027](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2201027.zip)[R1-2201028](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2201028.zip) | **Proposal 1**: based on the above two observations, conclude that the 1st SPS-PDSCH after receiving the activation DCI is considered as SPS-PDSCH, and the PUCCH handling follows the *SPS-Config*. The PUCCH-related fields in the SPS-PDSCH activation DCI are ignored.**Proposal 2:** Agree to the following clarification to TS 38.213 v15.14.0 and v16.8.0. A corresponding draft CR to Rel-15 is provided in [R1-2201028]:If a UE transmits HARQ-ACK information corresponding only to a PDSCH reception without a corresponding PDCCH, a PUCCH resource for corresponding PUCCH transmission with HARQ-ACK information is provided by *n1PUCCH-AN*. A PDCCH carrying a DL SPS activation is not considered to correspond to any of the SPS PDSCHs. |
| [R1-2201385](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2201385.zip) | Proposal 1: The PUCCH resource corresponding to the HARQ-ACK for the first SPS PDSCH associated with an activation DCI is determined by DCI. |
| [R1-2202116](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2202116.zip) | *Proposal 1:* Capture the following as a conclusion in RAN1 Chairman’s notes* PUCCH resource indicated by PRI in activation DCI is used to feedback HARQ-ACK for the first SPS PDSCH activated by activation DCI
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| [R1-2201656](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_108-e/Docs/R1-2201656.zip%22%20%5Ct%20%22_parent) | [Observation 1 For HARQ-ACK codebook construction and PUCCH resource determination of Case (A), there is no differentiation of first SPS PDSCH after activation DCI and subsequent SPS PDSCH.](file:///C%3A%5CUsers%5Ckrantaah%5CAppData%5CLocal%5CTemp%5C7zO8A612123%5CR1-2201656%20Clarification%20on%20HARQ-ACK%20for%20SPS%20PDSCH.docx#_Toc95486078)[Observation 2 For HARQ-ACK codebook construction and PUCCH resource determination of Case (B), there is no differentiation of first SPS PDSCH after activation DCI and subsequent SPS PDSCH.](file:///C%3A%5CUsers%5Ckrantaah%5CAppData%5CLocal%5CTemp%5C7zO8A612123%5CR1-2201656%20Clarification%20on%20HARQ-ACK%20for%20SPS%20PDSCH.docx#_Toc95486079)Correspondingly, we propose that RAN1 endorses the following conclusion for avoid future confusion.**Proposed Conclusion:** For HARQ-ACK codebook construction and PUCCH resource determination, there is no differentiation of first SPS PDSCH after activation DCI and subsequent SPS PDSCH, regardless of if there are HARQ-ACK bits for dynamically scheduled PDSCH in the same (sub-)slot. |

# 3 Discussion

# 3.1 Round 1

The issues raised by the documents illustrates the different understandings of the SPS-PDSCH activation DCI and whether it should be considered to correspond to the first SPS-PDSCH or not, i.e. is the 1st PDSCH after the DL SPS activation

* a “normal” dynamically granted PDSCH that was scheduled with the PDCCH carrying the DL SPS activation message, or
* an SPS-PDSCH like all the subsequent SPS-PDSCH, and has no corresponding PDCCH.

This defines the way the HARQ-ACK is transmitted for the 1st SPS-PDSCH.

**The issue:** should the PUCCH transmitting the HARQ-ACK in response to the first PDSCH triggered by an DL SPS activation DCI be considered as:

1. PUCCH corresponding to an SPS-PDSCH (following the RRC *SPS-Config*): 1027/1028, 1656
2. PUCCH corresponding to of a dynamically granted PDSCH (ignoring the RRC *SPS-Config)*: 1385, 2116

**Moderator proposes to take the discussion in two steps**

* Step 1: Agree on one of the interpretations:
* Step 2: Agree on the RAN1 action (A CR, a RAN1 conclusion)

**Please provide company comments to the table below**

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| **Company**  | **Comment** |
| Ericsson | We support moderator’s two-steps approach.For Step 1, our understanding of the specification is that the 1st DL SPS PDSCH and other DL SPS PDSCHs with respect to the corresponding HARQ-ACK, codebook construction and eventually PUCCH resource are treated the same (justifications available in our contribution).  |
| Fujitsu | The two-step approach proposed by the moderator looks good. Interpretation 1) is our understanding and support the justification in 1027 and 1656 |
| NTT DOCOMO | OK with the two-steps approach.Regarding interpretation, our interpretation is 2nd one; i.e. HARQ feedback for the initial SPS PDSCH is handled as one of dynamic scheduling, for PUCCH resource determination perspective.* a) Why spec editor uses the wording is for this interpretation.
* b) When activation DCI schedules corresponding PUCCH transmission as “the last DCI”, NW needs to consider the HARQ-ACK payload size. 2nd interpretation can allocate appropriate PUCCH resource, but 1st one cannot.
* c) From codebook construction perspective, there is no issue like b); thus the initial SPS PDSCH is handled as a normal SPS PDSCH.
* d) Misalignment to Rel-16 SPS should be discussed in Rel-16 URLLC WI after fixing this discussion. Here this is clarification for Rel-15 spec, so Rel-16 URLLC spec should not be considered in this discussion.
* e) The current Rel-15 spec text is the following. Clearly 2nd one is correct in our reading.

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| For a PUCCH transmission with HARQ-ACK information, a UE determines a PUCCH resource after determining a set of PUCCH resources for  HARQ-ACK information bits, as described in Clause 9.2.1. The PUCCH resource determination is based on a PUCCH resource indicator field [5, TS 38.212] in a last DCI format 1\_0 or DCI format 1\_1, among the DCI formats 1\_0 or DCI formats 1\_1 that have a value of a PDSCH-to-HARQ\_feedback timing indicator field indicating a same slot for the PUCCH transmission, that the UE detects and for which the UE transmits corresponding HARQ-ACK information in the PUCCH where, for PUCCH resource determination, detected DCI formats are first indexed in an ascending order across serving cells indexes for a same PDCCH monitoring occasion and are then indexed in an ascending order across PDCCH monitoring occasion indexes....If a UE transmits HARQ-ACK information corresponding only to a PDSCH reception without a corresponding PDCCH, a PUCCH resource for corresponding PUCCH transmission with HARQ-ACK information is provided by *n1PUCCH-AN*. |

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| Samsung | We are OK with the two-step approach. When *SPS-PUCCH-AN-List* is provided, clause 9.2.1 of 38.213 is clear and interpretation 1 applies – e.g. “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 …”When *SPS-PUCCH-AN-List* is not provided, the argument for interpretation 2 is based on the “corresponding PDCCH” in following “If a UE is not provided *SPS-PUCCH-AN-List* and transmits HARQ-ACK information corresponding only to a PDSCH reception without a corresponding PDCCH, a PUCCH resource for corresponding PUCCH transmission with HARQ-ACK information is provided by *n1PUCCH-AN*” being applicable only to the first SPS PDSCH.We do not understand such logic. If so, why only the first SPS PDSCH and not all SPS PDSCHs (i.e. use the resource indicated by PRI, instead of *n1PUCCH-AN*, for all SPS PDSCHs)? Why is the “corresponding PDCCH” corresponding to the first SPS PDSCH and not to every SPS PDSCH since every SPS PDSCH is activated/scheduled by that “corresponding PDCCH”? It should be clear that the activation DCI is not a scheduling DCI (e.g. fields used to indicate activation do not provide scheduling information, the HARQ-ACK of all SPS PDSCHs is put together for the Type-2 HARQ-ACK codebook without considering DAI, …” and SPS PDSCH do not have a “corresponding PDCCH”. Also, as it was well captured in x1027 and x1656, interpretation 2 is not consistent with other Rel-15 specifications (would require NBC changes) while interpretation 1 is. To summarize, our understanding is interpretation 1 – i.e. there is no difference between the first SPS PDSCH and non-first SPS PDSCHs with respect to resource determination for PUCCH transmission with corresponding HARQ-ACK. |
| ZTE | OK with the two-step approach. For Step 1, our understanding is Interpretation 2. As summarized by DOCOMO, the Rel-15 specification clearly specifies that the PRI in a last DCI, regardless of whether it is an activation DCI or not, would be used for PUCCH resources determination. And *n1PUCCH-AN* is only used for SPS PDSCH without a corresponding DCI. In addition, when discussing rate-matching for SPS PDSCH in R1-2112403 in RAN1#107-e, companies had a common understanding that the current spec text ‘*a PDSCH scheduled by a PDCCH*’ covers the first SPS PDSCH with activation DCI. In other words, the first SPS PDSCH with activation DCI is regarded as a dynamic PDSCH in RAN1, and this should be kept the same for all related handling.  |
| Intel | We are fine with the two-step approach. For Step 1, our understanding is Interpretation 2. The first PDSCH scheduled by activation DCI should be considered as dynamically granted PDSCH. The PUCCH resource corresponding to the HARQ-ACK for the first SPS PDSCH associated with an activation DCI is determined by DCI, i.e., RPI.  |
| QC | We are fine with the two-step approach. For step 1, our understanding is Interpretation 2. From RAN1 Rel-15 spec point of view, what DOCOMO provided clearly indicate RAN1 spec does not differentiate SPS activation DCI with a scheduling DCI. They are just with different RNTI, and following just say last DCI format 1\_0 or 1\_1, which of course include both RNTIs. “….The PUCCH resource determination is based on a PUCCH resource indicator field [5, TS 38.212] in a last DCI format 1\_0 or DCI format 1\_1, among the DCI formats 1\_0 or DCI formats 1\_1 that have a value of a PDSCH-to-HARQ\_feedback timing indicator field indicating a same slot for the PUCCH transmission”Even from RAN2 spec point of view, RAN2 spec has this note “NOTE 3a: A PDCCH indicating activation of SPS or configured grant type 2 is considered to indicate a new transmission.” To me, this note at least infer SPS activation DCI schedule a new transmission. |
| LG | We are also fine with the two-step approach. For Step 1, our understanding is also Interpretation 2.As observed by above companies (DOCOMO, ZTE, Intel, QC) as well as based on our understanding, the first PDSCH is to be treated as a dynamic PDSCH in terms of determining PUCCH resource and generating HARQ-ACK codebook. |
| vivo | We are ok with the two-step approach.For step 1, our understanding for the current specification is the 1st SPS PDSCH activated by DCI and the corresponding HARQ-ACK are considered the same as dynamic grant scheduled PDSCH and PUCCH. |
| CATT | We are fine with the two-step approach.For Step 1, our understanding is Interpretation 2. |
| Sharp | We support the two-step approach.For step 1, our understanding is Interpretation 2. We share the same observation as by Docomo, ZTE and others. |
| Nokia, NSB | Our understanding is interpretation 1 and all the PDSCHs that are triggered by the DL SPS activation DCI are SPS PDSCHs, but what is more important to us is that there is one interpretation that we can clarify as a group, and base our implementation on, or else DL SPS activation would not work.@NTT DOCOMO, the specification text you quote (from the Qualcomm Tdoc?) leads to interpretation 2 only if you assume that the 1st SPS PDSCH is a DG-PUSCH that has a corresponding PDCCH, NOT an SPS PDSCH. This is reciting an assumption as proof and as such doesn’t help, when the problem lies in whether that assumption is the correct assumption to take.  |
| Spreadtrum | We support the two-step approach. Our understanding is interpretation 2.1. There is no ignore UE behaviour defined in the specification. So UE should treat PRI field as a valid field in the activation DCI.
2. The first CG-PUSCH after activation is treated as same as dynamic scheduled. So SPS PDSCH after activation can share the same rule as CG-PUSCH
3. The field of “PDSCH-to-HARQ\_feedback timing indicator” is valid in activation DCI. Thus the activation DCI belongs to the “DCI format 1\_0 or DCI format 1\_1 for scheduling PDSCH receptions” in the spec. It share the same HARQ-ACK feedback mechanism as dynamic PDSCH, which does not need any changes.
4. If interpretation 1 is used, a lot of changes needed to clarify the different operations of the activation DCI, such as ignore the PRI field, the special handling of DAI in the activation DCI, etc.
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| Apple | At RAN1 #91 (November 2017), there was an LS reply to RAN2 from RAN1 (R1-1721574):**….**RAN1 would like to thank RAN2 on the questions related to DL SPS and grant-free operation. RAN1 has concluded the followings according to the questions asked by RAN2.**Q1**: RAN2 would like to kindly ask RAN1 on the feasibility to support DL SPS-like operation for NR. From RAN2 point of view, it is possible to support DL SPS-like operation in NR similar to LTE DL SPS.**A1:** RAN1 believes that it is feasible to support DL SPS operation in NR. The NR DL SPS scheme has no significant differences compared with LTE DL SPS scheme.….….The highlighted text should be relevant to the discussion here. We don’t have time to dig out the exact agreement concerning SPS HARQ feedback in NR. However, if LTE can be used as reference, then interpretation 2 should be the right one (copied text is from 36.213 v8.8.0): |

### Summary after round #1 NEW

**The issue:** should the PUCCH transmitting the HARQ-ACK in response to the first PDSCH triggered by an DL SPS activation DCI be considered as:

1. PUCCH corresponding to an SPS-PDSCH (following the RRC *SPS-Config*): 1027/1028, 1656
2. PUCCH corresponding to of a dynamically granted PDSCH (ignoring the RRC *SPS-Config)*: 1385, 2116

**Interpretation 1 supported by:**

* Ericsson, Fujitsu, Samsung, Nokia/NSB (4)

**Interpretation 2 supported by:**

* NTT DOCOMO, ZTE, Intel, Qualcomm, LG, vivo, CATT, Sharp, Spreadtrum, Apple (10)

If there is a different understanding between the UE and the gNB, there is a high risk that the SPS activation consistently fails as the gNB never receives ACK for the activation even if the UE received it correctly. Hence a common interpretation is a necessity for DL SPS to be supported by the standard.

The proponents of interpretation 1 derive the justification from the lack of differentiation between the 1st SPS-PDSCH and other SPS-PDSCHs, differentiation that would be needed for interpretation 2 and point out that there may be further issues in RAN2 and in Rel-16 specs if RAN1 is going to clarify that the 1st PDSCH after the SPS activation is not SPS-PDSCH, but a DG-PDSCH for Rel-15.

The proponents of interpretation 2 derive the justification from the TS38.213 text implying that the DL SPS activation DCI schedules the 1st SPS PDSCH as the PDCCH carrying the activation DCI corresponds to the first SPS-PDSCH. Apple further makes a compelling argument on the similarity to LTE DL SPS, which with seems to match the reality on the field.

Both arguments are understandable and can be defended and there is no compelling technical argument why one interpretation must be the correct one and the other the wrong one – the problem lies in RAN1 failing to properly address this question at the time of Rel-15 specification. Apple reference to the earlier RAN1-RAN2 LS exchange and the corresponding LTE implementation on the field is an additional piece of evidence in favour of Alt2.

There is, however, a fairly clear majority in favour of Alt2. Hence an attempt to accept the majority view is the starting point of the 2nd round.

## 3.2 Round 2 - NEW

**Moderator proposal: Accept the majority view as identified in round #1; The 1st PDSCH after the reception of the activation DCI is considered as a PDSCH with a corresponding PDCCH, only the subsequent PDSCHs are PDSCHs without a corresponding PDCCH.**

* **The PUCCH resource for the HARQ-ACK of the 1st PDSCH follows the PRI on the DL SPS activation DCI**
* **The HARQ-ACK CB construction for that PDSCH follows the DG-PDSCH construction**

Companies in favour of Alt1 in round 1, please be mindful of whether you believe you have arguments that could realistically be seen as turning the majority the other way around.

**Please provide company comments to the table below**

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| **Company**  | **Comment** |
| ZTE | Support the proposal in principle. We suggest the following changes to make it a bit more accurate. **Moderator proposal: Accept the majority view as identified in round #1; The 1st SPS PDSCH after ~~the reception of~~ the SPS activation DCI is considered as a PDSCH with a corresponding PDCCH, only the subsequent SPS PDSCHs are PDSCHs without a corresponding PDCCH.*** **The PUCCH resource for the HARQ-ACK of the 1st SPS PDSCH follows the PRI on the DL SPS activation DCI**
* **The HARQ-ACK CB construction for ~~that~~ 1st SPS PDSCH follows the DG-PDSCH construction**
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| NTT DOCOMO | We support the direction. It seems that ZTE’s suggestion is preferred to avoid misunderstanding.One question: this is intended for both Rel-15/16 or only for Rel-16? |
| Samsung | We do not support the proposal because it is not according to specifications. Interactive discussion with Q&A is needed. In particular, we would like to ask proponents of the proposal the following questions.Q1: What is the scrambling ID of the DM-RS for the SPS PDSCH receptions? Is it same or different for the ‘first’ SPS PDSCH and for the ‘non-first’ SPS PDSCHs?Q2: Is there any ambiguity for the Rel-16 specifications when *SPS-PUCCH-AN-List* is provided? We think there is not and interpretation 1 is clearly stated. If so, do the proponents of interpretation 2 intend to change the Rel-16 38.213 specifications?Q3: TS 38.321 specifies that “after receiving the activation DCI, the UE follows the SPS-PDSCH configuration”. Do proponents of interpretation 2 intend to change the TS 38.321 specifications? Q4: For the Type-1 HARQ-ACK codebook fallback operation, all SPS PDSCHs are equivalent and different from DCI-scheduled PDSCHs. Do the proponents of interpretation 2 intend to change the Rel-15 fallback operation for Type-1 CB?Q5: The Type-2 HARQ-ACK codebook considers all SPS PDSCHs as not having “corresponding PDCCH”. Do the proponents of interpretation 2 intend to change the Rel-15 Type-2 CB construction?Q6: Proponents of interpretation 2 based their argument on the “PDSCH-to-HARQ\_feedback timing indicator”. That field applies to all SPS PDSCHs. Shouldn’t then the PRI apply to all SPS PDSCHs for the PUCCH resource determination?Q7: The main ambiguity seems to come from “If a UE is not provided *SPS-PUCCH-AN-List* and transmits HARQ-ACK information corresponding only to a PDSCH reception without a corresponding PDCCH, a PUCCH resource for corresponding PUCCH transmission with HARQ-ACK information is provided by *n1PUCCH-AN*” and the argument from proponents of interpretation 2 is that “corresponding PDCCH” is for the ‘first’ SPS PDSCH. If so, why doesn’t “corresponding PDCCH” apply for the ‘non-first’ SPS PDSCHs? Based on what DCI are those ‘non-first’ SPS PDSCHs received or have HARQ-ACK reported?Q8: What other fields from the activation DCI, other than k1 and PRI (for interpretation 2), are used? |
| Ericsson | We share the same view as Samsung and have the same questions. True that we are in minority, but we struggle to be comfortable with the logic. We appreciate if proponents of interpretation 2, provide their views to questions raised by Samsung.Some additional comments:* If interpretation 2 is adopted, definitely couple of CR is needed for at least CB construction as we point out in contribution. Which in turn, impacts the related functionalities and creates more work make different part of specifications flows nicely together.
* Also, referring to LTE and reusing the same procedure, would be an appealing argument if NR DL SPS would have been the same.
	+ We even mentioned in our contribution that either interpretation would not make a big difference for Rel-15, since DL SPS periodicity is 10 ms, which makes Rel-15 very similar to LTE.
	+ But, in Rel-16, DL SPS enhancements not only introduced simultaneous activation of multiple configurations, but also much smaller periodicities as compared to Rel-15 (and LTE). Here, it becomes complicated and with interpretation 2, we definitely need to have CR to ensure 1st and other DL SPS are treated differently.
* Another aspect is about configuration of PUCCH resources. There is no mention in specification that configuration of DL SPS, requires configuration of PUCCH resource set used for dynamic DG-PDSCH.
	+ Hence, from specification point of view, we have the case that multiple DL SPS are configured but dedicated PUCCH resource set is not configured. That leaves us to use the default PUCCH resources before dedicated RRC if we go we interpretation 2. Then, we need to address the cases that we can not support more than 3 DL SPS..
	+ The point we try to make is that with interpretation 2, for the specifications to work really for multiple DL SPS configuration, we have a lot of fixing to do.

So, therefore to us, not only logically is a bit strange, but also we see more troubles with respect to specifications if we go with interpretation 2, than the potential clarifications in spec for interpretation 1.  |
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