3GPP TSG RAN WG1 #107 R1-2112574

e-Meeting, 11 – 19 November, 2021

**Agenda item: 7.1**

**Source: Moderator (Nokia)**

**Title: [107-e-NR-7.1CRs-08] Issue#15 Email discussion summary**

**Document for: Discussion and Decision**

# Introduction

This document is an email discussion summary of the RAN1#107 email discussion thread:

[107-e-NR-7.1CRs-08] Issue#15: PUCCH resource and resource set selection for HARQ-ACK and P-CSI multiplexing by Nov 17 – Karri (Nokia)

The thread was triggered by the following Tdoc:

[R1-2111785](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111785.zip) PUCCH resource and resource set selection for HARQ-ACK and P-CSI multiplexing Nokia, Nokia Shanghai Bell

The Tdoc raised two issues:

**Issue 1:** PRI interpretation when multiplexing HARQ-ACK and P-CSI

Does PRI it refer to

1. PUCCH resource in the HARQ-ACK PUCCH resource set for evaluationg PUCCH resource overlap
2. PUCCH resource in the PUCCH resource set selected by subclause 9.2.1
3. Both

**Issue 2:** *O*UCI interpretation in PUCCH resource set selection

Clarify that *O*UCI refers to the number of UCI bits before CSI part 2 dropping

# PRI interpretation when multiplexing HARQ-ACK and P-CSI

## Issue description

Ref: [R1-2111785](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111785.zip) PUCCH resource and resource set selection for HARQ-ACK and P-CSI multiplexing

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| When multiplexing HARQ-ACK and P-CSI, the procedure can be assumed to be:**Alt1:**1. The UE picks a PUCCH resource from the HARQ-ACK PUCCH resource set using the PRI in the DCI
2. The UE evaluates if the selected PUCCH resource overlaps with the PUCCH resource for the P-CSI
3. If there is an overlap, the UE determines the PUCCH resource set according to sub-clause 9.2.1 for the UCI with HARQ-ACK and P-CSI

In this interpretation the PRI is used to point to a resource in the HARQ-ACK resource set.How is the PUCCH resource selected after step 3, if PRI selectes the PUCCH resource from one set in step 1, and after step 3 another set has been selected?**Alt2:** 1. The UE evaluates if the PUCCH resources in the HARQ-ACK resource set overlap with the PUCCH resource for the P-CSI
2. If there is an overlap, the UE determines the PUCCH resource set according to sub-clause 9.2.1 for the UCI with HARQ-ACK and P-CSI
3. The UE pics a PUCCH resource from the set selected in step 2.

In this interpretation the PRI is used to point to a resource in the resource set after the set selection.Against what PUCCH resource is the overlap evaluation done in step 1, if there are multiple PUCCH resources in the HARQ-ACK PUCCH resource set?**Alt 3:** The same PRI is used first to select a resource from the HARQ-ACK set, and also later to select a resource from the set after the resource set selection. Is it reasonable to assume that one PRI needs to point to a correct and valid resource in two different PUCCH resource sets, one in the HARQ-ACK PUCCH resource set to evaluate overlap in step 1, another in the PUCCH resource set selected in step 3? |

## Discussion round 1

**Question 1.1:** What is the correct interpretation, Alt1, Alt2, Alt3 or something else?

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| **Company Name** | **Comments** |
| QC | Alt 3 is the correct interpretation of the spec. Alt 1 is not complete: After step 3, what should UE do?Alt 2 is NBC. The definition of overlapping is never based on PUCCH resource set. The overlapping is always based on individual resources.  |
| Apple | Alt3 is current spec and correct interpretation |
| NTT DOCOMO | Let me clarify difference between Alt 1 and Alt 3.Alt 1 uses the PRI only for the first determination of PUCCH resource for HARQ-ACK while Alt 3 uses the PRI for both of the first determination of PUCCH resource for HARQ-ACK and the second determination of PUCCH resource for HARQ-ACK and CSI. In both alternatives, PUCCH resource set can be different between for HARQ-ACK only and for HARQ-ACK and CSI. Is this understanding is correct?If correct, we think Alt 3 is correct interpretation. |
| ZTE | Alt 3 is the correct interpretation.  |
| Nokia, NSB | Re: DCM, correct, Alt.1 leaves it open how the resource from the second resource set is selectedIn our view only Alt.3 is a complete alternative and thus would have to be the correct interpretation |
| Sharp | Alt3 is aligned with the current specification. |
| Huawei, HiSilicon | We think Alt.3 is the only way that UE selects a PUCCH based on the PRI indication. For Alt.1, it is not complete, UE cannot find the PUCCH resource within the new set in the end. For Alt.2, which PUCCH resource is used to transmit HARQ is not clear, neither the PUCCH resource to judge the overlapping.  |
| Samsung | We share the same view with other companies that PRI indicates PUCCH resource for HARQ-ACK and PUCCH resource for HARQ-ACK and CSI.  |
| Intel | Alt. 3 is aligned with current spec. If Alt. 1 also uses PRI to select the PUCCH resource based on the determined PUCCH resource set after step 3, we think this is equivalent to Alt. 3.  |
| Ericsson | Alt 3 (but some modification below to be accurate):1. The UE picks a PUCCH resource set based on the HARQ-ACK bits size.
2. The UE picks a PUCCH resource from the PUCCH resource set selected in step 1 based on the PRI in the DCI
3. The UE evaluates if the selected PUCCH resource overlaps with the PUCCH resource for the P-CSI
4. If there is an overlap, the UE determines the PUCCH resource set according to sub-clause 9.2.1 for the UCI size with HARQ-ACK and P-CSI.
5. The UE picks a PUCCH resource from the PUCCH resource set based on the PRI in the DCI
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| LG | We also think that Alt 3 is aligned with the current spec, and agree with Ericsson’s formultation in above which seems to be accurate. |
| Moderator – after round 1 | There seems to be a good consensus that the correct understanding is Al3, the PRI is used twice, first to determine if there is an overlap, and then, if a new PUCCH resource set if selected in the 38.213 9.2.1, again when selecting the PUCCH resource from this new PUCCH resource set.Ericsson 5-step description is more complete than the original alt.3. One could emphasize further in step 5 that it is the same PRI:1. The UE picks a PUCCH resource from the PUCCH resource set selected in step 1 based on the PRI in the DCI
2. The UE picks a PUCCH resource from the PUCCH resource set The UE picks a PUCCH resource from the PUCCH resource set selected in step 4 based on the based on the same PRI as in step 2 ~~PRI in the DCI~~
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**Question 1.2:** If correct interpretation is alt1/alt2/alt3, then?

* **alt1:** How is the PUCCH resource selected after step 3, if PRI selectes the PUCCH resource from one set in step 1, and after step 3 another set has been selected?
* **alt2:** Against what PUCCH resource is the overlap evaluation done in step 1, if there are multiple PUCCH resources in the HARQ-ACK PUCCH resource set?
* **alt3:** Is it reasonable to assume that one PRI needs to point to a correct and valid resource in two different PUCCH resource sets, one in the HARQ-ACK PUCCH resource set to evaluate overlap in step 1, another in the PUCCH resource set selected in step 3?
* **Something else**: Please elaborate

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| **Company Name** | **Comments** |
| QC | Alt 3 is the correct interpretation. And it is gNB’s job to make one PRI points to a correct and valid resource in both PUCCH resource sets.  |
| Apple | Same view as QC |
| NTT DOCOMO | Same view as QC. |
| ZTE | Alt 3 is the correct interpretation. Agree QC that it’s up to gNB implementation.  |
| Nokia, NSB | Agree with all of the previous, the implication is that the second PUCCH resource set cannot be larger than the first set (or rather, if it is, there are resources that the PRI cannot point to as it would then point outside the 1st set when determining the overlap) |
| Sharp | Same view as QC. |
| Huawei, HiSilicon  | Alt. 3 is the correct understanding. Resource sets are configured by gNB, it will have a proper scheduling considering the overlapping,As the relationship on the size between the first ans second resource sets, we think there is no specific rules to define which set should have a larger size in the spec. It is gNB implementation to ensure the PRI point to a right resource in different set, although the size of each set is different.  |
| Samsung | Same view as QC |
| Intel | Same view as QC.  |
| Ericsson | Alt 3 is correct interpretation (please see our modifcaiton below). If the UCI size changes, the PUCCh resource set may change or not. In case of change of set, the PUCCh resource indicated by PRI would be different resources in the set (gNB could in fact configure the same resource as well.. ).How the resources are configured in the set is up to gNB. |
| LG | Same view with Ericssion.The gNB may select and indicate proper PRI value by predicting whether the resource would be overlapped and which resource would be finally determined in UE side. |
| Moderator – after round 1 | As was evident with question 1.1, there is a good consensus that the same PRI twice if the PUCCH resource set is changed after the overlap determination. PUCCH resource set configuration that works properly is up to the gNB.  |

**Question 1.3:** Any other aspects to consider?

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| **Company Name** | **Comments** |
| QC | No. We actually assumed Alt 3 was RAN1 common understanding anyway.  |
| Nokia, NSB | Should there be a spec change, as now it is hard to read Alt3 behaviour from 38.213? |
| Ericsson | Proper porcedures is as we described in Q 1.1. If there is different understanding, it si important to make sure the views are aligned. |

## Discussion round 2

Aim to agree on one of the three alternatives:

**Alt1: RAN1 conclusion based on the Ericsson description with moderator-suggested updates:**

Conclusion: It is RAN1 understanding that the correct interpretation of TS38.213 UE procedure for multiplexing HARQ-ACK/SR/CSI when determining a PUCCH resource for HARQ-ACK and P-CSI multiplexing is as follows

1. The UE picks a PUCCH resource set based on the HARQ-ACK bits size.
2. The UE picks a PUCCH resource from the PUCCH resource set selected in step 1 based on the PRI in the DCI
3. The UE evaluates if the selected PUCCH resource overlaps with the PUCCH resource for the P-CSI
4. If there is an overlap, the UE determines the PUCCH resource set according to sub-clause 9.2.1 for the UCI size with HARQ-ACK and P-CSI.
5. The UE picks a PUCCH resource from the PUCCH resource set The UE picks a PUCCH resource from the PUCCH resource set selected in step 4 based on the based on the same PRI as in step 2 ~~PRI in the DCI~~

**Alt 2: Agree to clarify TS38.213 along the following lines (exact CR text subject to discussion)**

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| If a UE has HARQ-ACK, SR and wideband or sub-band CSI reports to transmit and the UE determines a PUCCH resource with PUCCH format 2, or the UE has HARQ-ACK, SR and wideband CSI reports [6, TS 38.214] to transmit and the UE determines a PUCCH resource with PUCCH format 3 or PUCCH format 4, where - for each PUCCH resource set, the UE determines the PUCCH resource using the PUCCH resource indicator field [5, TS 38.212] in a last DCI format 1\_0 or DCI format 1\_1, from 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, from a PUCCH resource set provided to the UE for HARQ-ACK transmission, and - the UE determines the PUCCH resource set as described in Clause 9.2.1 and Clause 9.2.3 for  UCI bits |

**Alt 3: Do nothing**

**Question 1.4:** Which Alternative is preferrect? Any other comments wrt. the alternatives?

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| **Company Name** | **Comments** |
| NTT DOCOMO | Either conclusion or spec update is fine, but we are not sure that the current TP does not solve the discussed issue well. Between Alt 1 and Alt 2, we think Alt 1 is better.Besides, the behavior of Alt 1 is used also for SP-CSI/SR, right? It might be better to include SP-CSI/SR as well as P-CSI.Alt 3 is OK for us as well. |
| Samsung | Alt 3. Rel-15 NR has been widely deployed. If we make a change or conclusion on this, it may cause some mis-leadings to the outside of 3GPP. This should be avoided as much as possible and essential corrections/conclusions should be accepted. Since all of companies have the same understanding, we can live without such a change and conclusion. |
| Intel | Given that there is common understanding among companies in term of procedure, we slightly prefer Alt. 3 for this issue. We share similar view as NTT DOCOMO that this should be applied for the case when PUCCH carrying dynamic HARQ-ACK overlaps with PUCCH carrying P/SP-CSI and SR. Note that this does not apply for SPS HARQ-ACK feedback.  |
| Ericsson | We are fine with Alt-1. On comment from DCM and Intel, we shar ethe same view. However, we assumed it should be clear since PRI is used.We are also OK with Alt-2. For Alt-2, we suggest to change wording as the following (changing the order of bullets). The reason is that UE picks up one of the PUCCH resource set and then applies PRI. And not applying PRI for EACH PUCCH resource set.If a UE has HARQ-ACK, SR and wideband or sub-band CSI reports to transmit and the UE determines a PUCCH resource with PUCCH format 2, or the UE has HARQ-ACK, SR and wideband CSI reports [6, TS 38.214] to transmit and the UE determines a PUCCH resource with PUCCH format 3 or PUCCH format 4, where - the UE determines the PUCCH resource set as described in Clause 9.2.1 and Clause 9.2.3 for  UCI bits, and- the UE determines the PUCCH resource in the PUCCH resource set using the PUCCH resource indicator field [5, TS 38.212] in a last DCI format 1\_0 or DCI format 1\_1, from 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, from a PUCCH resource set provided to the UE for HARQ-ACK transmission~~, and~~ ~~- the UE determines the PUCCH resource set as described in Clause 9.2.1 and Clause 9.2.3 for  UCI bits~~We are OK with Alt-3 as well 😊 |
| QC | We support Alt 3. Since the spec is pretty clear and all companies have shown a same understanding of the spec, we don’t think change of spec or a conclusion is needed.  |
| Sharp | We agree with QC that companies have already common understanding. We don’t think any conclusion is necessary. |
| Huawei, HiSilicon | Alt. 3 is better at this stage, since the understanding among companies are aligned, the necessity to have additional conclusion and spec change is minor.As the clarification from DCM, our understanding is Yes. The procedure is applied to dynamic HARQ on a PUCCH overlapping with PUCCH converying P-CSI/SP-CSI/SR.  |
| CATT | We prefer Alt. 3 since it is clear that there is no other feasible alternative for the issue and all companies share the same view. In addition, the current formulation of Alt. 1 is not complete which only covers P-CSI.  |

# *O*UCI interpretation in PUCCH resource set selection

## Issue description

Ref: [R1-2111785](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_107-e/Docs/R1-2111785.zip) PUCCH resource and resource set selection for HARQ-ACK and P-CSI multiplexing

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| The subclause 9.2.1 states: “If the UE transmits *O*UCI information bits that include HARQ-ACK information bits, …”, i.e. the PUCCH resource set selection is to be done based on the actually transmitted number of bits in the UCI.Subclause 9.2.5.2 defines a CSI part 2 dropping rule that takes the selected PUCCH resource as an input in order to determine which of the CSI bits are to be multiplexed to the UCI and which are dropped. That is, if the actually transmitted UCI is considered in the PUCCH resource set selection, the PUCCH resource selection can only be done after the UE knows which UCI bits are actually to be transmitted, but this can only be determined after the PUCCH resource to be used is known. |

## Discussion round 1

**Question 2.1:** Does the *O*UCI in subclause 9.2.1 for PUCCH resource set selection refer to

* **alt1:** the number of UCI bits that are actually transmitted
* **alt2:** the number of UCI bits before CSI part 2 dropping defined in 9.2.5.2

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| **Company Name** | **Comments** |
| QC | Alt 2. PUCCH resource set determination should be based on # UCI bits before CSI part 2 dropping; otherwise, it will create chiken-egg problem, i.e., resource set depends on actual bits, while actual bits depends on resource in the selected resource set…  |
| Apple | Alt.2 is current spec (O\_UCI is before CSI part 2 dropping in 9.2.5.2, before CRC adding, etc, it represents all UCI info bits on the resource that is determined in 9.2.1)  |
| NTT DOCOMO | Alt 2. |
| ZTE | Alt 2.  |
| Nokia, NSB | Alt.1 would not work, hence must be Alt.2 |
| Sharp | Alt.2 |
| Huawei, HiSilicon | Alt.2. gNB does not actual CSI part 2 size before decoding part 1, so the number of UCI bits before dropping (i.e. the number determined assuming rank 1) should be used to select PUCCH resource. Otherwise, if the Alt.1 is used, gNB may not know the resource UE selects. |
| Samsung | Alt 2. |
| Intel | Alt. 2 |
| Ericsson | Alt. 2 in principle.Everytime we have to determine a PUCCH resource that the corresponding UCI of size Ouci carry HARQ-ACK that corresponds to PDSCH including DCI, PUCCH resource set in subclause 9.2.1 is referred. There are many occasions and not limited to alt 2.  |
| LG | Alt 2. Same view with QC. |
| Moderator – after round 1 | There seems to be a good consensus that the correct understanding is Al2. |

**Question 2.2:** If correct interpretation is alt1/alt2, then?

* **alt1:** How is the CSI part 2 dropping rule factored in, when the actually transmitted number of bits impact the PUCCH resource set selection, and the selected PUCCH resource set impacts the number of UCI bits through CSI part 2 dropping?
* **alt2:** Should there be a specification clarification that *O*UCI in 9.2.1 refers to number of UCI bits before CSI part 2 dropping in 9.2.5.2?

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| **Company Name** | **Comments** |
| QC | We think spec is clear enough. We prefer not change spec.  |
| Apple | We think spec is already clear (although we are open to a self-contained clarification text without referring to 9.5.2.5) |
| NTT DOCOMO | OK with either or having conclusion. |
| ZTE | No spec change is needed.  |
| Nokia, NSB | Prefer a spec change, but writing a RAN1 conclusion would be acceptable. |
| Sharp | No spec change is necessary. We are OK with writing a RAN1 conclusion if necessary. |
| Huawei, HiSilicon | Changes on spec is not preferred. A conculision may be acceptable. |
| Samsung | No spec change is necessary.  |
| Intel | We think spec is clear, but we can be okay for a conclusion if needed.  |
| Ericsson | We also think spec is clear. |
| LG | We also think spec is clear, but OK with a conclusion if necessary. |
| Moderator – after round 1 | There is a limited support for spec change.  |

**Question 2.3:** Any other aspects to consider?

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| **Company Name** | **Comments** |
| Moderator – after round 1 | No other aspects raised  |

## Discussion round 2

Aim to agree on one of the two alternatives:

**Alt1: RAN1 conclusion based on the Ericsson description with moderator-suggested updates:**

Conclusion: It is RAN1 understanding that the PUCCH resource set determination in subclause 9.2.1 of TS38.213 is done using the *O*UCI UCI information bits before the CSI part 2 dropping

**Alt 2: Do nothing**

**Question 2.4:** Which Alternative is preferrect? Any other comments wrt. the alternatives?

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| **Company Name** | **Comments** |
| NTT DOCOMO | Either is fine for us. |
| Samsung | Alt 2. Same as Question 1.4 in 2.3.  |
| Intel | We slightly prefer Alt. 2. But if majority companies support a conclusion, we are also fine. |
| Ericsson | We are fine with both. But for Alt-1, isn’t it better to capture the context in the conclusion as well?  |
| QC | We support Alt 2 for same reason as for the issue in Section 2.  |
| Sharp | We support Alt.2. We are OK with Alt.1 if necessary. |
| Huawei, HiSilicon | Either is fine for us.We also notice that CR01 is also discussing which number of CSI part 2 is applied to determine the PUCCH resource set and the number of CSI part 2 transmitted in a PUCCH. Based on the comments from companies and agreement (copy as below), the resource set is deremined assuming rank 1 which is the number of CSI part 2 before omission. So we think these two issues can clarify the UE haviour on CSI part 2 clearer together.Agreements:* In the pseudo code in 38.213 Section 9.2.5 to decide PUCCH resource set and PUCCH resource(s) in UCI multiplexing procedure, UE assumes rank 1 for CSI-part2.

If the conclusion is needed, we suggest following changes on it.Conclusion: It is RAN1 understanding that the PUCCH resource set determination in subclause 9.2.1 and UCI multiplexing procedure in subclasue 9.2.5.2 of TS38.213 is done using the *O*UCI UCI information bits before the CSI part 2 dropping |
| CATT | We are fine with either way. |

# Conclusion

* There is no disagreement on the interpretation of Issue #1 or Issue #2
* There is no need for a spec clarification or RAN1 conclusion detailing the interpretation on either of the two issues
* The email discussion thread can be closed