**3GPP TSG RAN WG1 Meeting #107-e R1-21xxxxx**

**e-Meeting, November 11th – 19th, 2021**

**Agenda Item: 7.1**

**Source: Moderator (Huawei)**

**Title: Summary of [107-e-NR-7.1CRs-01]: Correction on the determination of the number of part 2 CSI report**

**Document for: Discussion and Decision**

# Introduction

This document is created to collect company views on the proposed changes in [1] and [2].

# Background

In TS38.213, there are two places to describe the number of part 2 CSI reports. In Clause 9.2.5, the number is determined assuming that each of the CSI reports indicates rank 1. In Clause 9.2.5.2, the number also derived from the restriction of max code rate of the PUCCH resource.

**Clause 9.2.5**

|  |
| --- |
| If a UE would multiplex CSI reports that include Part 2 CSI reports in a PUCCH resource, the UE determines the PUCCH resource and a number of PRBs for the PUCCH resource or a number of Part 2 CSI reports assuming that each of the CSI reports indicates rank 1. |

**Clause 9.2.5.2**

|  |
| --- |
| If a UE has HARQ-ACK, SR and sub-band CSI reports to transmit and the UE determines a PUCCH resource with PUCCH format 3 or PUCCH format 4, where  - 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  and  - if , the UE transmits the HARQ-ACK, SR and the  CSI report bits by selecting the minimum number  of PRBs from the  PRBs satisfying  as described in Clauses 9.2.3 and 9.2.5.1  - else,  - if for  Part 2 CSI report priority value(s), it is  and  ,  the UE selects the first  Part 2 CSI reports, according to respective priority value(s) [6, TS 38.214], for transmission together with the HARQ-ACK, SR and  Part 1 CSI reports , where  is the number of Part 1 CSI report bits for the  CSI report and  is the number of Part 2 CSI report bits for the  CSI report priority value,  is a number of CRC bits corresponding to , and  is a number of CRC bits corresponding to  - else, the UE drops all Part 2 CSI reports and selects  Part 1 CSI report(s), from the  CSI reports in ascending priority value [6, TS 38.214], for transmission together with the HARQ-ACK and SR information bits where the value of  satisfies  and , where is a number of CRC bits corresponding to  UCI bits, and  is a number of CRC bits corresponding to  UCI bits. |

# Problem description

Recall the discussion of PUCCH resource set and PUCCH resource(s) determination, rank 1 is assumed for CSI part 2 by a UE to select a dedicated PUCCH resource. Thus, based on the Clause 9.2.5 of TS 38.213 cited above, when a UE would multiplex CSI reports that include part 2 CSI reports in a PUCCH resource, both the number of PRBs for the PUCCH resources and the number of Part 2 CSI reports are determined assuming that each of the CSI reports indicates rank 1.

However, in Clause 9.2.5.2, it also specifies that a number of Part 2 CSI reports needs to be dropped if the actual code rate of PUCCH with all Part 2 CSI reports is larger than the maximum one given by *maxCodeRate*. Regarding this, if the actual payload size of Part 2 CSI reports is larger than the size calculated assuming rank 1, some Part 2 reports are possibly dropped to satisfy the maximum code rate of the PUCCH, and the actual number of Part 2 CSI reports will be different from the number determined assuming rank 1. Therefore, which number of Part 2 CSI reports should be reported, the actual number subject to the max code rate or the determined number assuming rank 1, is not clear based on the current spec. Specifically, if the actual number is used, it may conflict with the description that “a number of Part 2 CSI reports assuming that each of the CSI reports indicates rank 1”; if the determined number of Part 2 CSI reports are transmitted, the actual code rate will be larger than the maximum code rate given by *maxCodeRate*.

To address such an ambiguity, [1] and [2] propose to remove the related description that a number of Part 2 CSI reports is determined assuming rank 1 in Clause 9.2.5 of TS38.213, which means to determine a dedicated PUCCH resource for multiplexing part 2 CSI reports, rank 1 is applied. On the number of part 2 CSI reports that UE transmits, it is the actual one determined based on the actual CSI report 2 size and the max code rate of PUCCH, which is specified in Clause 9.2.5.2.

|  |
| --- |
| If a UE would multiplex CSI reports that include Part 2 CSI reports in a PUCCH resource, the UE determines the PUCCH resource and a number of PRBs for the PUCCH resource assuming that each of the CSI reports indicates rank 1. |

# 1st Round discussion

## Companies’ view

**Q1: Do you agree that there is an ambiguity on the number of CSI part 2 reports that UE transmits on a PUCCH? If not, why?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or not** | **Comment** |
| QC | NO | Spec is pretty clear, according to the highlighted in this color.  “If a UE would multiplex CSI reports that include Part 2 CSI reports in a PUCCH resource, the UE determines the PUCCH resource and a number of PRBs for the PUCCH resource or a number of Part 2 CSI reports assuming that each of the CSI reports indicates rank 1.”  Actually, the above is very consistent with the following in 9.2.5. The highlighted blue part is for determining “a number of PRBs for the PUCCH resource” when # required PRBs is less than # PRBs of the PUCCH resource. The highlighted green part is for determining the number of CSI part 2 reports when # PRB of the PUCCH resource is not sufficient.  We see the two Subclause of the spec are very consistent with each other.  if , the UE transmits the HARQ-ACK, SR and the  CSI report bits by selecting the minimum number  of PRBs from the  PRBs satisfying  as described in Subclauses 9.2.3 and 9.2.5.1  - else,  - if for  Part 2 CSI report priority value(s), it is  and  , |
| SS | No | We understand the motivation of the CR but it is not essential (required). The number of Part 2 CSI reports in 9.2.5 serves as a placeholder as an additional stage to determine the actual number of Part 2 CSI reports multiplexed in PUCCH is specified in 9.2.5.2. As “a number of PRBs for the PUCCH resource” and “a number of Part 2 CSI reports” are connected by an ‘or’, we do not see any error in the spec that requires change. |
| OPPO | No | We think there is no collision for the two parts in 38.213. |
| Huawei,  HiSilicon | Yes | Two places in the spec, clause 9.2.5 and 9.2.5.2, describe the determination on the number of part 2, the ambiguity is UE uses which place in the spec to decide the number of part 2 CSI reports transmitted in a PUCCH resource.  On the comment from QC, “*The highlighted green part is for determining the number of CSI part 2 reports when # PRB of the PUCCH resource is not sufficient*.” It seems already clarified that there will be inconsistency between the number decided in clause 9.2.5 (assuming rank 1) and the one deiced in clause 9.2.5.2 (based on actual part 2 size and max code rate). In 9.2.5, The PUCCH resource are determined assuming rank 1 along with an assumed CSI part 2 number. However, in 9.2.5.2, the number of PRB may be not sufficient for all CSI part 2 reports, part or all of them are omitted. Therefore, the actual number that is capable to be transmitted in a PUCCH is different form the assumed one.  We have similar understanding with SS, the actual number of transmitted CSI part in a PUCCH is based on 9.2.5.2. That is why we propose to delete “or a number of Part 2 CSI reports” in 9.5.2 to avoid unnecessary misunderstanding. |
| vivo | Yes | There is space for the specification to improve clarify.  Our interpretation of the specification is that the overhead calculation in 9.2.5.2 is also based on the assumption of rank1 based on the agreement achieved in Rel-15.  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. |
| NTT DOCOMO | Yes | We have similar feeling with vivo. Clarification is better. |
| Sharp | No | We understand the motivation. On the other hand, as explained by Samsung, actual number of CSI reports will be determined in 9.2.5.2. |
| ZTE | No | We have similar understanding as Samsung. The spec texts in 9.2.5 serve as a placeholder or the first step to determine/presume the number of Part 2 CSI reports, and the texts in 9.2.5.2 serve as the next step to finalize the actual number of Part 2 CSI reports to be multiplexed in PUCCH. |
| Nokia, NSB | Yes | It is evident based on the answers provided that there are two interpretations, which would seem to be a text-book definition of ambiguity. |
| Ericsson | No | Same understanding as Samsung, on the other hand, since different companies make different interpretations, the spec language can be improved to avoid future misunderstandings. |

**Q2-1: Which number in your understanding (actual number subject to the maximum code rate, determined number assuming rank 1 or other number) is applied to transmit part 2 CSI reports on a PUCCH, and why?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Which Number?** | **Comment** |
| QC | determined number assuming rank 1 |  |
| Samsung | The number determined by 9.2.5.2 | As we have mentioned it for the above question, if the number of Part 2 CSI reports is determined based on 38.213/9.2.5, the determined number is a placeholder. The spec specifies a second stage to determine the actual number of Part 2 CSI reports carried by PUCCH in 38.213/9.2.5.2. |
| OPPO | The number finally determined by 9.2.5.2 | We share the same understanding as Samsung. The actual size is determined by the description in 9.2.5.2. |
| Huawei, HiSilicon | Actual number subject to the maximum code rate (i.e. the number determined by 9.2.5.2) | As the comment in the first question. The number of part 2 CSI reports in a PUCCH are determined by actual part 2 size and maximum code rate in clause 9.2.5.2 of 38.213. |
| vivo | The number determined number assuming rank 1. | The overhead calculation in 9.2.5.2 is based on the assumption of rank1 to determine how to drop CSI reports.  The following agreement was achieved in Rel-15. Understanding of the specification should be based on the following agreement.  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. |
| NTT DOCOMO | It seems that “determined number assuming rank 1” is correct | We feel QC’s comment is valid, and it would be aligned with the agreements captured by vivo. |
| Sharp | The number determined by 9.2.5.2 |  |
| ZTE | The number determined by 9.2.5.2 |  |
| Nokia, NSB | The number determined by 9.2.5.2 | The vivo-cited agreement can be understood as vivo and Qualcomm say, but it can also be understood is that the rank 1 assumption is used to determine the maximum number of part 2 CSI that may be reported, i.e. the value of N\_rep used in the priority table 5.2.3-1 of 214 (the same table is used for PUSCH as well).  "Omission of Part 2 CSI is according to the priority order shown in Table 5.2.3-1, where N\_rep is the number of CSI reports configured to be carried on the PUSCH."  The ambiguity can be removed by saying "or the number N\_rep of part 2 CSI reports used to determine the maximum number of priority reporting levels (see Table 5.2.3-1 in 38.214) assuming that each of the CSI reports indicates rank 1" |
| Ericsson | 9.2.5.2 |  |

**Q2-2: If the determined number assuming rank 1 in Q2-1 is applied, whether it is allowed to transmit CSI reports including the part 2 on a PUCCH with actual code rate larger than the maximum given by *maxCodeRate*?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Samsung | No. | The spec is clear about that in 38.213/9.2.5.2. |
| OPPO | No |  |
| Huawei, HiSilicon | No | The number is determined by clause 9.2.5.2 of 38.213. No such case would happen. |
| vivo | No | The size of CSI report for rank1 is the largest one. There is no such case even with the assumption of rank1. |
| NTT DOCOMO |  | It depends on Q2-1 |
| Sharp | No |  |
| ZTE | No |  |
| Nokia, NSB | No |  |
| Ericsson | No |  |

**Q3: Do you agree with proposed changes? If not, why?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or not** | **Comment** |
| QC | NO | This is NBC change to Rel-15. |
| Samsung | No | The CR is non-essential. |
| OPPO | No | The correction is not essential. |
| Huawei, HiSilicon | Yes | The CR if agreed makes more clear on which number is used to transmit CSI part 2 report in a PUCCH resource and avoid unnecessary misunderstanding.  As the comment of NBC problem from QC, we think if the change is aligned with common understanding. NBC issue could be possibly avoided. We can hear more views from companies. |
| vivo | Depends on the group’s consensus | Also fine with a conclusion on this. |
| NTT DOCOMO |  | Conclusion is preferable. Now companies views are divergent, so no CR/conclusion should be avoided. |
| Sharp | No | The CR is not essential. |
| ZTE | No | Not essential correction. |
| Nokia, NSB | A change is needed | It seems a clarification/RAN1 conclusion is a must |
| Ericsson | Yes | Claridication/RAN1conclusion is needed and spec may need to be enhanced to avoid misunderstandings. |

## Summary of 1st round input

Based on the 1st round discussion, companies’ views are summarized as below.

On whether there is ambiguity on the number of CSI part 2 reports that UE transmits on a PUCCH.

* Yes: Huawei/HiSilicon, Vivo, DCM, Nokia. *(4 companies)*
* No: QC, SS, OPPO, Sharp, ZTE, Ericsson. *(6 companies)*

On which number is applied to transmit part 2 CSI reports on a PUCCH

* Determined number assuming rank 1: QC, Vivo, DCM. *(3 companies)*
* Actual number determined by 9.2.5.2: SS, OPPO, Huawei/HiSilicon, Sharp, ZTE, Nokia, Ericsson *(7 companies)*

On whether it is allowed to transmit CSI reports including the part 2 on a PUCCH with actual code rate larger than the maximum given by *maxCodeRate*.

* *8 companies feedback no, 1 company feedback depends on Q2-1*.

# 2nd Round Discussion

Based on the companies’ input from 1st round, it can clearly see there are two interpretations on the number of part 2 CSI reports finally transmitted on a PUCCH. The majority (7 companies) think UE should transmit a number of part 2 CSI reports determined by Clause 9.2.5.2. A few companies think a number of CSI part2 assuming rank 1 should be reported by UE. However, as moderator observed, there may be some misunderstanding between “the number applied to Clause 9.2.5.2” and “the number determined by Clause 9.2.5.2.”

As explained by QC and the agreement cited by Vivo, UE determines a number of CSI part 2 on the assumption of rank 1 in Clause 9.2.5. This number of part 2 CSI report is also used to determine a PUCCH resource set and then a dedicated resource. On the other word, as explained by Nokia, it is the maximum number of CSI part 2 reports can be transmitted on the determined PUCCH resource. However, the actual rank may be different from rank 1, and actual part 2 size could be larger than the size assuming rank 1. Thus, a determined PUCCH resource may be not sufficient to convey all the assumed CSI part 2 reports, and in Clause 9.2.5.2, a reported number of part 2 CSI reports are determined subject to the max code rate. Regarding this, moderator shares views with SS and others, Clause 9.2.5 is a placeholder that UE determines a number of CSI part 2 report applied to next procedure Clause 9.2.5.2., and the final number of part 2 CSI reports transmitted on a PUCCH resource are determined based on 9.2.5.2 subject to the maximum code rate.

Therefore, a clarification on the number of part 2 CSI reports UE transmitted in a PUCCH resource seems needed. And based on the analysis above, moderator thinks it should be clarified that UE transmits an actual number of part 2 CSI reports determined by 9.2.5.2 in a PUCCH resource, which is also the majority views.

Based on the input on Q2-1, Nokia provides a suggested change to remove the ambiguity, but it is more related to the CSI on PUSCH and does not cover the case on PUCCH. Thus, moderator suggests to have following changes on the Clause 9.2.5 of TS 38.213, companies can provide your views in section 5.1.

|  |
| --- |
| **TS38.213, Clause 9.2.5**  If a UE would multiplex CSI reports that include Part 2 CSI reports in a PUCCH resource, the UE determines the PUCCH resource and a number of PRBs for the PUCCH resource or a number of Part 2 CSI reports assuming that each of the CSI reports indicates rank 1 before CSI omission. |

## Companies’ view

**Q: Do you agree with proposed changes in above? If not, please feel free to provide your preferred changes?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or not** | **Comment** |
| Samsung | No | We believe the current spec reads better. If all the companies, saving one, believe the UE is not allowed to transmit PUCCH with coding rate above the *maxCodeRate*, then it means there is an aligned understanding that the phrase “a number of Part 2 CSI reports” in 9.2.5 refers to the number before the omission rule in 9.2.5.2 is applied. Then, there is no misalignment on interpreting the existing clause in 9.5.2. |
| QC | No | Like we commented in first round, we think the spec is clear. Section 9.2.5.2 is about “determines … a number of RBs for the PUCCH resource or a number of Part 2 CSI reports”. The two things on the two sides of “or” match exactly the “if-else” statement in 9.2.5.2. Given 9.2.5.2 is a sub-section of 9.2.5, we don’t see any ambiguity of the spec. When one read spec, one should read the two sections of the spec together. Section 9.2.5.2 does not explicitly say assuming rank 1 because section 9.2.5 already said that.  With above, we think the change proposed is NBC and we don’t accept it. |
| NTT DOCOMO | No | Our understanding is the same with Samsung/QC.  The agreements captured by vivo above is saying that 9.2.5 pseudo-code uses the assumption of rank 1. And the pseudo-code includes 9.2.5.2. This means that 9.2.5.2 should follow the assumption or rank 1. |
| OPPO | No | It seems almost all the companies have the same understanding on the UE behavior and the relationship between 9.2.5 and 9.2.5.2. In this case, we don’t think specification modification is needed. |
| Huawei, HiSilicon | Yes | Ok to have a CR to clarify the understanding or a clarification in the chair’s note.  In our understanding, the ambiguity is “a number of Part 2 CSI reports…assuming rank 1” is applied to the 9.2.5.2, but whether it is the final number that UE should transmit on the PUCCH resource. Based on inputs for Q2-1 in first round, there is still no common understanding on the final number. This CR helps to clarify the final number of part 2 CSI report is determined based on 9.2.5.2, and the number assuming rank 1 is determined to apply to CSI omission (i.e. before CSI omission). |
| Apple |  | Related to companies’ questions on Q 2-2, maybe here we can check companies’ understanding on PUCCH resource set/PUCCH resource configuration:  Is there a requirement PUCCH resource in PUCCH resource set X’s capacity:  (the payload including including CRC bits)/(*maxCodeRate) >= (*maxPayloadSize of the lower-indexed PUCCH resource set (resource set X-1)) – 1?  Our understanding is there is no such requirement from specification (but it seems to make sense practically speaking – though it does not give assurance for UE implementation). Then how to ensure that **actual number subject to the maximum code rate?** It seems Huawei has point here.  PUCCH-ResourceSet ::= SEQUENCE {  pucch-ResourceSetId PUCCH-ResourceSetId,  resourceList SEQUENCE (SIZE (1..maxNrofPUCCH-ResourcesPerSet)) OF PUCCH-ResourceId,  maxPayloadSize INTEGER (4..256) OPTIONAL -- Need R  } |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# Conclusions

To be updated based on the discussion

# References

1. R1-2110799, “Correction on the determination of the number of part 2 CSI report”, Huawei, HiSilicon
2. R1-2111921, “Correction on the determination of the number of part 2 CSI report (mirrored to Rel-16)”, Huawei, HiSilicon

# Appendix: Proposed CR in R1-2110799 and R1-2111921

### 9.2.5 UE procedure for reporting multiple UCI types

This clause is applicable to the case that a UE has resources for PUCCH transmissions or for PUCCH and PUSCH transmissions that overlap in time and each PUCCH transmission is over a single slot without repetitions. Any case that a PUCCH transmission is with repetitions over multiple slots is described in clause 9.2.6. If a UE is configured with multiple PUCCH resources in a slot to transmit CSI reports

- if the UE is not provided *multi-CSI-PUCCH-ResourceList* or if PUCCH resources for transmissions of CSI reports do not overlap in the slot, the UE determines a first resource corresponding to a CSI report with the highest priority [6, TS 38.214]

- if the first resource includes PUCCH format 2, and if there are remaining resources in the slot that do not overlap with the first resource, the UE determines a CSI report with the highest priority, among the CSI reports with corresponding resources from the remaining resources, and a corresponding second resource as an additional resource for CSI reporting

- if the first resource includes PUCCH format 3 or PUCCH format 4, and if there are remaining resources in the slot that include PUCCH format 2 and do not overlap with the first resource, the UE determines a CSI report with the highest priority, among the CSI reports with corresponding resources from the remaining resources, and a corresponding second resource as an additional resource for CSI reporting

- if the UE is provided *multi-CSI-PUCCH-ResourceList* and if any of the multiple PUCCH resources overlap, the UE multiplexes all CSI reports in a resource from the resources provided by *multi-CSI-PUCCH-ResourceList*, as described in clause 9.2.5.2.

A UE multiplexes DL HARQ-ACK information, with or without SR, and CSI report(s) in a same PUCCH if the UE is provided *simultaneousHARQ-ACK-CSI*; otherwise, the UE drops the CSI report(s) and includes only DL HARQ-ACK information, with or without SR, in the PUCCH. If the UE would transmit multiple PUCCHs in a slot that include DL HARQ-ACK information and CSI report(s), the UE expects to be provided a same configuration for *simultaneousHARQ-ACK-CSI* each of PUCCH formats 2, 3, and 4.

If a UE would multiplex CSI reports that include Part 2 CSI reports in a PUCCH resource, the UE determines the PUCCH resource and a number of PRBs for the PUCCH resource assuming that each of the CSI reports indicates rank 1.

#### < Unchanged parts are omitted >