**3GPP TSG RAN WG1 #107-e R1-211xxxx**

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

**Agenda item:** 7.1

**Source:** Moderator **(**Qualcomm Incorporated)

**Title:** Summary of [107-e-NR-7.1CRs-12] discussion on RI bitwidth and UCI mapping for non-PMI CSI feedback

**Document for:** Discussion/Decision

# Introduction

Non-PMI CSI feedback was introduced (with report quantity set to “cri-ri-cqi”) to NR since Rel-15. In non-PMI CSI feedback, CRI, RI, LI and CQI are reported, but their bit-width and mapping order are not clearly defined in 212 spec. This tdoc is used to collect companies’ views for email thread [107-e-NR-7.1CRs-19].

# Issue 1: bit-width of UCI components for non-PMI CSF

In current TS38.212 spec (sec 6.3.1.1.2 and 6.3.2.1.2), the bitwidth for UCI components are defined for each codebook, none of the table from 6.3.1.1.2-1 to 6.3.1.1.2-6 are defined for non-PMI based CSI feedback. In non-PMI based CSI feedback, UE should report CRI, RI, LI and CQI, and the maximum allowable rank could be upto 8. With that, one can see that the UCI components of non-PMI CSI is similar to that of Type I CSI part 1, and it is straightforward to reuse the bit-width defined in table 6.3.1.1.2-3.

For the bitwidth of RI, it is widely used in all codebook type that the bitwidth is dependent on the number of allowable rank, but this may not feasible for non-PMI based CSI because the allowable rank, provided by the higher layer parameter *PortIndexFor8Ranks*, is CSI-RS resource specific. To solve this issue, we think there are two ways

* Alt1: the bitwidth of RI is dependent on the total number of different allowable rank across all the resources associated to the non-PMI based CSI report config. And the codepoints are mapped to the allowable ranks across all resources in increasing order where codepoint 0 is mapped to the smallest allowable rank across all resources.
* Alt2: the bitwidth of RI is always 3-bit (regardless of the higher layer parameter *non-PMI-PortIndication*) assuming smallest rank is rank-1 and largest rank is rank-8. And the codepoints are mapped to the allowable rank in increasing order. UE only report the valid codepoints of the selected CSI-RS resource

A concrete example is provided in R1-2112190. Alt1 is proposed in R1-2112190.

**Moderator proposal 1: For Rel-15 non-PMI CSI feedback,**

* **Clarify the bitwidth of UCI components CRI, RI, LI and CQI using table 6.3.1.1.2.3 of TS38.212 by revising the table title to accommodate non-PMI CSI.**
* **For RI reporting, its bitwidth is dependent on the total number of different allowable rank across all the resources associated to the non-PMI based CSI report config. And the codepoints are mapped to the allowable rank in increasing order with 0 mapped to the smallest rank across all resources.**

**Following spec change can be considered for TS38.212 spec:**

### 6.3.1.1.2 CSI only

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The bitwidth for RI/LI/CQI/CRI of *codebookType=typeI-SinglePanel* and *reportQuantity* set to 'cri-RI-CQI' is provided in Tables 6.3.1.1.2-3.

Table 6.3.1.1.2-3: RI, LI, CQI, and CRI of *codebookType=typeI-SinglePanel*, or *reportQuantity* set to 'cri-RI-CQI'

|  |  |
| --- | --- |
| **Field** | **Bitwidth** |
| **1 antenna port** | **2 antenna ports** | **4 antenna ports** | **>4 antenna ports** |
| **Rank1~4** | **Rank5~8** |
| Rank Indicator | 0 |  |  |  |  |
| Layer Indicator | 0 |  |  |  |  |
| Wide-band CQI for the first TB | 4 | 4 | 4 | 4 | 4 |
| Wideband CQI for the second TB | 0 | 0 | 0 | 0 | 4 |
| Subband differential CQI for the first TB | 2 | 2 | 2 | 2 | 2 |
| Subband differential CQI for the second TB | 0 | 0 | 0 | 0 | 2 |
| CRI |  |  |  |  |  |

For *codebookType=typeI-SinglePanel,*  in Table 6.3.1.1.2-3 is the number of allowed rank indicator values according to Clause 5.2.2.2.1 [6, TS 38.214]. For higher layer parameter *reportQuantity* set to 'cri-RI-CQI',  in Table 6.3.1.1.2-3 is the number of different allowable rank indicator values according to Clause 5.2.1.4.2 [6, TS 38.214] across all CSI-RS resources associated to the CSI reporting setting.  is the value of the rank. The value of  is the number of CSI-RS resources in the corresponding resource set. The values of the rank indicator field are mapped to allowed rank indicator values with increasing order, where '0' is mapped to the smallest allowed rank indicator value.

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**Companies are invited to provide views on moderator proposal 1. Please comment on 1) whether the bitwith of UCI components can be clarified using the table of Type I SP or using a separate table, 2) whether Alt1 or Alt2 is preferred for RI bitwidth, and 3) any suggestion on the TP.**

|  |  |
| --- | --- |
| Company | Comments |
| Qualcomm | 1. Ok with using table 6.3.1.1.2-3 by revising the title. Otherwise, if a new table is defined, more changes are needed in solving issue 2.
2. For RI, both Alt1 and Alt2 are fine, can live with majority view.
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# Issue 2: UCI mapping order and PMI format

Apart from UCI bitwidth, UCI mapping order for non-PMI based CSI reporting is also missing in current TS38.212 spec. One issue with UCI mapping table Table 6.3.1.1.2-7, Table 6.3.1.1.2-9 to Table 6.3.1.1.2-11 and Table 6.3.2.1.2-3 to 6.3.2.1.2-5 is that they are related to pmi-FormatIndicator. However, this would cause ambiguity for non-PMI CSI reporting as there is no PMI components and the granularity is purely dependent on cqi-FormatIndicator. To solve this issue, following proposal is proposed by the moderator

**Moderator proposal 2: Clarify that UE is not expected to be configured with pmi-FormatIndicator for non-PMI based CSI feedback.**

**Following text proposal can be considered for TS38.214 spec:**

### 5.2.1.4 Reporting configurations

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- wideband PMI or subband PMI reporting as configured by the higher layer parameter *pmi-FormatIndicator*. When wideband PMI reporting is configured, a wideband PMI is reported for the entire CSI reporting band. When subband PMI reporting is configured, except with 2 antenna ports, a single wideband indication (*i1* in Clause 5.2.2.2) is reported for the entire CSI reporting band and one subband indication (*i2* in clause 5.2.2.2) is reported for each subband in the CSI reporting band. When subband PMIs are configured with 2 antenna ports, a PMI is reported for each subband in the CSI reporting band.

- a UE is not expected to be configured with *pmi-FormatIndicator* if reportQuantity set to ‘cri-ri-cqi'.

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**Companies are invited to provide views moderator proposal 2, whether the spec change is needed.**

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| --- | --- |
| Company | Comments |
| Qualcomm | We prefer to change the spec or at least a conclusion, configuring pmi-FormatIndicator for non-PMI based CSI does not make sense.Besides, in some UCI mapping order tables, it is specified that PMI X1 or X2 is included if pmi-FormatIndicator=wideband or subband. This may cause ambiguity if pmi-FormatIndicator is configured for non-PMI based CSI reporting. |

**Moderator proposal 3: For UCI mapping order of non-PMI feedback,**

* **For CSI on PUCCH and wideband CQI (single part UCI), UCI mapping Table 6.3.1.1.2.7 also applies to non-PMI based CSI feedback. Spec change is needed to revise the table title so as to accommodate non-PMI based CSI reporting.**
* **For CSI on PUCCH and subband CQI (two-part UCI), Table 6.3.1.1.2-9 to Table 6.3.1.1.2-11** **apply to non-PMI based CSI feedback. No spec change is needed.**
* **For CSI on PUSCH (two-part UCI), Table 6.3.2.1.2-3 to 6.3.2.1.2-5 apply to non-PMI based CSI feedback. No spec change is needed.**

**Following text proposal can be considered for TS38.212 spec**

### 6.3.1.1.2 CSI only

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Table 6.3.1.1.2-7: Mapping order of CSI fields of one CSI report, *pmi-FormatIndicator=widebandPMI* and *cqi-FormatIndicator=widebandCQI, or reportQuantity* set to 'cri-RI-CQI' and *cqi-FormatIndicator=widebandCQI*

|  |  |
| --- | --- |
| CSI report number | CSI fields |
| CSI report #n | CRI as in Tables 6.3.1.1.2-3/4, if reported |
| Rank Indicator as in Tables 6.3.1.1.2-3/4, if reported |
| Layer Indicator as in Tables 6.3.1.1.2-3/4, if reported |
| Zero padding bits , if needed |
| PMI wideband information fields , from left to right as in Tables 6.3.1.1.2-1/2, if reported |
| PMI wideband information fields , from left to right as in Tables 6.3.1.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if reported |
| Wideband CQI for the first TB as in Tables 6.3.1.1.2-3/4, if reported  |
| Wideband CQI for the second TB as in Tables 6.3.1.1.2-3/4, if reported |

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**Companies are invited to provide views moderator proposal 3, whether the moderator assessment is correct and any suggestion of spec change.**

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| Company | Comments |
| Qualcomm | We support the proposal. |

# Conclusion

TBD