**3GPP TSG RAN WG1 #106-e R1-21abcde**

**e-Meeting, August 16th – August 27th, 2021**

**Agenda item:** 7.1

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

**Title:** Summary of [106-e-NR-7.1CRs-08]

**Document for:** Discussion/Decision

# Introduction

In Rel-15 Type II CSI, a precoding matrix on a subband is obtained as linear combination of 2L spatial beams. Each linear combination coefficients are quantized by wideband amplitude (i.e., $i\_{1,4,l}$), subband amplitude (i.e., $i\_{2,2,l}$) and subband phase (i.e., $i\_{2,1,l}$). The wideband amplitudes are reported following the order of beam index, while the reporting order of subband amplitude/phase is unclear in current spec. In this contribution, we discuss possible understandings of the reporting order and propose potential text change.

# Discussion (Round 1)

In Rel-15 Type II CSI, a precoding matrix on a subband is obtained as linear combination of 2L spatial beams. Each linear combination coefficients are quantized by wideband amplitude (i.e., $i\_{1,4,l}$), subband amplitude (i.e., $i\_{2,2,l}$) and subband phase (i.e., $i\_{2,1,l}$). For wideband amplitude, though not explicitly written in the spec, it seems that the only possible reporting order is following the beam indices. That is, the elements of $i\_{1,4,l}=\left[k\_{l,0}^{(1)},k\_{l,1}^{(1)},\cdots ,k\_{l,2L-1}^{(1)}\right]$ are applied to the 1st, 2nd, …, the (2L-1)-th beam, respectively, where the beam indices are in increasing order. However, for subband amplitude and subband phase, there are two possible understandings.

* Alt1: the elements of $i\_{2,2,l}=\left[k\_{l,0}^{(2)},k\_{l,1}^{(2)},\cdots ,k\_{l,2L-1}^{(2)}\right]$ and $i\_{2,1,l}=\left[c\_{l,0},c\_{l,1},\cdots ,c\_{l,2L-1}\right]$ are mapped following the same order as $i\_{1,4,l}$ (i.e., based on beam indices).
* Alt2: the elements of $i\_{2,2,l}=\left[k\_{l,0}^{(2)},k\_{l,1}^{(2)},\cdots ,k\_{l,2L-1}^{(2)}\right]$ and $i\_{2,1,l}=\left[c\_{l,0},c\_{l,1},\cdots ,c\_{l,2L-1}\right]$ are mapped based on the beam strength, i.e., the value reported in wideband amplitude indicator $i\_{1,4,l}$.

Detailed analysis can be found in R1-2107314**.**

**Companies please provide views on coefficient mapping order, either Alt1 or Alt2.**

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| Company | Comments |
| Qualcomm | Slightly prefer Alt1, can go with majority view.  |
| ZTE | We support Alt 1, and we cannot agree on Alt 2. We think Alt 1 is the natural way to go given the description of these two vectors ($i\_{2,2,l}$ and $i\_{2,1,l}$) in the current specification. Hence we are okay to clarify this. However, there is no clue in the current specification that implies Alt 2. Alt 2 shall be considered as NBC. |
| LG | Support Alt1. We agree with ZTE’s comment that Alt2 can be considered as NBC. |
| vivo | Support Alt1.  |
| OPPO  | Support Alt1. |
| Intel | Support Alt1. We agree with ZTE’s comment. |
| Nokia/NSB | Support Alt1. Agree with ZTE’s comment. In the spec description, the same beam index $i$ is used for the three vector components - WB amplitudes ($k\_{l,i}^{(1)}$ in the indicator $i\_{1,4,l}$), SB amplitudes ($k\_{l,i}^{(2)}$ in the indicator $i\_{2,2,l}$) and SB phase ($c\_{l,i}$ in the indicator $i\_{2,1,l}$) - to identify those SB amplitudes and phases that are not reported. No remapping is specified for the beam index of $k\_{l,i}^{(2)}$ and $c\_{l,i}$ with respect to that of $k\_{l,i}^{(1)}$ for the SB amplitudes and phases that are reported. Hence, the implied order of beam index for the reported SB coefficients should be the same as that of the WB amplitudes, unless stated otherwise. |
| Samsung | We support Alt1. We second the comments given by ZTE and Nokia/NSB. Additionally, Alt2 seems problematic when the WB amplitude coefficients are the same. In this case, an additional rule (possibly ordering with beam indices) may be required. Alt1 is a clean and natural solution.  |
| Fraunhofer IIS/HHI | Support Alt1. There was no mention of the coefficient ordering based on the WB amplitude strength in the specification.  |
| Ericsson | Support Alt.1 |
| Apple | Support Alt1 |

# Text proposal (round 2, to be decided after round 1)

**In R1-2107314, following text proposal is provided for Alt1 and Alt2.**

**Following spec change is proposed if following beam index:**

### 5.2.3 CSI reporting on PUSCH

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For Type I and Type II CSI feedback on PUSCH, a CSI report comprises of two parts. Part 1 has a fixed payload size and is used to identify the number of information bits in Part 2. Part 1 shall be transmitted in its entirety before Part 2.

- For Type I CSI feedback, Part 1 contains RI (if reported), CRI (if reported), CQI for the first codeword (if reported). Part 2 contains PMI (if reported) and contains the CQI for the second codeword (if reported) when RI (if reported) is larger than 4.

- For Type II CSI feedback, Part 1 contains RI (if reported), CQI, and an indication of the number of non-zero wideband amplitude coefficients per layer for the Type II CSI (see clause 5.2.2). The fields of Part 1 – RI (if reported), CQI, and the indication of the number of non-zero wideband amplitude coefficients for each layer – are separately encoded. Part 2 contains the PMI of the Type II CSI. The elements of $i\_{1,4,l}$, $i\_{2,1,l}$ and $i\_{2,2,l}$ are reported in the increasing order of their indices, where the lowest index is mapped to the most significant bits and the last index to be reported is mapped to the least significant bits. Part 1 and 2 are separately encoded.

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**Following spec change is proposed if following beam strength reported in wideband amplitude:**

### 5.2.3 CSI reporting on PUSCH

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For Type I and Type II CSI feedback on PUSCH, a CSI report comprises of two parts. Part 1 has a fixed payload size and is used to identify the number of information bits in Part 2. Part 1 shall be transmitted in its entirety before Part 2.

- For Type I CSI feedback, Part 1 contains RI (if reported), CRI (if reported), CQI for the first codeword (if reported). Part 2 contains PMI (if reported) and contains the CQI for the second codeword (if reported) when RI (if reported) is larger than 4.

- For Type II CSI feedback, Part 1 contains RI (if reported), CQI, and an indication of the number of non-zero wideband amplitude coefficients per layer for the Type II CSI (see clause 5.2.2). The fields of Part 1 – RI (if reported), CQI, and the indication of the number of non-zero wideband amplitude coefficients for each layer – are separately encoded. Part 2 contains the PMI of the Type II CSI. The elements of $i\_{2,1,l}$ and $i\_{2,2,l}$ are reported in the decreasing order of their wideband amplitude reported in $i\_{1,4,l}$, where the element with strongest wideband amplitude is mapped to the most significant bits and the element with weakest wideband ampltidue to be reported is mapped to the least significant bits. Part 1 and 2 are separately encoded.

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**Companies please provide comments on the proposed spec change**

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| Company | Comments |
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# Conclusion

TBD