**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., ), subband amplitude (i.e., ) and subband phase (i.e., ). 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., ), subband amplitude (i.e., ) and subband phase (i.e., ). 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 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 and are mapped following the same order as (i.e., based on beam indices).
* Alt2: the elements of and are mapped based on the beam strength, i.e., the value reported in wideband amplitude indicator .

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 ( and ) 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 is used for the three vector components - WB amplitudes ( in the indicator ), SB amplitudes ( in the indicator ) and SB phase ( in the indicator ) - to identify those SB amplitudes and phases that are not reported. No remapping is specified for the beam index of and with respect to that of 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 |
| CATT | Support Alt1. |
| Huawei | We support Alt 1. Alt 2 is not preferred. In our reading, referred specification seem not implying a new order of arranging SB amplitude and phase, but only for further clarification about what are reported or omitted due to specific design. Therefore Alt 2 is considered as NBC in our understanding. We are open to clarify specification with Alt 1, if it can be helpful for UE vendors.  |

# Text proposal (Round 2)

**Based on companies’ views in the 1st round discussion, there is clear majority view on supporting Alt1. Based on that, moderator proposed the following text proposal for change of TS38.214.**

### 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 , and 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.

>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>> unchanged text omitted <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

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

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| Company | Comments |
| ZTE | We are fine with the proposed text change. However, we think the cover page for the draft CR needs revision in “reason for change”. We don’t need to list the two alternatives. It is clear no companies think the current spec can be interpreted as Alt 2. We can simply say that the reason for change is there is no clear description in the current specification on the mapping order of the subband parameters, which may cause ambiguity or even misalignment between UE and gNB. |
| vivo | It seems that all companies’s are aligned on the understanding. Do we need a CR for this? A conclusion might be enough. |
| Nokia | Thanks for the updated CR proposal. May I suggest removing the second part of the added text? I don’t think that is necessary and may be slightly confusing (the element of lowest index is mapped.. rather than the lowest index of the element, and it may be unclear what bit sequence length “least and most significant bits” refer to). I also suggest adding the two brackets because is not reported for WB reporting and is not reported for WB reporting and SB reporting w/o SB amplitudes. -  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 , (if reported) and (if reported) are mapped in increasing order of their index . Part 1 and 2 are separately encoded. |
| CATT | Thanks for the efforts. We prefer to have a CR.                Is there a special reason to have the words ‘to be reported’ which is highlighted below? If not, we suggest to remove these words.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 , and are reported in the increasing order of their indices, where the lowest index is mapped to the most significant bits and the highest index of an element to be reported is mapped to the least significant bits. Part 1 and 2 are separately encoded.  |
| OPPO | We also prefer to have a CR to make the specification clearer. |
| Mod (Qualcomm) | Thanks for the good comments.@CATT, I am fine with your revision of deleting “to be reported”@Nokia, I slightly prefer adding the bit sequence mapping order. Otherwise, there might be further ambiguity: whether the lowest index element is mapped to LSB or MSB? E.g., i14 = [1,2,3] = [01,10,11]b = [011011] = 27d or [111001] = 57d (reverse)? But I agree with you that the wording is better to be polished, it should be “the elements of lowest/highest index”, rather than “lowest/highest index of the elements”. Besides, the “least and most significant bits” is trying to clarify the bit sequence order, it seems that the bitwidth of each element does not matter. So, we propose the following revision, hope it can address your concern.The elements of , (if reported) and (if reported) are reported in the increasing order of their indices, , where the element of the lowest index is mapped to the most significant bits and ~~the highest index of an element~~ the element of the highest index ~~to be reported~~ is mapped to the least significant bits. |
| Samsung | We support the merged proposal. It is clear the “lowest/highest indices” are among the reported elements as subsets of the 2L elements are reported. We are fine with the deletion of the words “to be reported”. |
| Nokia2 | Thanks for updating the text proposal, that looks fine. |
| LGE | Thanks for your hard work.We are fine with latest CR below. |

# Conclusion

Based on the discussion in Round 1 and Round 2, following text proposal was recommended to Chaiman:

-  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 , (if reported) and (if reported) are reported in the increasing order of their indices, , where the element of the lowest index is mapped to the most significant bits and the element of the highest index is mapped to the least significant bits. Part 1 and 2 are separately encoded.