**3GPP TSG RAN WG1 #110 R1-220XXXX**

**Toulouse, France, August 22nd – 26th, 2022**

**Agenda item:** 7.2.6

**Source:** CATT

**Title:** Summary for R1-2206372 on LI reporting for Rel.16 Enhanced Type II CSI feedback

**Document for:** Discussion and Decision

1. Introduction

This document collects company views on a Rel.16 CR in RAN1#110 to clarify the LI reporting for Enhanced Type II CSI feedback when *reportQuantity* in *CSI-ReportConfig* contains LI parameter.

1. Summary for change

The issue is summarized in the following table:

**Table 1 Summary**

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| **The reason for CR proposal** | **Consequences if not approved** | **Summary of CR proposal** |
| In current TS 38.214, the UE shall calculate and report LI when *reportQuantity* in *CSI-ReportConfig* contains LI parameter, for all the codebook types. It is not captured in the CSI Part 2 reporting for Enhanced Type II CSI feedback in the spec. | It is unclear how to report LI when *reportQuantity* contains LI for Enhanced Type II CSI feedback. | Clarify 212 and 214 specs that CSI Part 2 for Enhanced Type II CSI feedback can contain LI if *reportQuantity* in *CSI-ReportConfig* contains LI parameter.  The following two alternatives can be down-selected,  **Alt 1:** **clarify UE is not expected to be configured with LI reporting in for 214 spec**  Section 5.2.1.4.2 in 38.214 spec: (The following change is not in the original CR. It is proposed based on company comments.)  If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI', ' cri-RI-i1', 'cri-RI-i1-CQI', 'cri-RI-CQI' or 'cri-RI-LI-PMI-CQI', then the UE is not expected to be configured with more than 8 CSI-RS resources in a CSI-RS resource set contained within a resource setting that is linked to the *CSI-ReportConfig*.  If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-LI-PMI-CQI', UE is not expected that *CSI-ReportConfig,* to be configured with higher layer parameter *codebookType* set to '*typeII-r16*' or '*typeII-PortSelection-r16*'  If the UE is configured with a *CSI-ReportConfig* with higher layer parameter *reportQuantity* set to 'cri-RSRP', 'cri-SINR' or 'none' and the *CSI-ReportConfig* is linked to a resource setting configured with the higher layer parameter *resourceType* set to 'aperiodic', then the UE is not expected to be configured with more than 16 CSI-RS resources in a CSI-RS resource set contained within the resource setting.  **Alt 2: clarify the LI reporting in 212 and 214 specs if reportQuantity in CSI-ReportConfig contains LI parameter**  Section 5.2.3 in 38.214 spec:  - For Enhanced Type II CSI feedback, Part 1 contains RI (if reported), CQI, and an indication of the overall number of non-zero amplitude coefficients across layers for the Enhanced Type II CSI (see Clause 5.2.2.2.5). The fields of Part 1 – RI (if reported), CQI, and the indication of the overall number of non-zero amplitude coefficients across layers – are separately encoded. Part 2 contains the PMI and LI (if reported) of the Enhanced Type II CSI. Part 1 and 2 are separately encoded.  <Unrelated part omitted>  - For Enhanced Type II reports, for a given CSI report , each reported element of indices and , indexed by and , is associated with a priority value , with with , , and , and where is defined in Clause 5.2.2.2.5. The element with the highest priority has the lowest associated value . Omission of Part 2 CSI is according to the priority order shown in Table 5.2.3-1, where  - Group 0 includes indices LI (if reported), (if reported), (if reported) and ().  Section 6.3.2.1.2 in 38.212 spec: (The following change is not in the original CR. It is proposed based on company comments.)  Table 6.3.2.1.2-5A: Mapping order of CSI fields of one CSI report, CSI part 2 of *codebookType=typeII-r16 or typeII-PortSelection-r16*   |  |  | | --- | --- | | CSI report number | CSI fields | | CSI report #n  CSI part 2, group 0 | Layer Indicator as in Table 6.3.2.1.2-8, if reported | | PMI fields , from left to right as in Tables 6.3.2.1.2-1A/2A, if reported | | CSI report #n  CSI part 2, group 1 | The following PMI fields , from left to right, as in Tables 6.3.2.1.2-1A/2A:, , and highest priority bits of  highest priority bits of and highest priority bits of, in decreasing order of priority based on function defined in clause 5.2.3 of TS38.214, if reported | | CSI report #n  CSI part 2, group 2 | The following PMI fields , from left to right, as in Tables 6.3.2.1.2-1A/2A lowest priority bits of lowest priority bits of and lowest priority bits of , in decreasing order of priority based on function defined in clause 5.2.3 of TS38.214, if reported |   <Unrelated part omitted>  Table 6.3.2.1.2-8: RI ,LI and CQI of *codebookType=typeII-r16 or typeII-PortSelection-r16*   |  |  | | --- | --- | | Field | Bitwidth | | Rank Indicator |  | | Layer Indicator |  | | Wide-band CQI | 4 | | Subband differential CQI | 2 | | Indicator of the total number of non-zero coefficients summed across all layers | if max allowed rank is 1;  otherwise |   where is the number of allowed rank indicator values according to Clauses 5.2.2.2.5 and 5.2.2.2.6 [6, TS 38.214], is the value of the rank. , where , , , and are given by Clause 5.2.2.2.5 and 5.2.2.2.6 in [6, TS 38.214]. 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. The values of the indicator field are mapped to the allowed values of , according to Clauses 5.2.2.2.5 and 5.2.2.2.6 [6, TS 38.214], with increasing order, where '0' is mapped to . |

1. Company views

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| **Company** | **Input** |
| CATT0 | **According to the FL’s assessment, this CR proposal can be treated as an editorial change.**  **Please share your views on this CR.** |
| Qualcomm | Not support. This is late change for R16 eT2 CSI feedback. Lots of IODT work have been done, and no issue is reported. This means that there might exist UEs implementing following current spec (i.e., no LI reporting for eT2 even if LI is configured in report quantity). So, accepting this change has NBC risk which affect existing UEs. Besides, 212 spec has no table for LI reporting in eT2 as well. |
| Lenovo | Although the editorial change seems fine, we understand QC’s concerns regarding NBC. Current 212 spec does not contain LI field in mapping order of CSI fields tables corresponding to eType-II and eType-II PS codebook, and hence this editorial change may require much more modifications than what appears. Further discussion is needed |
| CATT1 | We can understand the concern from QC. However, in current specs, there is no restriction on LI configuration for Rel-16 eType II. If LI is configured, according current specs, LI should be reported. But it is unclear how to report LI when *reportQuantity* contains LI. We are open to discuss the following two solutions.  •        Add the restriction on LI for Rel-16 eType II. If Rel-16 eType II codebook is configured by RRC parameter, the LI is not expected to be configured in *reportQuantity*.  •        Add the LI reporting in 214 spec and LI field in 212 tables. If *reportQuantity* contains LI for Rel-16 eType II codebook, the LI should be reported in Part 2 of CSI field. |
| Nokia/NSB | Agree with QC. LI is a wideband indicator which is mapped in the wideband part of a CSI, either Part 1 for wideband reporting on PUCCH, or Part 2-wideband for subband reporting on PUCCH/PUSCH. For R16-Type-II CBs, there is no wideband part of a CSI, so if we introduced this change, we would also need to decide which of the three priority groups LI maps to and update the tables in 212 accordingly |
| Apple | CATT raised a good issue. However, we prefer to clarify that L1 cannot be configured as part of reportQuantity, i.e., NW configures “cri-RI-PMI-CQI” instead of “cri-RI-LI-PMI-CQI” for eType II codebook. |
| CATT2 | @QC@Lenovo@Nokia: Thanks for the clarification. According to the current 212 specs, indeed, there is currently no relevant bitwidth and mapping order on LI reporting for Rel.16 eType II. Since LI is the wideband reporting quantity similar as PMI fields , the same mapping order as PMI fields can be considered, which is similar as wideband Part 2 for Rel.15 Type II. Hence, the following change for mapping order and bitwidth for Rel.16 eType II can be considered.  Table 6.3.2.1.2-5A: Mapping order of CSI fields of one CSI report, CSI part 2 of *codebookType=typeII-r16 or typeII-PortSelection-r16*   |  |  | | --- | --- | | CSI report number | CSI fields | | CSI report #n  CSI part 2, group 0 | Layer Indicator as in Table 6.3.2.1.2-8, if reported | | PMI fields , from left to right as in Tables 6.3.2.1.2-1A/2A, if reported | | CSI report #n  CSI part 2, group 1 | The following PMI fields , from left to right, as in Tables 6.3.2.1.2-1A/2A:, , and highest priority bits of  highest priority bits of and highest priority bits of, in decreasing order of priority based on function defined in clause 5.2.3 of TS38.214, if reported | | CSI report #n  CSI part 2, group 2 | The following PMI fields , from left to right, as in Tables 6.3.2.1.2-1A/2A lowest priority bits of lowest priority bits of and lowest priority bits of , in decreasing order of priority based on function defined in clause 5.2.3 of TS38.214, if reported |   Table 6.3.2.1.2-8: RI ,LI and CQI of *codebookType=typeII-r16 or typeII-PortSelection-r16*   |  |  | | --- | --- | | Field | Bitwidth | | Rank Indicator |  | | Layer Indicator |  | | Wide-band CQI | 4 | | Subband differential CQI | 2 | | Indicator of the total number of non-zero coefficients summed across all layers | if max allowed rank is 1;  otherwise |   @Apple: Thanks for provide your preference for this issue. If I understand correctly, your preference is similar as our first solution, (e.g. if Rel-16 eType II codebook is configured by RRC parameter, the LI is not expected to be configured in *reportQuantity*). We are fine to discuss the detail changes for this solution.  Other company’s input on the following issues is appreciated. Thank you. |
| Qualcomm2 | Based on the discussion in first round, there seems two alternatives   * Alt1: clarify UE is not expected to be configured with LI reporting for eT2 * Alt2: clarify the LI reporting in 212 and 214 specs when necessary   In our view, since it is quite late change for R16, the most import factor is to minimize the NBC risk. From this aspect, to address ambiguity, RAN1 should **adopt the most common and reasonable implementation** that could have been implemented in UE and gNB. Thus, we think Alt1 is safer than Alt2 and a conclusion maybe sufficient. However, we can be flexible if majority think Alt2 is the most common and reasonable implementation.  Besides, for Alt2, we should also add description for v under the table, and also change relevant text of group0 component in 214 spec. |
| LG | Agree to QC’s comment and prefer Alt1 on above in terms of minimizing NBC issue. |
| CATT3 | @QC: Please check our views for these alternatives.  Alt 1 is more simple solution for inconsistency between LI configuration and reporting for less NBC issue. However, LI is helpful for determination of both PTRS and PDCCH, which is effective especially for MU-MIMO. And LI can be reported in CSI group 0 without the change of priority order across groups for less specs impact. In addition, LI reporting is supported for Rel.15 Type II that also contains subband and wideband reporting. Hence, Alt 2 is preferred but we are open to discuss both alternatives.  Besides, based the current report quantity configurations in 214, the codebook that UE expects has been specified and restricted when UE is configured with different report quantities. Hence, some specs changes and restrictions in 214 are preferred instead of one conclusion. I update relevant changes according to two alternatives and your supplementary changes. Thank you.  @All: I added **two alternatives and relevant changes** in Table I above. Please provide your views for these two alternatives and relevant specs changes. |
| Lenovo | OK to rephrase to Qualcomm’s wording with two alternatives. Agree with Apple, Nokia, QC and LG on Alt1: UE is not expected to be configured with LI reporting for eType-II codebook |
| Intel | According to the TS 38.214 and Tables 6.3.2.1.2-1A/2A for TS38.212 LI reporting is not supported for eType II in the current spec. As some other companies commented addition of LI reporting is considered as NBC change, so our preference is Alt 1in Table 1 above. |
| Xiaomi | Before giving which alternative is selected, we should discuss whether needs to report LI for eType II. In TS38.214, the function of LI is described as follows:  *The LI indicates which column of the precoder matrix of the reported PMI corresponds to the strongest layer of the codeword corresponding to the largest reported wideband CQI. If two wideband CQIs are reported and have equal value, the LI corresponds to strongest layer of the first codeword. If the UE is configured with a CSI-ReportConfig with reportQuantity set to 'cri-RI-LI-PMI-CQI' and the corresponding NZP-CSI-RS-ResourceSet for channel measurement is configured with two Resource Groups and Resource Pairs, and the UE reports a CRI associated to a Resource Pair, and a rank combination , the first LI indicates which column of the precoder matrix of the first reported PMI corresponds to the strongest of the first layers of the codeword and the second LI indicates which column of the precoder matrix of the second reported PMI corresponds to the strongest of the last layers of the codeword.*  It seems that LI is necessary to report when there are more than one CQI. For Type II codebook, up to rank=4 is supported and only one wideband CQI is reported. From this perspective, LI is not necessary to report for all Type II codebook, e.g., Rel-15 Type II codebook, Rel-16 Type II, or even Rel-17 Type II port selection codebook. Hence, when ‘*cri-RI-LI-PMI-CQI*’ is configured, we can support that UE is not expected to be configured with LI reporting for Type II, eType II or FeType II port selection codebook to clarify UE behavior. Considering that LI has been supported to report for Rel-15 Type II codebook in current specification, we are fine that the LI can still be reported for Rel-15 Type II codebook if necessary when ‘*cri-RI-LI-PMI-CQI*’ is configured. |

# References

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| 1 | [**R1-2206372**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110/Docs/R1-2206372.zip) | Clarification of LI reporting for Enhanced Type II CSI feedback | CATT |
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