**3GPP TSG RAN WG1 Meeting #108-e R1-220xxxx**

**e-Meeting, February 21 – March 3, 2022**

**Agenda Item: 8.1.4**

**Source: (Moderator) Huawei, HiSilicon**

**Title: Summary of CSI enhancements for MTRP and FDD (Round 0)**

**Document for: Discussion and Decision**

# Introduction

Enhancement on CSI measurement and reporting:

* Evaluate and, if needed, specify CSI reporting for DL multi-TRP and/or multi-panel transmission to enable more dynamic channel/interference hypotheses for NCJT, targeting both FR1 and FR2
* Evaluate and, if needed, specify Type II port selection codebook enhancement (based on Rel.15/16 Type II port selection) where information related to angle(s) and delay(s) are estimated at the gNB based on SRS by utilizing DL/UL reciprocity of angle and delay, and the remaining DL CSI is reported by the UE, mainly targeting FDD FR1 to achieve better trade-off among UE complexity, performance and reporting overhead

For Rel-17 CSI enhancement in RAN1 108-e, proposals are roughly classified as one of three categories to facilitate RAN1 meeting schedule and efficient RAN1 decisions:

* **Proposals of Further Enhancement:** some proposals need RAN1 high-level agreements/common understanding firstly before discussing associated TP draft. It is targeted to make a RAN1 decision during Week 1, to see any agreement can be made by Email (or GTW for exceptional cases). If does, we will translate the agreement into agreeable TP in Week 2 at least, i.e. there is no follow-up email discussion after March 3.
* **Text Proposals of Correction:** sometext proposals need RAN1 discussion firstly during Round 0, to see whether specification corrections are needed, like normal Rel-15/16 CR preparation phase. Companies are encouraged to share your views, and suggested changes if need in your view. We will consolidate CR draft and RAN1 comments in an agreeable TP during Week 1.
* **Text Proposals of Editorial Changes:** some text proposals might be obvious editorial changes, up to FL understanding, assuming that they are agreeable or straightforward at least. If not, they will be moved up for further RAN1 discussion. We will combine all editorial changes during Week 1.

# Summary of CSI enhancement for FDD

## Proposals of Further Enhancement

Companies have suggested further enhancements to address some issues of Rel-17 Port Selection Codebook enhancement and are summarized as following.

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| **Company** | **View** |
| **Lenovo** | **Proposal 1:** The parameter paramCombination-r17 configures the supported parameter combination values of the parameters (α, Mv, β, R) |
| **Samsung** | **Proposal 2:** support Rel.17 codebook for BWP size < 24 PRBs with the current restriction in the specification, i.e. support only WB CSI implying M=1  **Proposal 3:** Regarding Rel.17 codebook parameters,   * + support   + allowed rank (via RI-restriction-r17) can’t be 3 or 4 when (i.e., paramCombination-r17=5) and |
| **Vivo** | **Proposal 4:** UE reports the combinatorial coefficients of non-selected beams when the number of selected beams is larger than half of the number of candidate beams, e.g., when alpha = 3/4.  **Proposal 5:** UE can use partial CSI-RS ports to search target tap 0 to reduce the complexity.   * + gNB can map SD-FD bases to CSI-RS ports with a predetermined order or indicating the ports for timing calibration. |

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| Company | Comments |
| **Mod** | From Mod perspective, above five proposals might not be essential. However, it is up to RAN1 to balance spec complexity and necessity of changes. After Round 0 feedback, proposals with most supporting companies will be moved to next Round.  The target is to have an agreement of design (if we can agree) during Week 1 and then discuss associated TP during Week 2. |
| OPPO | Agree with the moderator |
| Nokia/NSB | Agree with the FL. We don’t think any of the proposal is essential  P1. This seems related to capability discussion. We don’t think it is needed  P2. This issue of small BWP was discussed in RAN1#106-e. None of the Rel15/16 Type II/eType II CBs is supported for BWP<24 and we don’t see the need to make an exception for Rel17 FeType II PS.  P3. Issue 1. The minimum number of ports configurable for all Rel15/16 Type II/eType II CBs is 4 and we don’t see a need to reduce this number to 2 for Rel17 FeType II PS.  Issue 2. We don’t think a hard restriction is needed. The gNB can always restrict the rank to 1 and 2 for some parameter combinations  P4. Unnecessary optimisation in our view, with high spec impact  P5. Unnecessary optimisation in our view, which can be addressed by UE implementation. |
| vivo | For P4, reporting the combinatorial coefficients of non-selected beams when the number of selected beams is larger than half of the number of candidate beams will surely alleviate UE’s complexity. Besides, we haven’t discussed this new case yet. In our view, an agreement is needed on how to report the combinatorial coefficients when the number of selected beams is larger than half of the number of candidate beams. |
| CATT | Agree with FL. We support to discuss proposal 2 in the next round. The other proposals are not essential in our view. |
| Samsung | Re P2, in R1-2202002, we provided the rationale behind the support of R17 CB for small BWPs. Only Type I codebook is currently supported for such BWPs. Supporting R17 CB can bring large (16% in avg UPT). Such gains can be beneficial for low cost UEs and more futuristic UEs. There is no technical reason behind restricting the support of R17 CB to BWP >= 24 PRBs.  Re P3   * issue 1: what is the technical reason for not supporting 2 port CSI-RS for R17 codebook? In our view, there is no extra work (efforts needed) in supporting this. Plus, it is a useful configuration for some UEs, e.g. those with small #channel clusters such as LOS UEs. * Issue 2: The current spec allows the following configurations for which UE behaviour is unclear since the UE can’t calculate rank 3 or 4 CSI.   + 4 CSI-RS ports, paraComb=5 (alpha=1/2), and RI-restriction allowing only rank 3   + 4 CSI-RS ports, paraComb=5 (alpha=1/2), and RI-restriction allowing only rank 4   + 4 CSI-RS ports, paraComb=5 (alpha=1/2), and RI-restriction allowing only rank 3 or 4 |

## Text Proposals of Correction

Some companies have proposed some specification corrections as following:

### TP 1: The wrong number of PMI in 38.214

* **Reasons of Change:**

When M=1 (Wf is OFF), implying Wf is an all-one vector, which means a single (WB) precoding matrix indicated by the PMI for all SBs for the entire CSI reporting band. However, according to the spec, N3 is defined as the total number of precoding matrices (based on the cyan text). If N3 >1, it can’t say “N3 precoding matrices” for M=1.

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| **Section 5.2.2.2.7**  Unchanged test is omitted  …  vectors, , , are identified by , where is defined as in clause 5.2.2.2.5, and where  with the indices assigned such that increases with . is indicated by the index , when and , where   * If , or and , is not reported. * If and , the nonzero offset between and is reported with assuming that (reference for the offset) is 0. The nonzero offset values are mapped to the index values of in increasing order with offset value 1 mapped to index value '0'.   **Section 5.2.2.2.5**  Unchanged test is omitted   * The parameter is configured with the higher-layer parameter numberOfPMI-SubbandsPerCQI-Subband. This parameter controls the total number of precoding matrices indicated by the PMI as a function of the number of configured subbands in csi-ReportingBand, the subband size configured by the higher-level parameter subbandSize and of the total number of PRBs in the bandwidth part according to Table 5.2.1.4-2, as follows:   Unchanged test is omitted |

* **Proposed TP (**as Proposal 6 from Samsung in R1-2202002)

When M=1, the description on needs to be corrected according to one of the following:

* Alt1: a single precoding matrix is indicated by the PMI
* Alt2: N3 precoding matrices indicated by the PMI, but they are the same when M=1

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| Company | Comments |
| **Mod** | It seems to me that there is certain terminology issue for N3 in case of M=1 in current specification. RAN1 may discuss whether there is any change required to address it, and if does, what your preferred changes are. |
| Nokia/NSB | We don’t think a correction is needed. The spec description is already consistent with Alt2: the fact that the N3 precoding matrices are the same for M=1 follows immediately from the precoder equation in Table 5.2.2.2.7-3 |
| CATT | Prefer Alt1. |
| Samsung | The text in 5.2.2.2.5 says “the total number of precoding matrices indicated by the PMI” which is not correct when M=1 since we have one precoding matrix (not multiple) in this case.  @Nokia/NSB: precoder equation unifies the codebook description for both M=1 and M=2. It is not obvious just by looking at the equation that the precoding matrices are the same when M=1. |

## Text Proposals of Editorial Changes

Some companies have proposed some text proposals to the spec, which mainly focus on editorial issues and are shown in the following.

### TP 2: The missing description of bitmap absence in CSI feedback in 38.214

* **Reasons of change:**

According to above the agreement, the bitmap(s) of indicating non-zero coefficients for corresponding layer(s) is not reported when . However, Group 1 and Group 2 of Part 2 for feType II port selection reports always include the bitmap for CSI omission in subsection 5.2.3 in TS 38.214. This makes UE’s behavior be unclear when the bitmap(s) is absent

* **Proposed TP (**Proposal 1 from CATT in R1-2201334)**:**

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| **Company** | **View** |
| **CATT** | 5.2.3 CSI reporting using PUSCH <unchanged text omitted>  When CSI reporting on PUSCH comprises two parts, the UE may omit a portion of the Part 2 CSI. Omission of Part 2 CSI is according to the priority order shown in Table 5.2.3-1, where  is the number of CSI reports configured to be carried on the PUSCH. Priority 0 is the highest priority and priority  is the lowest priority and the CSI report n corresponds to the CSI report with the nth smallest Prii,CSI(y,k,c,s) value among the  CSI reports as defined in Clause 5.2.5. The subbands for a given CSI report n indicated by the higher layer parameter csi-ReportingBand are numbered continuously in increasing order with the lowest subband of csi-ReportingBand as subband 0. When omitting Part 2 CSI information for a particular priority level, the UE shall omit all of the information at that priority level.  - …  - For Further Enhanced Type II Port Selection reports, for a given CSI report , each reported element of and , indexed by , and , is associated with a priority value , with , and . 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 (if reported), () and (if reported).  - Group 1 includes the highest priority elements of (if reported), , the highest priority elements of and the highest priority elements of ().  - Group 2 includes the lowest priority elements of (if reported), the lowest priority elements of and the lowest priority elements of (). |

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| Company | Comments |
| **Mod** | Above TP is editorial change. |
| OPPO | ok |
| Nokia/NSB | Ok |
| vivo | Support. |
| CATT | Ok with FL’s assessment. |
| Samsung | OK |

### TP 3: The missing description for the mapping order of in 38.212

* **Reasons of Change:**

It was agreed to clarify the mapping order of the for Rel-16 eType II codebook. Similarly, above clarification and associated CR shall be applied to Rel-17 FeTypeII PS codebook and avoid ambiguity between reported values and actual values.

* **Proposed TP** (Proposal 1 from HW and Hisilicon in R1-2200935**):**

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| **Company** | **View** |
| **Huawei, HiSilicon** | 6.3.2.1.2 CSI  -- Unchanged text is omitted---  The bitwidth for RI/CQI of codebookType= typeII-r16 or codebookType=typeII-PortSelection-r16 is provided in Table 6.3.2.1.2-8.  Table 6.3.2.1.2-8: RI and CQI of codebookType=typeII-r16 or typeII-PortSelection-r16   |  |  | | --- | --- | | Field | Bitwidth | | Rank 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],, 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 .  The bitwidth for RI/CQI of codebookType= codebookType=typeII-PortSelection-r17 is provided in Table 6.3.2.1.2-9.  Table 6.3.2.1.2-9: RI and CQI of codebookType=typeII-PortSelection-r17   |  |  | | --- | --- | | Field | Bitwidth | | Rank 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 5.2.2.2.7 [6, TS 38.214],, where , , and are given by Clause 5.2.2.2.7 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 5.2.2.2.7 [6, TS 38.214], with increasing order, where '0' is mapped to . |

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| Company | Comments |
| **Mod** | Above TP is editorial change. |
| OPPO | ok |
| Nokia/NSB | Ok (typo in the TP above: codebookType=typeII-PortSelection-r17) |
| vivo | OK with Nokia/NSB’s revision. |
| CATT | Ok with FL’s assessment. |
| Samsung | OK with Nokia’s version |

### TP 4: The missing citation/overall description for Part 1 CSI in 38.214

* **Reasons of change:**

The sentence providing overall descriptions of CSI fields in Part 1 for both codebooks in section 5.2.3 seems to be incomplete and may leads to a certain ambiguity and inconsistency for Part 1 CSI reporting fields of FeType II PS CSI

* **Proposed TP** (Proposal 2 from HW and Hisilicon in R1-2200935):

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| **Company** | **View** |
| **Huawei, HiSilicon** | 5.2.3 CSI reporting using PUSCH  -- Unchanged text is omitted---  For Type I, Type II, Enhanced Type II and Further Enhanced Type II Port Selection 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 Enhanced Type II CSI feedback (see Clause 5.2.2.2.5) and Further Enhanced Type II Port Selection CSI feedback (see Clause 5.2.2.2.7), Part 1 contains RI (if reported), CQI, and an indication of the overall number of non-zero amplitude coefficients across layers. 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 of the Enhanced Type II or Further Enhanced Type II Port Selection CSI. Part 1 and 2 are separately encoded |

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| Company | Comments |
| **Mod** | Above TP is editorial change. |
| OPPO | ok |
| Nokia/NSB | Ok |
| vivo | OK |
| CATT | Ok with FL’s assessment. |
| Samsung | OK |

### TP 5: The missing citation/overall description for Part 1 CSI in 38.214

* **Reasons of change:**

Based on the equation of , there is no ambiguity to obtain and . Therefore, following equations to calculate and are redundant, which can be removed to make RAN1 specifications relatively concise.

* **Proposed TP** (Proposal 3 from HW and Hisilicon in R1-2200935)**:**

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| **Company** | **View** |
| **Huawei, HiSilicon** | 5.2.2.2.7 Further enhanced Type II port selection codebook  -- Unchanged text is omitted---  Let be the index of and be the index of which identify the strongest coefficient of layer , i.e., the element of , for . The strongest coefficient of layer is identified by the index  which is found from |

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| Company | Comments |
| **Mod** | Above TP is editorial change. |
| Nokia/NSB | Ok |
| vivo | OK |
| CATT | Ok with FL’s assessment. |
| Samsung | OK |

# Summary of CSI enhancement for Multi-TRP

**3.1 Proposals of Further Enhancement**

**Proposal 6: Additional restriction to decouple enhanced group-based beam reporting and enhanced multi-TRP CSI reporting**

This issue is raised by Ericsson in R1-2202276 as following:

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| **Company** | **View** |
| **Ericsson** | * The UE is not expected to be configured with higher layer parameter cmrGroupingAndPairing-r17 in an NZP CSI-RS resource set that is indicated as the second NZP CSI-RS resource set via higher layer parameter resourcesForChannel2 in CSI-AssociatedReportConfigInfo. * For a higher layer parameter resourcesForChannelMeasurement configured with two Periodic or semiPersistent NZP CSI-RS resource sets, the UE is not expected to be configured with higher layer parameter cmrGroupingAndPairing-r17 in any of the two NZP CSI-RS resource sets. |

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| Company | Comments |
| **Mod** | Up to FL understanding, further restriction might not be needed but it is worth checking further.  For a UE supporting and have group-based beam reporting, the UE shall ignore *cmrGroupingAndPairing-r17* configured for give a CMR set associated with NCJT CSI reporting. |
| QC | We agree that these restrictions are needed as there is no intention for joint operation of these two features in the same CSI-RS resource set. We support having a conclusion on this. |
| MediaTek | We share the same view as QC and support to have a conclusion. |
| OPPO | In principle we support these restrictions to decouple enhanced group-based beam reporting and NC-JT CSI, though it only happens in 2 ports CSI-RS case, which is not a common configuration for NC-JT. |
| Nokia/NSB | We also support a conclusion saying that the two resource sets configured for group-based beam reporting cannot be configured with CMR grouping and pairing.  Because this is a restriction on the MTRP beam reporting configuration rather than on MTRP CSI configuration, it should probably be agreed and captured under the MTRP beam management topic, but it’s ok to do it here too. |
| vivo | We think FL’s understanding makes sense. |

**Proposal 7: Support PMI/RI sharing**

The issue is raised by Samsung in R1-2202002 as following:

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| **Company** | **View** |
| **Samsung** | * Support full and/or partial compression/omission/Sharing of PMI among single-TRP and NCJT hypotheses. * Support the dynamic variation on the level of compression/omission/Sharing of PMI and the associated payload of PMI for single-TRP and NCJT hypotheses. |

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| Company | Comments |
| **Mod** | Enhancing PMI/RI sharing mechanism has been extensively discussed without progress. Therefore related enhancement is not needed during the maintenance phase. |
| QC | Do not support. |
| MediaTek | Agree with the moderator. |
| OPPO | Do not support. |
| Nokia/NSB | Agree with FL |
| vivo | Fine with the FL’s assessment. |

**Proposal 8: Support non-PMI based CSI reporting for NCJT**

The issue is raised by Samsung in R1-2202002 as following:

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| **Company** | **View** |
| **Samsung** | For NC-JT CSI reporting enhancement, support following   * Non-PMI CSI reporting * Minimize the remaining specification work by adopting Non-PMI CSI without non-PMI-PortIndication configuration. |

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| Company | Comments |
| Mod | Supporting non-PMI based CSI reporting for NCJT has been extensively discussed without progress. Therefore related enhancement is not needed during the maintenance phase. |
| QC | Do not support. |
| MediaTek | Agree with the moderator. |
| Nokia/NSB | Agree with FL |
| vivo | Fine with the FL’s assessment. |

**Proposal 9: Relaxed values on Z and Z’ for NCJT CSI**

The issue is raised by ZTE in R1-2201191 and OPPO in R1-2201229 as following:

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| **Company** | **View** |
| **ZTE** | No changes of value on Z and Z’. And of table 5.4-2 in 38.214 is used for NCJT CSI. |
| **OPPO** | For CSI computation delay requirement associated with a CSI-ReportingConfig for a NCJT measurement hypothesis, consider to introduce relaxed values on Z and Z’. |

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| Company | Comments |
| Mod | Supporting relaxed values of Z and Z’ for NCJT has been extensively discussed without progress. Therefore related enhancement is not needed during the maintenance phase. |
| QC | Not needed at this stage. |
| MediaTek | Agree with the moderator. |
| OPPO | We can accept if majority companies don’t like this. |
| Nokia/NSB | Agree with FL |
| vivo | Agree with the FL’s assessment. |

**Proposal 10: Number of candidate values of RI restriction**

The issue is raised by Samsung in R1-2202002, CMCC in R1-2201850 and Nokia/NSB in R1-2202322 as following:

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| **Company** | **View** |
| **Samsung** | For a CSI report associated with a Multi-TRP/panel NCJT measurement hypothesis configured by single CSI reporting settings support multiple RI candidate values X and Y for Single-TRP and Multi-TRP measurement hypotheses, respectively. |
| **CMCC** | Support multiple candidate values of X and Y for rank restriction of Multi-TRP. |
| **Nokia/NSB** | [TP to TS 38.214, Sec. 5.2.1.4.2] Allow multiple candidate values to be indicated in the RI restriction parameter for NCJT measurement hypotheses |

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| Company | Comments |
| Mod | Up to FL understanding, at least we need to clarify and remove the bracket in 38.214. Also we might address whether similar sentence of “indicates one or more” shall be added toward single TRP/M CSI-RS resources. Otherwise it may leads to unsymmetrical description of RI restriction and may be potentially misleading.  “*The CodebookConfig in CSI-ReportConfig can be configured with two RI restriction parameters. One parameter applies to a reported RI when conditioned on a CRI corresponding to an entry of the CSI-RS resources defined above. Another parameter applies to a reported joint RI index when conditioned on a CRI corresponding to an entry of the Resource Pairs and indicates one [or more] of the four rank combinations that are allowed to correspond to the reported PMIs and RIs.*” |
| QC | Support removing the bracket in 38.214. |
| MediaTek | Support to remove the bracket. |
| OPPO | Support removing the bracket in 38.214. |
| Nokia/NSB | Support removing the brackets |
| vivo | Agree with FL. |

**3.2 Text Proposals of Correction**

**TP 6: The missing description of the relationship between the number of STRP measurement hypotheses and the number of CMR in Resource Group**

* **Reasons of changes:**

For the UE configured to report one CSI associated with NCJT measurement hypothesis, i.e. Mode1 with X=0, without CMR sharing, M1 = M2 = 0 is derived according to TS 38.214 and there is no relationship between the M1/M2 and K1/ K2. The relationship between M1/M2 and K1/ K2 needs to be clarified. For example if M1 = M2 = 0, the K1 = K2 = 1 needs to be clarified when the UE is configured to report one CSI associated with NCJT measurement hypothesis and do not share CMR.

* **Proposed TP (**Proposal 3 from Vivo in R1-2201084**):**

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| **Company** | **View** |
| **Vivo** | ------------------------------------------Start of Text Proposal ----------------------------------  **5.1.4.2 Report Quantity Configurations**  < Unchanged parts are omitted >  If the UE is configured with a CSI-ReportConfig with the higher layer parameter reportQuantity set to 'cri-RI-PMI-CQI', or 'cri-RI-LI-PMI-CQI' and the corresponding NZP-CSI-RS-ResourceSet for channel measurement is configured with resources, two Resource Groups with resources in Group 1, resources in Group 2, , and Resource Pairs:  - each resource can contain, subject to UE capability, at most 32 CSI-RS ports.  - each of the Resource Pairs is associated to a CRI value.  - The CSI-ReportConfig may be configured with higher layer parameter sharedCMR. and are the numbers of resources associated to a CRI value, other than the N CRIs defined above, in Group 1 and Group 2, respectively, with , such that the total number of CRI values configured for the CSI-ReportConfig is .  - If the higher layer parameter csi-ReportMode is set to 'Mode1' and the higher layer parameter numberOfSingleTRP-CSI-Mode1 is set to , ~~; otherwise,~~  - if N = 1, and ,  - if N = 2,  - and , if the two resource pairs do not share any CSI-RS resource  - and , if the two resource pairs share the same CSI-RS resource from the first CSI-RS resource group  - and , if the two resource pairs share the same CSI-RS resource from the second CSI-RS resource group  - if the higher layer parameter csi-ReportMode is set to 'Mode1' and the higher layer parameter numberOfSingleTRP-CSI-Mode1 is set to , or if csi-ReportMode is set to 'Mode2',  - if sharedCMR is configured: and ; otherwise  - if sharedCMR is not configured, only the resources in Group 1 and Group 2 that are not referred to in any Resource Pair are associated to M CRI values other than the N CRIs defined above.  < Unchanged parts are omitted >  --------------------------------------- End of Text Proposal ------------------------------------ |

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| Company | Comments |
| **Mod** | Up to FL understanding, above TP might not be needed but it is worth checking further.  The values of “ and are the numbers of resources associated to a CRI value, other than the N CRIs defined above, in Group 1 and Group 2, respectively, with ” so that defining M1 and M2 are meaningful when X>0 and associated with single CMR/TRP. For above case, the payload is simply log2(N). |
| QC | Agree with the moderator. The TP is not needed. |
| MediaTek | Agree with the moderator. |
| OPPO | We don’t think the TP is needed. |
| Nokia/NSB | Agree with FL, this in not needed. |
| vivo | The similar description is included in TS 38.212 as following, with clear relationship between M1 and K1, M2 and K2 depending on sharedCMR is absent or not.   |  | | --- | | In TS 38.212  The value of *N* in Table 6.3.1.1.2-3A and Table 6.3.1.1.2-3B is the number of CSI-RS resource pairs configured within a CSI-RS resource set. The values of M1 and M2 in Table 6.3.1.1.2-3A and Table 6.3.1.1.2-3B are given by  - If *sharedCMR* = "Enabled", *M*1 = *K*1 and *M*2 = *K*2  - If *sharedCMR* is absent and *N* = 1, *M*1 = *K*1 - 1 and *M*2 = *K*2 – 1  - If *sharedCMR* is absent and *N* = 2,  *- M*1 = *K*1 - 2 and *M*2 = *K*2 – 2, if the two resource pairs do not share any CSI-RS resource  *- M*1 = *K*1 - 1 and *M*2 = *K*2 – 2, if the two resource pairs share the same CSI-RS resource from the first CSI-RS resource group  *- M*1 = *K*1 - 2 and *M*2 = *K*2 – 1, if the two resource pairs share the same CSI-RS resource from the second CSI-RS resource group |   Therefore, in our view, at least alignment between TS 38.214 and TS 38. 212 is needed. A simplest way is to refer to TS 38.212 on this part in TS 38.214. |

**TP 7: The missing restriction on the CMRs within a Resource Pair having the same TX ports.**

* **Reasons of changes:**

In RAN1#103e meeting, we have achieved one agreement to state that CMRs corresponding to different TRPs respectively have the same number of ports among CMRs. But the agreement is not captured in the current spec.

* **Proposed TP (**Proposal 1 from Spreadtrum in R1-2201540**):**

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| **Company** | **View** |
| **Spreadtrum** | -------------------------------Start of Text Proposal#1 for TS 38.214-------------------------------  **5.2.1.4.2 Report Quantity Configurations**  -----------------------------Unchanged part omitted--------------------------  If the UE is configured with a CSI-ReportConfig with the higher layer parameter reportQuantity set to 'cri-RI-PMI-CQI', or 'cri-RI-LI-PMI-CQI' and the corresponding NZP-CSI-RS-ResourceSet for channel measurement is configured with resources, two Resource Groups with resources in Group 1, resources in Group 2, , and Resource Pairs:  - each resource can contain, subject to UE capability, at most 32 CSI-RS ports.  - each of the Resource Pairs is associated to a CRI value.  - CMR resources for one Resource Pair have the same number of ports.  ------------------------------End of Text Proposal#1 for TS 38.214----------------------------------- |

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| --- | --- |
| Company | Comments |
| **Mod** | Up to FL understanding, above TP might not be needed because all NZP CSI-RS resources within one set are restricted to having same nrofPorts.  Section 5.2.2.3.1 in 38.214  “*All CSI-RS resources within one set are configured with same density and same nrofPorts, except for the NZP CSI-RS resources used for interference measurement*.” |
| QC | Agree with the moderator. The TP is not needed. |
| MediaTek | Agree with the moderator. |
| OPPO | Agree with the moderator. |
| Nokia/NSB | Agree with FL, this is not needed |
| vivo | Agree with FL. |

**TP 8: The missing restriction on the CMRs within a Resource Pair without DL/UL switching.**

* **Reasons of changes:**

In RAN1#106b-e, we have achieved one agreement to state that CMRs corresponding to different TRPs respectively to be restricted within X continuous slot(s) without DL/UL switch between two CMRs. But the agreement is not captured in the current spec.

* **Proposed TP (**Proposal 2 from Spreadtrum in R1-2201540**):**

|  |  |
| --- | --- |
| **Company** | **View** |
| **Spreadtrum** | --------------------------------Start of Text Proposal#2 for TS 38.214----------------------------  **5.2.2.3.1 NZP CSI-RS**  -----------------------------Unchanged part omitted--------------------------  For a CSI-RS Resource Set for channel measurement configured with two Resource Groups and Resource Pairs, the slot offsets of the two resources in a Resource Pair are configured within slots, without DL/UL switching in between the two resources, where implies that the two resources are configured in the same slot without DL/UL switching, and implies that the two resources are configured within two adjacent slots without DL/UL switching.  ------------------------------End of Text Proposal#2 for TS 38.214------------------------------- |

|  |  |
| --- | --- |
| Company | Comments |
| **Mod** | Up to FL understanding, above TP might not be needed.  “*without DL/UL switching in between the two resources*” within the same paragraph shall be sufficient. However we might need to address the bracket in RAN1, i.e. “within slots”. |
| QC | Agree with the moderator. The TP is not needed as it is already mentioned in the paragraph. |
| MediaTek | Agree with the moderator. |
| OPPO | Agree with the moderator. |
| Nokia/NSB | Agree with FL, this is not needed |
| vivo | Agree with FL. |

**3.3 Text Proposals of Editorial Changes**

**TP 9: The wrong reporting quantity in 38.214**

* **Reasons of Changes:**

The first codepoints of the CRI correspond to resources associated to Group 1 and Group 2. The last codepoints of the CRI correspond to the configured Resource Pairs. The UE shall report one RI, one PMI, one LI, if configured, and one or two CQIs conditioned on CRI if ; or two RIs, two PMIs, two LIs, if configured, associated to the resource in Group 1 and the resource in Group 2, respectively, of the (- M +1)-th Resource Pair rather than the (+1)-th Resource Pair, and one CQI, otherwise. For example, from Agreement #3, if the value of is , the codepoint of the CRI corresponds to the first Resource Pair, rather than the (+1)-th Resource Pair.

* **Proposed TP (by consolidating all TP from following)** 
  + Proposed change #4 from Huawei/HiSilicon in R1-2200935
  + Proposal 2 from ZTE in R1-2201191
  + Proposal 1 from CMCC in R1-2201850
  + Proposal 1 from Qualcomm in R1-2202128

|  |  |
| --- | --- |
| **Company** | **View** |
| **Huawei, HiSilicon, ZTE, CMCC, Qualcomm** | 5.2.1.4.2 Report Quantity Configuration  <Unchanged part omitted>  - The UE shall derive the CSI parameters other than CRI(s) conditioned on the reported CRI(s), as follows:  - If the higher layer parameter csi-ReportMode is set to 'Mode1' and the higher layer parameter numberOfSingleTRP-CSI-Mode1 is set to , CRI(s) are reported:  - one CRI corresponds to the configured -th entry of the associated Resource Pairs in the corresponding CSI-RS Resource Set for channel measurement, and -th entry of the corresponding CSI-IM Resource Set, if configured. The UE shall report two RIs, two PMIs, two LIs (if configured), associated to the resource in Group 1 and the resource in Group 2, respectively, of the -th Resource Pair, and one CQI; and  - if , one CRI () corresponds to the configured -th entry of the associated resources in the corresponding CSI-RS Resource Set for channel measurement, and -th entry of the corresponding CSI-IM Resource Set, if configured. The UE shall report one RI, one PMI, one LI (if configured) and one or two CQIs conditioned on CRI ; or  - if , one CRI corresponds to the configured -th entry of the associated resources in Group 1 of the corresponding CSI-RS Resource Set for channel measurement, and -th entry of the associated resources in the corresponding CSI-IM Resource Set, if configured, and one CRI corresponds to the configured -th entry of the associated resources in Group 2 of the corresponding CSI-RS Resource Set for channel measurement, and -th entry of the corresponding CSI-IM Resource Set, if configured. The UE shall report one RI, one PMI, one LI (if configured) and one or two CQIs conditioned on CRI and one RI, one PMI, one LI (if configured) and one or two CQIs conditioned on CRI .  - If the higher layer parameter csi-ReportMode is set to 'Mode2', one CRI is reported, which corresponds to the -th entry of the resources or Resource Pairs in the corresponding CSI-RS Resource Set for channel measurement, and -th entry of the associated resources in the corresponding CSI-IM Resource Set, if configured. The first codepoints of the CRI correspond to resources associated to Group 1 and Group 2. The last codepoints of the CRI correspond to the configured Resource Pairs. The UE shall report one RI, one PMI, one LI, if configured, and one or two CQIs conditioned on CRI if ; or two RIs, two PMIs, two LIs, if configured, associated to the resource in Group 1 and the resource in Group 2, respectively, of the ( – M +1)-th Resource Pair, and one CQI, otherwise.  <Unchanged part omitted> |

|  |  |
| --- | --- |
| Company | Comments |
| **Mod** | Above TP is editorial change. |
| QC | Support. |
| MediaTek | Support. |
| OPPO | Support |
| Nokia/NSB | Support |
| vivo | Support. |

**TP 10: The missing definition of Resource Group index in 38.214**

* **Reasons of changes:**

Based on current specs for NCJT CSI enhancement, as two CMR groups and N pair of CMRs are configured for CSI measurement, in CQI calculation, the UE should assume that the v layers are mapped to the CSI-RS ports of that pair of CMRs and PDSCH are from 2 TRPs, , , fully overlap in time and frequency. CATT proposes to state that j is the index of corresponding CMR group, which is implicitly associated with TRPs.

* **Proposed TP (**Proposal 2 from CATT in R1-2201334):

|  |  |
| --- | --- |
| **Company** | **View** |
| **CATT** | -------------------------------------- Start of text proposal for 38.214-------------------------------  5.2.2.5 CSI reference resource definition  <unchanged text omitted>   * The PDSCH transmission scheme where the UE may assume that PDSCH transmission would be performed with up to 8 transmission layers as defined in Clause 7.3.1.4 of [4, TS 38.211]. For CQI calculation, the UE should assume that PDSCH signals on antenna ports in the set [1000,…, 1000+ν-1] for ν layers would result in signals equivalent to corresponding symbols transmitted on antenna ports [3000,…, 3000+P-1], as given by     where  is a vector of PDSCH symbols from the layer mapping defined in Clause 7.3.1.4 of [4, TS 38.211],  is the number of CSI-RS ports. If only one CSI-RS port is configured, W(i) is 1. If the higher layer parameter reportQuantity in CSI-ReportConfig for which the CQI is reported is set to either 'cri-RI-PMI-CQI' or 'cri-RI-LI-PMI-CQI', W(i) is the precoding matrix corresponding to the reported PMI applicable to x(i). If the higher layer parameter reportQuantity in CSI-ReportConfig for which the CQI is reported is set to 'cri-RI-CQI', W(i) is the precoding matrix corresponding to the procedure described in Clause 5.2.1.4.2. If the higher layer parameter reportQuantity in CSI-ReportConfig for which the CQI is reported is set to 'cri-RI-i1-CQI', W(i) is the precoding matrix corresponding to the reported i1 according to the procedure described in Clause 5.2.1.4.2. The corresponding PDSCH signals transmitted on antenna ports [3000,…,3000 + P - 1] would have a ratio of EPRE to CSI-RS EPRE equal to the ratio given in Clause 5.2.2.3.1.   * If the higher layer parameter reportQuantity in CSI-ReportConfig for which the CQI is reported is set to either 'cri-RI-PMI-CQI' or 'cri-RI-LI-PMI-CQI', the corresponding CSI-RS Resource Set for channel measurement is configured with two Resource Groups and Resource Pairs, as described in clause 5.2.1.4.1, the reported CRI corresponds to an entry of the Resource Pairs, and the reported rank combination is , as described in clause 5.2.1.4.2, for CQI calculation, the UE should assume that   - PDSCH signals on antenna ports in the set for layers would result in signals equivalent to corresponding symbols transmitted on antenna ports of the Group 1 CSI-RS resource in the Resource Pair indicated by the CRI, and PDSCH signals on antenna ports in the set for layers would result in signals equivalent to corresponding symbols transmitted on antenna ports of the Group 2 CSI-RS resource in the Resource Pair indicated by the CRI, as given by    where , are the two precoding matrices corresponding to the two reported PMIs applicable to , as described in clause 5.2.1.4.2; that the signals , , fully overlap in time and frequency, and that, for the calculation of RI, PMI and LI (if configured) of layers, , the interference from the other layers is derived from channel measurement and precoding matrix corresponding to the other layers. j are the indexes of two Resource Groups that configured in the corresponding CSI-RS Resource Set for channel measurement, respectively.  - The UE shall assume that the corresponding PDSCH signals for layers transmitted on the antenna ports of the CSI-RS resource in Group would have a ratio of EPRE to CSI-RS EPRE equal to the powerControlOffset of the respective CSI-RS resource, for .  ----------------------------------- End of text proposal for 38.214--------------------------------- |

|  |  |
| --- | --- |
| Company | Comments |
| **Mod** | Above TP is editorial change. |
| QC | Ok with the TP. |
| MediaTek | OK. |
| OPPO | Fine with it in principle. |
| Nokia/NSB | In our view this is redundant. It’s clear from the above description and formula that , , are associated with the resource from Group in the resource pair. |
| vivo | We are fine to make the notation “j” clear. |

# Proposals for Online/Offline Discussion

TBD

# Work Plan

TBD

# References

1. 3GPP R1-2200935, Remaining issues on CSI enhancement in Rel-17, Huawei, HiSilicon, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
2. 3GPP R1-2201084, Maintenance on MTRP CSI and Partial reciprocity, vivo, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
3. 3GPP R1-2201191, Remaining issues on CSI enhancements for multi-TRP and FR1 FDD reciprocity, ZTE, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
4. 3GPP R1-2201229, CSI enhancement for M-TRP and FDD reciprocity, OPPO, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
5. 3GPP R1-2201334, Maintenance of CSI enhancement on FDD CSI and Multi-TRP/panel Transmission, CATT, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
6. 3GPP R1-2201469, Remaining issues on CSI enhancements, NTT DOCOMO, INC., RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
7. 3GPP R1-2201540, Discussion on CSI enhancements for M-TRP and FR1 FDD reciprocity, Spreadtrum Communications, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
8. 3GPP R1-2201573, CSI enhancements for Rel-17, LG Electronics, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
9. 3GPP R1-2201850, Remaining issues of enhancements on CSI reporting for Multi-TRP, CMCC, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
10. 3GPP R1-2202002, Maintenance on Rel-17 CSI enhancements, Samsung, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
11. 3GPP R1-2202089, CSI enhancements for multi-TRP and FDD reciprocity, Lenovo, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
12. 3GPP R1-2202128, Remaining details of mTRP CSI, Qualcomm Incorporated, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
13. 3GPP R1-2202276, Remaining issues on multi-TRP CSI, Ericsson, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.
14. 3GPP R1-2202322, Maintenance of enhancements for CSI measurement and reporting, Nokia, Nokia Shanghai Bell, RAN1#108e, E-meeting, Feb 21st – March 3rd, 2021.

# Appendix

The text proposals are omitted here for concise. Please refer to each company’s paper for the detailed text proposals.

* **Companies’ proposals on CSI enhancements for FDD**

**Table A-1 Companies’ proposals on CSI enhancements for FDD**

|  |  |
| --- | --- |
| **Companies** | **Views** |
| **Huawei, HiSilicon** | **Proposal 1: Text proposal to 38.212**  **Proposal 2: Text proposal to 38.214**  **Proposal 3: Text proposal to 38.214** |
| **vivo** | Proposal 5:   * UE reports the combinatorial coefficients of non-selected beams when the number of selected beams is larger than half of the number of candidate beams, e.g., when alpha = 3/4.   **Proposal 6:**   * UE can use partial CSI-RS ports to search target tap 0 to reduce the complexity.   + gNB can map SD-FD bases to CSI-RS ports with a predetermined order or indicating the ports for timing calibration. |
| **CATT** | **Proposal 1: Text proposal to 38.214** |
| **Samsung** | **Proposal 6**: When M=1, the description on needs to be corrected according to one of the following:   * Alt1: a single precoding matrix is indicated by the PMI * Alt2: N3 precoding matrices indicated by the PMI, but they are the same when M=1   **Proposal 7**: support Rel.17 codebook for BWP size < 24 PRBs with the current restriction in the specification, i.e. support only WB CSI implying M=1  **Proposal 8**: Regarding Rel.17 codebook parameters,   * support * allowed rank (via RI-restriction-r17) can’t be 3 or 4 when (i.e., paramCombination-r17=5) and |
| **Lenovo** | Proposal 3: The parameter *paramCombination-r17* configures the supported parameter combination values of the parameters (α, *Mv*, *β*, *R*) |

* **Companies’ proposals on CSI enhancements for Multi-TRP**

**Table A-2 Companies’ proposals on** **CSI enhancements for Multi-TRP**

|  |  |
| --- | --- |
|  |  |
| **Huawei, HiSilicon** | **Proposal 4: Text proposal to 38.214** |
| **vivo** | **Proposal 1:**   * The default maximum number of CMR is 2 with Rel-17 MIMO UE capability for MTRP CSI measurement.   Proposal 2:   * The relationship between M1/M2 and K1/ K2 needs to be clarified. E.g., if M1 = M2 = 0, the K1 = K2 = 1 needs to be clarified when the UE is configured to report one CSI associated with NCJT measurement hypothesis and do not share CMR.   **Proposal 3: Text proposal to 38.214.**  Proposal 4:   * For the measurement of a MTRP CSI report, the CBSR parameters are also applied for both 2Tx and more than 2Tx. Besides, the number of configured CBSRs should be 2 in the new CodebookConfig. |
| **ZTE** | **Proposal 1:** For CSI computation delay requirement associated with a CSI-ReportingConfig for a NCJT measurement hypothesis, support Alt 2, i.e., no changes of values on Z and Z’   * of table 5.4-2 in 38.214 is used for NCJT CSI   **Proposal 2:** **Text proposal to 38.214** |
| **OPPO** | ***Proposal 1: For CSI computation delay requirement associated with a CSI-ReportingConfig for a NCJT measurement hypothesis, consider to introduce*** ***relaxed values on Z and Z’.***  ***Proposal 2: The Rel-15/16 restriction on maximal number of CSI-RS ports per resource is applied to each CMR group respectively. That is, for each CMR group with Ki resources (i = 1 or 2), the maximal number of CSI-RS ports per resource in the CMR group is:***   * ***8 when Ki is larger than 2;*** * ***16 when Ki=2*** * ***32 when Ki =1;*** * ***Note: Whether to support more than 32 ports within a CMR pair is up to UE capability.*** |
| **CATT** | **Proposal 2: Text proposal to 38.214** |
| **Spreadtrum** | **Proposal 1: Text proposal to 38.214.**  **Proposal 2: Text proposal to 38.214.** |
| **LG** | **Proposal #1: Support UE capability for X=2.** |
| **CMCC** | **Proposal 1: Text proposal to 38.214**  **Proposal 2: Support multiple candidate values of X and Y for rank restriction of Multi-TRP.** |
| **Samsung** | **Proposal 1**: For a CSI report associated with a Multi-TRP/panel NCJT measurement hypothesis configured by single CSI reporting settings support multiple RI candidate values X and Y for Single-TRP and Multi-TRP measurement hypotheses, respectively.  **Proposal 2**: For two CMRs within a same CMR pair configured for NCJT measurement hypothesis to be restricted within X continuous slot(s) without DL/UL switch between two CMRs:   * Do not support UE capability for X=2   **Proposal 3**: Support full and/or partial compression/omission/Sharing of PMI among single-TRP and NCJT hypotheses.  **Proposal 4**: Support the dynamic variation on the level of compression/omission/Sharing of PMI and the associated payload of PMI for single-TRP and NCJT hypotheses.  **Proposal 5:** For NC-JT CSI reporting enhancement, support following   * Non-PMI CSI reporting * Minimize the remaining specification work by adopting Non-PMI CSI without non-PMI-PortIndication configuration. |
| **Lenovo** | 1. CBSR is supported for 2Tx based on *twoTX-CodebookSubsetRestriction* configuration, and for >2Tx based on *typeISinglePanel-codebookSubsetRestriction-i2* configuration 2. Two codebook configurations are defined corresponding to the two CSI-RS resource groups, where each codebook configuration comprises a CBSR configuration |
| **Qualcomm** | Proposal 1: Text proposal to 38.214. |
| **Ericsson** | [**Proposal 1 The UE is not expected to be configured with higher layer parameter cmrGroupingAndPairing-r17 in an NZP CSI-RS resource set that is indicated as the second NZP CSI-RS resource set via higher layer parameter resourcesForChannel2 in CSI-AssociatedReportConfigInfo.**](#_Toc95753585)  [**Proposal 2 For a higher layer parameter resourcesForChannelMeasurement configured with two Periodic or semiPersistent NZP CSI-RS resource sets, the UE is not expected to be configured with higher layer parameter cmrGroupingAndPairing-r17 in any of the two NZP CSI-RS resource sets.**](#_Toc95753586) |
| **Nokia, Nokia Shanghai Bell** | **Proposal 1 Test proposal to TS 38.214**  **Proposal 2 Regarding the timing restriction in the configuration of a CMR pair for NCJT measurement, clarify that capability signalling is not needed for the value and that the gNB can configure a CMR pair within 2 consecutive slots.**  **Proposal 3 Clarify that only the CBSR parameters twoTX-CodebookSubsetRestriction, for two antenna ports, and n1-n2, for more than two antenna ports, should be supported in CodebookConfig for MTRP CSI reporting. The CBSR parameter typeISinglePanel-codebookSubsetRestriction-i2 does not need supporting because the reportQuantity 'cri-RI-i1-CQI' is not supported for MTRP CSI reporting. The CBSR parameters for the two CMR groups are configured with the same number of ports.** |