**3GPP TSG RAN WG1 #122 R1-2506513**

**Bengaluru, India, Aug 25th – 29th, 2025**

**Agenda item:** 8.2.2

**Source:** Moderator (Samsung)

**Title:** Moderator Summary#1 on Rel-19 CSI enhancements: Round 2

**Document for:** Discussion and Decision

## Introduction

The scope given in the Rel-19 NR MIMO Phase 5 WID pertaining to CSI enhancement is as follows (2d added in [1]):

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| 1. Specify CSI support for up to 128 CSI-RS ports, targeting FR1    1. Type-I codebook refinement supporting up to a total of 128 CSI-RS ports across all resources, assuming legacy CSI-RS resources (with up to 32 CSI-RS ports per resource), based on extension of legacy codebooks    2. Type-II codebook refinement supporting up to a total of 128 CSI-RS ports across all resources, assuming legacy CSI-RS resources (with up to 32 CSI-RS ports per resource), based on extension of legacy codebooks, **without modifying any codebook parameter other than** introducing additional values for the number of ports codebook parameter(s)    3. Extension of CRI(s)-based CSI reporting (CQI/PMI/RI calculated per CRI for ≥1 CRIs) for hybrid beamforming supporting up to a total of 128 CSI-RS ports across all resources, with up to 32 CSI-RS ports per resource, without new codebook design    4. SRS port grouping and its association to the two codewords for the 6/8Rx low complexity receiver supporting more than 4 layers, with legacy codebook       * No enhancement on codeword-to-layer mapping, DL resource allocation, CSI feedback, and DCI format       * Note: Whether to support 6Rx with more than 4 layers is to be decided in RAN4 Rel-19 RF enhancements WI 2. Specify UE reporting enhancement for CJT deployments under non-ideal synchronization and backhaul, targeting FR1, both FDD and TDD 3. Inter-TRP time misalignment and frequency/phase offset measurement and reporting, assuming legacy CSI-RS design, with stand-alone aperiodic reporting on PUSCH |

## Summary of companies’ proposals and views

### Issue 1 (WID objective 2a and 2b): Type-I and Type-II codebook refinement for up to 128 CSI-RS ports

Table 1A Summary: issue 1

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| **#** | **Issue/proposal** | **Companies’ views** |
| **New proposals** | | |
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| **Proposals from previous more recent meeting(s) and/or round(s)** | | |
| 1.2 | **[120bis] Conclusion**  For the Rel-19 Type-I SP codebook refinement for 48, 64, and 128 CSI-RS ports, when the Rel-18 SD NES Type-I is configured for the Rel-19 Type-I SP codebook, the *powerOffset* parameter **can be configured** in all the respective subConfiguration IEs   * The supported values for *powerOffset* follow the legacy specification   **Proposal 1.B**: For the Rel-19 Type-I SP codebook refinement for 48, 64, and 128 CSI-RS ports, when the Rel-18 SD NES Type-I is configured for the Rel-19 Type-I SP codebook with the *powerOffset* parameter configured in all the respective subConfiguration IEs, the soft scaling (if configured) is calculated based on *powerControlOffset* (in linear scale) of the respective CSI-RS resource and *powerOffset* (in linear scale) in the respective sub-configuration  **FL assessment**: For this proposal to be valid, a UE must be configured with Rel-19 Type-I SP, SD+PD NES, and soft scaling.   * But the use of soft scaling together with SD+PD NES has not yet been agreed, at least explicitly. * Even if it were not precluded, this would seem to fall into optimization rather than an essential change.   More discussion on the combination is needed. | **Support/fine:** Google, Fujitsu (open), Lenovo, ZTE/Sanechips,  **Not support:** Samsung, OPPO, NTT DOCOMO (discuss combo first), Spreadtrum, vivo, ETRI, Ericsson, Apple, CATT, Xiaomi (discuss combo first), Qualcomm, Nokia, |
| 1.3 | **Proposal 1.C**: For the Rel-19 Type-I SP codebook refinement for 48, 64, and 128 CSI-RS ports mode-B, support following TP to accurately referring spatial domain basis vector selection.  5.2.2.2.1a Refined Type I Single-Panel Codebook  <Unchanged part omitted>  The index is given by  where for and for . The mapping of and to and for is obtained as in Clause 5.2.2.2.3 by replacing with and replacing with , where the values of are given in Table 5.2.2.2.5-4 and Table 5.2.2.2.1a-5, and and for one to one mapping to and for with ,.  The index , for and is given by  and is mapped to . The mapping of index , for and , to , with , is given in Table 5.2.2.2.1a-6. The quantities and for *typeI-codebookMode-r19* = 'modeB' are the same as defined above for 'modeA'.  <Unchanged part omitted>  **FL assessment**: This TP seems to be correct and clearer than the current text. Whether this is needed or not can be discussed.  **The TP can be found in Section 3.3** | **Support/fine:** NEC, Google, Samsung, OPPO, NTT DOCOMO, Spreadtrum, Fujitsu, vivo, ETRI, Ericsson, Lenovo, Apple, ZTE/Sanechips, CATT, Xiaomi, Qualcomm,  **Not support (obvious):** Nokia**,** |
| 1.4 | **Proposal 1.D**: For Rel-19 Type-II codebook refinement for 48, 64, and 128 CSI-RS ports based on the Rel-18 Type-II Doppler codebook, a UE shall assume that CSI-RS ports mapped to the same port index across the K aperiodic CSI-RS resources, , as described in Clause 7.4.1.5.3 of [4, TS 38.211], share the same antenna port.  **FL assessment**: This proposal has been discussed since RAN1#121. The proposal is reformulated based on vivo’s latest Tdoc [5]  The proposal is technically sound. It was argued by vivo that for “KDOPP = {4, 8, 12} CSI-RS resource groups are introduced for Type-II Doppler CSI. This means that within a CMR group, there may be multiple CSI-RS ports with the same CSI-RS port index mapped to different antenna ports.” | **Support/fine:** vivo, Apple, CATT, Xiaomi, NEC,  **Not support** (NW implementation)**:** Google, Samsung, OPPO, NTT DOCOMO, Spreadtrum, Fujitsu, ETRI, Ericsson, Lenovo, ZTE/Sanechips, |
| 1.6 | **[117] Agreement**  For the Rel-19 Type-II codebook refinement for 48, 64, and 128 CSI-RS ports, on CBSR,   * -bit group-based CBSR * the following (X1, X2) values are supported:  |  |  |  | | --- | --- | --- | | **P** | **(N1, N2)** | **(X1, X2)** | | 48 | (8,3) | (1,1), (2,1), (4,1) | | (6,4) | (1,1), (2,1), (2,2), | | 64 | (16,2) | (1,1), (2,1), (2,2), (4,1), (4,2) | | (8,4) | (1,1), (2,1), (2,2), (4,1), (4,2) | | 128 | (16,4) | (1,1), (2,1), (2,2), (4,1), (4,2) | | (8,8) | (1,1), (2,1), (2,2), (4,1), (4,2) |   **Proposal 1.F**: For the Rel-19 Type-II codebook refinement for 48, 64, and 128 CSI-RS ports, on CBSR, clarify that the -bit group-based bitmap is identical for all the groups  **FL assessment**: This proposal is technically sound. Although the proposal is aligned with the understanding of the FL (and should be to other 😊), it doesn’t hurt to clarify to avoid ambiguity, | **Support/fine:** Fraunhofer IIS/HHI, Samsung, Spreadtrum, Fujitsu, vivo, Ericsson, Lenovo, Apple, CATT, Xiaomi, NEC,  **Not support:** NTT DOCOMO, Google, ETRI, ZTE/Sanechips, Huawei/HiSi, |
| 1.7 | **[118bis] Agreement**  For a UE configured with a total of PSRS=6 or 8 ports across ≥1 SRS resources for antenna switching intended for xT6R or xT8R, respectively, support the following fixed SRS port grouping where (with the PSRS ports indexed in an ascending order according to SRS resource ID and port number within each SRS resource):   * SRS port group 0, corresponding to CW0, comprises the even PSRS/2 out of PSRS ports; and * SRS port group 1, corresponding to CW1, comprises the odd PSRS/2 out of PSRS ports   The above feature is applicable only for reportQuantity = ‘cri-RI-CQI’  No other spec enhancement is introduced on new CW-to-layer mapping, DL resource allocation, CSI feedback, and DCI format  Note: The above grouping assumption is to align NW and UE on the association between SRS ports and reported CQIs for the two CWs when reportQuantity = ‘cri-RI-CQI’.  Note: different SRS ports are associated with different UE antenna ports.  Note: if one single CW is scheduled, both SRS port groups can correspond to the same CW, i.e. no enhancement is needed for the single-CW case  Note: This feature is a separate UE capability and, for UEs supporting this capability, configured via RRC (FFS details on the extend of RRC configuration)  Note: Whether to support 6Rx with more than 4 layers is to be decided in RAN4 Rel-19 RF enhancements WI  FFS (by RAN1#118bis): Whether there is impact on mapping between CWs to CSI-RS ports  For SRS antenna switching with multiple aperiodic SRS resource sets, PSRS ports indexed in an ascending order according to SRS resource set ID and SRS resource ID in a set and port number within each SRS resource  **Proposal 1.G**: For a UE configured with a total of PSRS=6 or 8 ports across ≥1 SRS resources for antenna switching intended for xT6R or xT8R, respectively, when SRS port grouping is configured,   * For P/SP SRS, the 6/8R ports consists of ports within an SRS resource set * For AP SRS, the 6/8R ports consists of ports across multiple sets.   **FL assessment**: This proposal attempts to revise the description in TS38.214 for SRS port grouping based on the legacy behaviour, i.e. the ports from different SRS resources correspond to a same set for P/SP and different sets for AP. The proposal seems valid.  **The TP can be found in Section 3.5** | **Support/fine:** Huawei/HiSi, NTT DOCOMO, vivo, ETRI, ZTE/Sanechips, CATT, Xiaomi, NEC, Qualcomm, Samsung (ok)  **Not support** (no ambiguity with the current text)**:** Google, Spreadtrum, Xiaomi, Nokia, |

Table 1B SLS results: issue 1

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Table 1C Additional inputs: issue 1

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| **Company** | **Input** |
| Mod V0 | **Please share your inputs on each of the issues and, if applicable, proposals in TABLE 1A.** |
| vivo | Proposal 1.D: Support.  Replying OPPO’s comments:  In a legacy aperiodic CMR configuration for Rel-18 Type-II Doppler codebook, the UE shall assume that the antenna ports with the same port index of the K aperiodic CSI-RS resources are the same. However, for 'typeII-Doppler-r19', a similar clarification seems to have been missed.   |  | | --- | | <omitted text>  A UE configured with a CodebookConfig with the higher layer parameter vectorLengthDD, a CSI-ReportConfig with the higher layer parameter reportQuantity set to 'cri-RI-PMI-CQI', or a CSI-ReportConfig with the higher layer parameter [RRC\_name-r19] and codebookType set to 'typeII-Doppler-r18', is expected to be configured with K∈{4,8,12} aperiodic CSI-RS resources or with a single periodic or semi-persistent CSI-RS resource in the resource set for channel measurement. For an aperiodic CSI-RS resource set for channel measurement, the K CSI-RS resources are triggered by the same triggering instance and the separation between two consecutive CSI-RS resources is m∈{1,2} slots, which is configured by higher layer parameter aperiodicResourceOffset in the CodebookConfig. The K aperiodic CSI-RS resources are transmitted following the order of the CSI-RS resource IDs configured in the CSI-RS resource set. The UE shall assume that the antenna port with the same port index of the K aperiodic CSI-RS resources is the same. If interference measurement is performed on CSI-IM, only one resource is configured in the corresponding csi-IM-ResourceSet. If interference measurement is performed on NZP CSI-RS, only one resource is configured in the corresponding NZP-CSI-RS-ResourceSet for interference measurement.  <omitted text> | |
| Huawei, HiSilicon | **Proposal 1.G:** Support the proposal and the TP. The problem in the current specification is that the SRS indexing across multiple SRS resources always happens no matter P/SP or AP SRS. However, following previous agreement, this only happens for AP SRS. While for P/SP, the SRS indexing should be within one SRS resource.  For SRS antenna switching with multiple aperiodic SRS resource sets, PSRS ports indexed in an ascending order according to SRS resource set ID and SRS resource ID in a set and port number within each SRS resource |
| NEC | **Proposal 1.C**: @ Nokia, thank you. It’s not only for clear description. But as the selection of SD basis in clause 5.2.2.2.3 is defined for , which is starting from 0, as:   |  | | --- | | 5.2.2.2.3 Type II Codebook  <Irrelevant part omitted>  Then the elements of  and  are found from using the algorithm:    for  Find the largest  in Table 5.2.2.2.3-1 such that            When  and  are known,  is found using:  where the indices  are assigned such that  increases as  increases  , where  is given in Table 5.2.2.2.3-1.  <Irrelevant part omitted> |   While it’s defined for as , if we simply refer the selection, the formula is not accurate (e.g. the initial value  doesn’t exist for . So we proposed this TP. |
| Mod V00 | **Please check the above arguments from the proponents 1.C, 1.D, 1.G** |

### Issue 2 (WID objective 2c): CRI-based CSI for hybrid beamforming (HBF)

Table 2A Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| **New proposals** | | |
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| **Proposals from previous more recent meeting(s) and/or round(s)** | | |
| 2.1 | Proposal 2.A: For the Rel-19 CRI-based CSI refinement for up to 128 CSI-RS ports,   * If higher layer parameter *mrSelectedResources* is not configured for the CSI report, support to associate the NZP CSI-RS resource for interference measurement with the NZP CSI-RS resource for channel measurement with smallest CRI; * Else, support to associate the NZP CSI-RS resource for interference measurement with the first configured NZP CSI-RS resource for channel measurement among the non-reported MR CRIs.   FL assessment: For the KS NZP CSI-RS resources for CM, only 1 NZP CSI-RS resource for IM can be configured (regardless whether MR is configured or not). The proposal introduces an association rule where the single NZP CSI-RS resource for IM corresponds to the “first” NZP CSI-RS resource for CM.  It is unclear if this association is needed since NZP CSI-RS resource for IM is typically used for interference emulation. | **Support/fine:** Huawei/HiSi, Google (ok), NTT DOCOMO,  Not support: Samsung, OPPO, Spreadtrum, Fujitsu, vivo, ETRI, Ericsson, Lenovo, Apple, ZTE/Sanechips, CATT (may need clarification), Xiaomi (already agreed to reuse legacy), Qualcomm, |
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Table 2B SLS results: issue 2

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Table 2C Additional inputs: issue 2

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| **Company** | **Input** |
| Mod V0 | **It seems proposal 2.A is not agreeable. To conclude this issue, either one of the three alternatives can be agreed:**   * **Alt1. Conclude that when one NZP CSI-RS for IM is configured, it is associated with all the KS CMRs** * **Alt2. Conclude that when one NZP CSI-RS for IM is configured, the association between the one NZP CSI-RS for IM to KS CMRs is left to NW implementation** * **Alt3. No conclusion needed**   **Companies are encouraged to comment on the above 3 alternatives** |
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### Issue 3 (WID objective 3): CJT calibration reporting for non-ideal synchronization and backhaul

Table 3A Summary: issue 3

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| **#** | **Issue** | **Companies’ views** |
| **New proposals** | | |
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| **Proposals from previous more recent meeting(s) and/or round(s)** | | |
| 3.1 | **Proposal 3.A**: For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, when linking CJTC Dd and Rel-18 eType-II CJT CSI reports is configured, regarding CQI/PMI/RI calculation, the PDSCH is assumed to be transmitted according to  Where are the selected CSI-RS resource, k is the subcarrier index, is the reference subcarrier, is the subcarrier spacing and is within the interval in which the delay offset, is reported by the UE.  **FL assessment**: This proposal is technically sound and correct. Note that the digitally compensated DO is functionally equivalent to Rel-18 Type-II CJT mode-1 which also uses a similar text.  **The TP can be found in Section 3.6** | **Support/fine:** Huawei/HiSi, ZTE/Sanechips, Google, Samsung, OPPO, Spreadtrum, Fujitsu, vivo, ETRI, Ericsson, Lenovo, Apple, ZTE/Sanechips, CATT, Xiaomi, NEC, NTT DOCOMO, Qualcomm,  **Not support (already clear without equation):** Nokia, |

Table 3B LLS/SLS results: issue 3

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Table 3C Additional inputs: issue 3

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| **Company** | **Input** |
| Nokia | **Proposal 3.A.** Not support. The specs seem already clear on the UE behaviour when it comes to delay offset compensation for jointly or separately triggered Dd and CJT reports |
| Mod V0 | **Please share your inputs on each of the issues and, if applicable, proposals in TABLE 3A. Please also review Nokia’s explanation above which seems to indicate that the proposal is not needed.** |
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## Text proposals

### Proposal 1.A

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### Proposal 1.A.2

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### Proposal 1.C

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| **Reason for change**: The current description for Type-I Scheme-B basis selection can benefit from clearer description |
| **Summary of the change**: Refine the current description in TS38.214 in clause 5.2.2.2.1a |
| **Consequences if not approved**: Potential lack of clarity in the description of UE behaviour in TS38.214 |
| 5.2.2.2.1a Refined Type I Single-Panel Codebook  <Unchanged part omitted>  The index is given by  where for and for . The mapping of and to and for is obtained as in Clause 5.2.2.2.3 by replacing with and replacing with , where the values of are given in Table 5.2.2.2.5-4 and Table 5.2.2.2.1a-5, and and for one to one mapping to and for with ,.  The index , for and is given by  and is mapped to . The mapping of index , for and , to , with , is given in Table 5.2.2.2.1a-6. The quantities and for *typeI-codebookMode-r19* = 'modeB' are the same as defined above for 'modeA'.  <Unchanged part omitted> |

### Proposal 1.E

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### Proposal 1.G

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| **Reason for change**: In RAN1 #118bis meeting [1], SRS port grouping has been agreed for periodic, semi-persistent and aperiodic SRS resource sets. The SRS ports indexing for P/SP SRS resource set and AP SRS resource set are different following the agreement. For P/SP SRS, the 6/8R ports consists of ports within a set, while for AP SRS, the 6/8R ports can consist of ports across multiple sets.  While the current description in TS38.214 seems sufficient, the proposed TP can improve the clarity. |
| **Summary of the change**: Separated description in TS38.214 for aperiodic from periodic and semi-persistent SRS |
| **Consequences if not approved**: Potential lack of clarity in description in TS38.214 |
| < Start of the text proposal > 5.2.2.5.1 UE assumptions for CQI/PMI/RI calculation *--- unchanged text omitted ---*  - For a UE configured with one or more SRS resource sets with higher layer parameter *usage* set to 'antennaSwitching' and higher layer parameter *resourceType* set to 'periodic' or 'semi-persistent', with a total of or 8 ports across the resources in a set intended for xT6R or xT8R, respectively, if the higher layer parameter *reportQuantity* in *CSI-ReportConfig* for which the CQI is reported is set to 'cri-RI-CQI' and the UE is configured with the higher layer parameter *SRSPortGrouping-r19*, the UE can assume that SRS port group 0 corresponds to codeword 0 and comprises the even ports, and that SRS port group 1 corresponds to codeword 1 and comprises the odd ports out of the total ports. The SRS ports are indexed in an ascending order according to SRS resource ID and port number within each SRS resource.  - For a UE configured with one or more SRS resource sets with higher layer parameter *usage* set to 'antennaSwitching' and higher layer parameter *resourceType* set to 'aperiodic', with a total of or 8 ports across the resources across the resource set(s) intended for xT6R or xT8R, respectively, if the higher layer parameter *reportQuantity* in *CSI-ReportConfig* for which the CQI is reported is set to 'cri-RI-CQI' and the UE is configured with the higher layer parameter *SRSPortGrouping-r19*, the UE can assume that SRS port group 0 corresponds to codeword 0 and comprises the even ports, and that SRS port group 1 corresponds to codeword 1 and comprises the odd ports out of the total ports. The SRS ports are indexed in an ascending order according to SRS resource set ID, SRS resource ID and port number within each SRS resource.  *--- unchanged text omitted ---*  < End of the text proposal > |

### Proposal 3.A

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| **Reason for change**: It was agreed that CJTC Dd report can be linked with Rel-18 Type-II CJT, which implies that the CQI/PMI calculation for Rel-18 Type-II CJT can be configured to assume a previously reported CJTC Dd report. Analogous to Rel-19 Type-II CJT mode-1, this can be reflected in the CQI/PMI calculation equation.  However, the current description in TS38.214 already captures the necessary behaviour albeit without equation. |
| **Summary of the change**: Added the equation for CQI/PMI calculation when CJTC Dd report is linked with Rel-18 Type-II CJT |
| **Consequences if not approved**: Possible lack of clarity in UE behaviour when CJTC Dd report is linked with Rel-18 Type-II CJT |
| 5.2.2.5.1b UE assumptions for CQI/PMI/RI calculation for CJT  If the higher layer parameter *reportQuantity* in *CSI-ReportConfig* for which the CQI is reported is set to 'cri-RI-PMI-CQI', the higher layer parameter *codebookType* is set to 'typeII-CJT-r18' or ' typeII-CJT-PortSelection-r18', and the corresponding CSI-RS Resource Set for channel measurement is configured with CSI-RS resources, for CQI calculation  - a UE should assume PDSCH signals on antenna ports in the set for layers would result in signals equivalent to corresponding symbols transmitted on antenna ports of each of the *N*0 selected CSI-RS resources, as given by    where is the precoding matrix corresponding to the procedure described in Clause 5.2.2.2.8 and 5.2.2.2.9 for *codebookType* set to 'typeII-CJT-r18' and ' typeII-CJT-PortSelection-r18', respectively, and are the indices of the *N*0 selected CSI-RS resources in increasing order, such that . A UE should assume that the signals , , fully overlap in time and frequency.  - if the CSI reports with *reportQuantity* set to 'cri-RI-PMI-CQI' and *codebookType* set to 'typeII-CJT-r18' is linked to a CSI report with *reportQuantity* set to 'cjtc-Dd' by the higher layer parameter *linkedCJTCReport*, and the two CSI reports are jointly triggered, or separately triggered and the compensation is enabled by the higher layer parameter *delayOffsetCompensation,* a UE should assume PDSCH signals on antenna ports in the set for layers would result in signals equivalent to corresponding symbols transmitted on antenna ports of each of the *N*0 selected CSI-RS resources, as given by    where is the precoding matrix corresponding to the procedure described in Clause 5.2.2.2.8 and 5.2.2.2.9 for *codebookType* set to 'typeII-CJT-r18', and are the indices of the *N*0 selected CSI-RS resources in increasing order, such that , is the subcarrier index and is the reference subcarrier index, is the subcarrier spacing and is within the interval in which the delay offset, is reported by the UE. A UE should assume that the signals , , fully overlap in time and frequency. |

# References

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| --- | --- | --- | --- |
| 1 | R1-2505206 | Maintenance of 128 CSI-RS ports and UE reporting enhancement | Huawei, HiSilicon |
| 2 | R1-2505255 | CSI Enhancement for NR MIMO | Google |
| 3 | R1-2505268 | Maintenance on CSI enhancements | ZTE Corporation, Sanechips |
| 4 | R1-2505321 | Maintenance on Rel-19 CSI enhancements | CATT |
| 5 | R1-2505371 | Maintenance on Rel-19 CSI enhancements | vivo |
| 6 | R1-2505428 | Maintenance on Rel-19 CSI enhancement | Xiaomi |
| 7 | R1-2505534 | Remaining issues on Rel-19 CSI enhancements | Samsung |
| 8 | R1-2505736 | CSI enhancements for Rel-19 MIMO | OPPO |
| 9 | R1-2505809 | Maintenance on CSI enhancements | Lenovo |
| 10 | R1-2505817 | Maintenance on CSI enhancements | LG Electronics |
| 11 | R1-2505938 | Remaining issues on CSI enhancements | NEC |
| 12 | R1-2506042 | Maintenance on Rel. 19 MIMO CSI enhancements | Fraunhofer IIS, Fraunhofer HHI |
| 13 | R1-2506161 | Maintenance of CSI enhancement for NR MIMO Phase 5 | Nokia |
| 14 | R1-2506167 | Maintenance on CSI enhancements for large antenna arrays and CJT | Ericsson |
| 15 | R1-2506176 | Maintenance on Rel-19 CSI for >32 ports and UE-assisted CJT | Qualcomm Incorporated |
| 16 | R1-2506273 | Maintainance on CSI enhancements | NTT DOCOMO, INC. |
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