**3GPP TSG RAN WG1 #121 R1-250xxxx**

**St Julian, Malta, May 19th – 23rd, 2025**

**Agenda item:** 9.2.2

**Source:** Moderator (Samsung)

**Title:** Moderator Summary on Offline Session for Rel-19 CSI enhancements

**Document for:** Discussion and Decision

## Introduction

The following proposals were discussed.

## Summary of proposals

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

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| 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 $i\_{1,2}$ is given by$$i\_{1,2}\in \left\{0,1,…,\left(\begin{matrix}N\_{1}N\_{2}\\L\_{G}\end{matrix}\right)-1\right\}$$where $L\_{G}=3$ for $υ=5,6$ and $L\_{G}=4$ for $υ=7,8$. The mapping of $i\_{1,1}$ and $i\_{1,2}$ to $m\_{1}^{(g)}$ $m^{'}\_{1}^{(g^{'})}$ and $m\_{2}^{(g)}$ $m^{'}\_{2}^{(g^{'})}$ for $g=1,…,L\_{G}$ $g^{'}=0,…,L\_{G}-1$ is obtained as in Clause 5.2.2.2.3 by replacing $i$ with $g^{'}$ and replacing $L$ with $L\_{G}$, where the values of $C(x,y)$ are given in Table 5.2.2.2.5-4 and Table 5.2.2.2.1a-5, and $m^{'}\_{1}^{(g^{'})}$ and $m^{'}\_{2}^{(g^{'})}$ for $g^{'}=0,…,L\_{G}-1$ one to one mapping to $m\_{1}^{(g)}$ and $m\_{2}^{(g)}$ for $g=1,…,L\_{G}$ with $g=g^{'}+1$,.The index $i\_{2,l}$, for $l=1,…,υ$ and $υ=1,2,3,4$ is given by$$i\_{2,l}\in \{0,1,2,3\}$$and is mapped to $c\_{l}=i\_{2,l}$. The mapping of index $i\_{2,g}$, for $g=1,…,L\_{G}$ and $υ=5,6,7,8$, to $c\_{l}$, with $l=1,…,υ$, is given in Table 5.2.2.2.1a-6. The quantities $φ\_{c\_{l}}$ and $v\_{m\_{1}^{\left(l\right)},m\_{2}^{(l)}}$ for *typeI-codebookMode-r19* = 'modeB' are the same as defined above for 'modeA'.<Unchanged part omitted>**Support/fine:** NEC, Google, Samsung, OPPO, NTT DOCOMO, Spreadtrum, Fujitsu, vivo, ETRI, Ericsson, Lenovo, Apple, ZTE/Sanechips, CATT, Xiaomi, Qualcomm, **Not support (obvious):** Nokia**,****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** | 5.2.2.2.1a Refined Type I Single-Panel Codebook<Unchanged part omitted>The index $i\_{1,2}$ is given by$$i\_{1,2}\in \left\{0,1,…,\left(\begin{matrix}N\_{1}N\_{2}\\L\_{G}\end{matrix}\right)-1\right\}$$where $L\_{G}=3$ for $υ=5,6$ and $L\_{G}=4$ for $υ=7,8$. The selection of $m\_{1}^{(g)}$ and $m\_{2}^{(g)}$ for $g=1,…,L\_{G}$ is obtained as in Clause 5.2.2.2.3, where the values of $C(x,y)$ are given in Table 5.2.2.2.5-4 and Table 5.2.2.2.1a-5.The index $i\_{2,l}$, for $l=1,…,υ$ and $υ=1,2,3,4$ is given by$$i\_{2,l}\in \{0,1,2,3\}$$and is mapped to $c\_{l}=i\_{2,l}$. The mapping of index $i\_{2,g}$, for $g=1,…,L\_{G}$ and $υ=5,6,7,8$, to $c\_{l}$, with $l=1,…,υ$, is given in Table 5.2.2.2.1a-6. The quantities $φ\_{c\_{l}}$ and $v\_{m\_{1}^{\left(l\right)},m\_{2}^{(l)}}$ for *typeI-codebookMode-r19* = 'modeB' are the same as defined above for 'modeA'.<Unchanged part omitted> |

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 $P\_{SRS}=6$ 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 $P\_{SRS}/2$ ports, and that SRS port group 1 corresponds to codeword 1 and comprises the odd $P\_{SRS}/2$ ports out of the total $P\_{SRS}$ 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 $P\_{SRS}=6$ 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 $P\_{SRS}/2$ ports, and that SRS port group 1 corresponds to codeword 1 and comprises the odd $P\_{SRS}/2$ ports out of the total $P\_{SRS}$ 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 > |

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| 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 $p^{'}$ across the K aperiodic CSI-RS resources, $p^{'}=0,1,…,P\_{CSI-RS}-1$, 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,  |

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| 1.6 | **[117] Agreement**For the Rel-19 Type-II codebook refinement for 48, 64, and 128 CSI-RS ports, on CBSR, * $\frac{N\_{1}⋅N\_{2}}{X\_{1}⋅X\_{2}}$-bit group-based CBSR
* the following (X1, X2) values are supported:

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| **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 $\frac{N\_{1}⋅N\_{2}}{X\_{1}⋅X\_{2}}$-bit group-based bitmap is identical for all the $O\_{1}O\_{2}$ 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,  |

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| 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,  |

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

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| 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.  **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**
 | **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,  |

### Issue 3 (WID objective 3): CJT calibration reporting for non-ideal synchronization and backhaul

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 $1\leq N\_{TRP}\leq 4$ CSI-RS resources, for CQI calculation- a UE should assume PDSCH signals on antenna ports in the set $[1000,…,1000+υ-1]$ for $υ$ layers would result in signals equivalent to corresponding symbols transmitted on antenna ports $[3000,…,3000+P-1]$ of each of the *N*0 selected CSI-RS resources, as given by $\left[\begin{matrix}\begin{array}{c}y\_{σ\_{1}}^{\left(3000\right)}(i)\\\vdots \\y\_{σ\_{1}}^{\left(3000+P-1\right)}(i)\end{array}\\\begin{matrix}y\_{σ\_{2}}^{\left(3000\right)}(i)\\\vdots \\y\_{σ\_{2}}^{\left(3000+P-1\right)}(i)\\\vdots \\\begin{array}{c}y\_{σ\_{N\_{0}}}^{\left(3000\right)}(i)\\\vdots \\y\_{σ\_{N\_{0}}}^{\left(3000+P-1\right)}(i)\end{array}\end{matrix}\end{matrix}\right]=W\left(i\right)\left[\begin{array}{c}x^{\left(0\right)}\left(i\right)\\\vdots \\x^{\left(υ-1\right)}\left(i\right)\end{array}\right]$where $W(i)$ 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 $\{σ\_{1},…,σ\_{N\_{0}}\}$ are the indices of the *N*0 selected CSI-RS resources in increasing order, such that $1\leq σ\_{1}<…<σ\_{N\_{0}}\leq N\_{TRP}$. A UE should assume that the signals $y\_{σ\_{j}}$, $j=1,…,N\_{0}$, 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 $[1000,…,1000+υ-1]$ for $υ$ layers would result in signals equivalent to corresponding symbols transmitted on antenna ports $[3000,…,3000+P-1]$ of each of the *N*0 selected CSI-RS resources, as given by $\left[\begin{matrix}\begin{array}{c}y\_{σ\_{1}}^{\left(3000\right)}\left(k\right)\\\vdots \\y\_{σ\_{1}}^{\left(3000+P-1\right)}\left(k\right)\\\vdots \end{array}\\\begin{matrix}y\_{σ\_{n\_{ref}}}^{\left(3000\right)}(k)\\\vdots \\y\_{σ\_{n\_{ref}}}^{\left(3000+P-1\right)}(k)\\\vdots \\\begin{array}{c}y\_{σ\_{N\_{0}}}^{\left(3000\right)}(k)\\\vdots \\y\_{σ\_{N\_{0}}}^{\left(3000+P-1\right)}(k)\end{array}\end{matrix}\end{matrix}\right]=\left[\begin{matrix}e^{-j2π\left(k-k\_{0}\right)∆f∆τ\_{σ\_{1}}}W\_{σ\_{1}}(k)\\\begin{matrix}\vdots \\W\_{σ\_{n\_{ref}}}(k)\\\vdots \end{matrix}\\e^{-j2π(k-k\_{0})∆f∆τ\_{σ\_{N}}}W\_{σ\_{N}}(k)\end{matrix}\right]\left[\begin{array}{c}x^{\left(0\right)}\left(k\right)\\\vdots \\x^{\left(υ-1\right)}\left(k\right)\end{array}\right]$ where $W(k)$ 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 $\{σ\_{1},…,σ\_{N\_{0}}\}$ are the indices of the *N*0 selected CSI-RS resources in increasing order, such that $1\leq σ\_{1}<…<σ\_{N\_{0}}\leq N\_{TRP}$, $k$ is the subcarrier index and $k\_{0}$ is the reference subcarrier index, $∆f$ is the subcarrier spacing and $∆τ\_{σ\_{n}}$ is within the interval $[δ\_{i\_{n}},δ\_{i\_{n}+1})$ in which the delay offset, $D\_{n,offset}$ is reported by the UE. A UE should assume that the signals $y\_{σ\_{j}}$, $j=1,…,N\_{0}$, fully overlap in time and frequency. |

# References