**3GPP TSG RAN WG1 #122 R1-2505535**

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

**Agenda item:** 8.2.2

**Source:** Moderator (Samsung)

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

**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
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## Summary of companies’ proposals and views

**Please read**:

* As we are now in the maintenance phase, only *potentially* essential issues/proposals will be discussed. Essential means without the changes the specs are ambiguous, inconsistent, and/or broken.
* Proposals related to editorial changes (e.g. minor typos) and past agreements *perhaps* not properly or sufficiently captured should be addressed by the editors. Please contact the editors directly. Examples:
	+ ZTE’s R1-2505268 TP-1, TP-4
	+ CATT’s R1-2505321 TPs 2.1, 2.2, 3.1
	+ Vivo’s R1-2505371 TP-2
	+ Xiaomi’s R1-2505428 Proposals 2, 3
	+ LG’s R1-2505817 Proposal 1
	+ Nokia’s R1-2506161 Proposals 1 and 2
	+ Ericsson’s R1-2506167 Proposal 2
* Proposals related to RRC parameters that do not need significant discussion in 8.2.2 can be directly commented to the MIMO RRC moderator (Darcy Tsai) during the RAN1#122 email discussion. Examples:
	+ Samsung’s R1-2505534 Proposal 2
* Proposals related to UE capability will be handled in UE feature session. Examples:
	+ ZTE’s R1-2505268 Proposal 1
* I will provide the corresponding **official TPs only** for proposals that seem promising and are clearly essential (based on companies’ views gathered in round-1) *no later than prior to round-1 (Monday) online session.*

### 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** |
| 1.1 | **[116bis] Agreement**For the Rel-19 Type-I and Type-II codebook refinement for 48, 64, and 128 CSI-RS ports, regarding the mapping from CSI-RS resource index/port index per resource and port index to CSI/PMI calculation, support NW to configure UE with one of the following mapping methods via higher-layer (RRC) signaling, * *Mapping method 1*: Sequential ordering/indexing within (1st resource, 1st polarization), then (2nd resource, 1st polarization), …, then (Kth resource, 1st polarization), then (1st resource, 2nd polarization), then (2nd resource, 2nd polarization), …, then (Kth resource, 2nd polarization)
* *Mapping method 2*: Sequential ordering/indexing within (where K\*n2 = N2):

**[117] Agreement**For the Rel-19 Type-I and Type-II codebook refinement for 48, 64, and 128 CSI-RS ports, regarding port mapping, * Following legacy principle, “sequential ordering/indexing within” a group of Q indices {i0, i1, …, iQ-1} is a linearly increasing sequence such that iq < iq+1 (where q=0, 1, …, Q-2 is the port index within a CSI-RS resource, and iq or iq+1 $\in $ {0, 1,…, KQ-1}) is the port index for the codebook, across the K>1 CSI-RS resources).
* After resource aggregation, P (=48, 64, or 128) ports are numbered in accordance to Table 7.4.1.5.3-1 from TS 38.211

**[121] Agreement**For the Rel-19 Type-I SP and Type-II codebook refinement for *P*=48, 64, and 128 CSI-RS ports with K>1 aggregated NZP aperiodic CSI-RS resources for CMR, to implement the previous agreements on the mapping from CSI-RS resource index/port index per resource and port index to CSI/PMI calculation* In TS38.211, extend the enumeration of antenna port *p=*3000+*p*’ with *p*’=0 …*P–*1
* In TS38.214, remove the term ‘port index for CSI/PMI calculation’

**Proposal 1.A**: For the Rel-19 Type-I SP and Type-II codebook refinement, refine the following agreement in RAN1#121 as follows:**Agreements**For the Rel-19 Type-I SP and Type-II codebook refinement for *P*=48, 64, and 128 CSI-RS ports with K>1 aggregated NZP ~~aperiodic~~ CSI-RS resources for CMR, to implement the previous agreements on the mapping from CSI-RS resource index/port index per resource and port index to CSI/PMI calculation* In TS38.211, extend the enumeration of antenna port *p=*3000+*p*’ with *p*’=0 …*P–*1
* In TS38.214, remove the term ‘port index for CSI/PMI calculation’

Consequently, based on the endorsed version of TS38.214 V19.0.0, the current description for aperiodic CSI-RS resources should also be applied to periodic and semi-persistent CSI-RS resources.**FL assessment**: The above proposal attempts to harmonize the texts in 211 and 214 for port mapping. While the text in 211 is fine, the text in 214 exhibits discrepancy for P and SP CSI-RS as it assumes a different port indexing scheme from the one specified in 211. This should be fixed. Note that the previous agreement in RAN1#121 was limited only to AP due to a trivial yet unfortunate “*obvious typo*” (from JD’s wording in [15]) from the FL.Example TPs can be found in * Huawei [1], where 2 TPs are proposed: one for port mapping per se, the other for SRS port grouping in relation to port mapping
* ZTE [3], TP-3
* OPPO [8], TP-2
* Qualcomm [15], TP-1 and TP-2
* NTT DOCOMO [16], TP
 | **Support/fine:** Huawei, HiSi, ZTE/Sanechips, Xiaomi, Samsung, OPPO, NEC, Ericsson, Qualcomm, NTT DOCOMO, **Not support:**  |
| 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 is needed.  | **Support/fine:** Google**Not support:** |
| 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>**FL assessment**: This TP seems to be correct and clearer than the current text. Whether this is needed or not can be discussed.  | **Support/fine:** NEC, **Not support:** |
| 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, **Not support:**  |
| 1.5 | **Proposal 1.E**: Adopt the following changes to TS38.214 V19.0.0 Clause 6.2.1.3 on priority rules for UE sounding procedure as follows:**6.2.1.3 UE sounding procedure between component carriers**< Unchanged part omitted >- the UE shall drop PUCCH/PUSCH transmission carrying periodic/semi-persistent CSI not comprising RI/CRI/SSBRI ~~comprising only CQI/PMI/L1-RSRP/L1-SINR~~, and/or SRS transmission on a carrier of a serving cell in set $S\left(c\_{2}\right)$ configured for PUSCH/PUCCH transmission whenever the transmission and SRS transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *SRS-SwitchingTimeNR)* on the carrier of the serving cell $c\_{1}$ happen to overlap in the same symbol- the UE shall drop PUSCH transmission carrying aperiodic CSI not comprising RI/CRI/SSBRI ~~comprising only CQI/PMI/L1-RSRP/L1-SINR/TDCP~~ on a carrier of a serving cell in set $S\left(c\_{2}\right) $whenever the transmission and aperiodic SRS transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133]) as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *SRS-SwitchingTimeNR)* on the carrier of the serving cell $c\_{1}$ happen to overlap in the same symbol.< Unchanged part omitted >**FL assessment**: This proposal is technically sound since Rel-19 introduces new reportQuantities (mostly not from MIMO), including 'cli-SRS-RSRP', 'cli-RSSI', 'p-cri-r19', 'p-cri-RSRP-r19', 'p-ssb-index-r19', 'p-ssb-index-RSRP-r19', 'rs-pai-r19', 'csi-pai-r19', 'cjtc-Dd', 'cjtc-F', 'cjtc-Dd-F' or 'cjtc-P'. | **Support/fine:** OPPO, **Not support:**  |
| 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, **Not support:**  |
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| **Proposals from previous more recent meeting(s) and/or round(s)** |
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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.** |
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### 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** |
| 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, Not support: |
| **Proposals from previous more recent meeting(s) and/or round(s)** |
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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 | **Please share your inputs on each of the issues and, if applicable, proposals in TABLE 1A** |
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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** |
| 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$$\left[\begin{matrix}\begin{matrix}\begin{matrix}y\_{t\_{1}}^{\left(3000\right)}(k)\\\vdots \\y\_{t\_{1}}^{\left(3000+P-1\right)}(k)\end{matrix}\\\begin{matrix}\vdots \\\begin{matrix}y\_{n\_{ref}}^{\left(3000\right)}(k)\\\vdots \\y\_{n\_{ref}}^{\left(3000+P-1\right)}(k)\end{matrix}\end{matrix}\end{matrix}\\\vdots \\\begin{array}{c}\&y\_{t\_{N}}^{\left(3000\right)}(k)\\\vdots \\\&y\_{t\_{N}}^{\left(3000+P-1\right)}(k)\end{array}\end{matrix}\right]=\left[\begin{matrix}e^{-j2π\left(k-k\_{0}\right)∆f∆τ\_{t\_{1}}}W\_{t\_{1}}(k)\\\begin{matrix}\vdots \\W\_{n\_{ref}}(k)\\\vdots \end{matrix}\\e^{-j2π(k-k\_{0})∆f∆τ\_{t\_{N}}}W\_{t\_{N}}(k)\end{matrix}\right]\left[\begin{array}{c}\&x^{\left(0\right)}\left(k\right)\\\vdots \\\&x^{\left(υ-1\right)}\left(k\right)\end{array}\right]$$Where $t\_{1}$ is the selected CSI-RS resource, k is the subcarrier index, $k\_{0}$ is the reference subcarrier, $∆f$ is the subcarrier spacing and $∆τ\_{t\_{n}}$ is the DO. **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. | **Support/fine:** Huawei/HiSi, ZTE/Sanechips, **Not support:** |
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| **Proposals from previous more recent meeting(s) and/or round(s)** |
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Table 3B LLS/SLS results: issue 3

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Table 3C Additional inputs: issue 3

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| **Company** | **Input** |
| Mod V0 | **Please share your inputs on each of the issues and, if applicable, proposals in TABLE 3A** |
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# 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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