**3GPP TSG RAN WG1 #119 R1-2410752**

**Orlando, US, November 18th – 22nd, 2024**

**Agenda item:** 9.2.2

**Source:** Moderator (Samsung)

**Title:** Moderator Summary#3 on Rel-19 CSI enhancements: Round 3

**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

***Ground rules in sharing your inputs:***

* **Please do NOT input anything in Tables 1A, 2A, and 3A**
	+ **Including company names - appreciate your trying to save me some work, but …**
	+ **For some reason, most likely due to poor MS Word inter-platform/version compatibility support (if any), the formatting of the FL proposals will change (for the worse) if you do so. This has happened several times in Athens and Changsha ☹**
* **Please input your comments ONLY in Tables 1C, 2C, and 3C, thanks! 😊**

### 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** |
| 1.2 | **Proposal 1.B**: For the Rel-19 Type-I SP codebook refinement for 48, 64, and 128 CSI-RS ports, extend the agreed Scheme-A and Scheme-B to 16, 24, and 32 CSI-RS ports, for all applicable RI values with K=1 only, and without any further modification/enhancement of the sub-features pertinent to the Rel-19 Type-I SP design (including, e.g. the Rel-19 Type-I SP CBSR, soft scaling).* For the Rel-19 Type-I SP codebook, the support for 16, 24, and 32ports are 3 separate UE capabilities from the support for the previously agreed number of ports (48, 64, 128 ports)
* The Rel-18 SD NES schemes applicable to Rel-15 Type-I SP codebooks are also applicable to the extension of the Rel-19 Type-I SP codebook to 16, 24, and 32 ports
* FFS: whether to adopt the extended orthogonal set for the 2nd SD basis for Scheme-A, RI=2-4 and 16, 24, and 32 CSI-RS ports

**FL assessment**: This was discussed OFFLINE [1] as well as OFFLINE-2. We have tried the possibilities of extending only Scheme-A, but the number of companies raising concerns is very large. The same goes with only Scheme-B. FFS:* Yes: Nokia/NSB,
* No: NTT DOCOMO, NTT CORP, ZTE, Tejas,
 | **Support/fine:** ZTE, IDC, Samsung, Xiaomi, Nokia/NSB, NEC, Fujitsu, NTT DOCOMO, NTT CORP, Spreadtrum, UNISOC, CMCC, MediaTek, Ericsson, Apple, Google, IDC, Tejas, Sharp, Orange, Lenovo/MotM (ok, low priority), China Telecom, KDDI, Intel (ok), New H3C,**Strong concern:** vivo, CATT, OPPO |
| 1.4. | **Proposal 1.D**: For the Rel-19 Type-I SP codebook refinement for P=48, 64, 128 CSI-RS ports, regarding Scheme-B, when the UE is configured to report wideband CSI on PUCCH:* For PUCCH format 2, one-part CSI is used
* For PUCCH formats 3 and 4, two-part CSI is used where SD basis selection is reported in CSI-part2
	+ CSI fields in CSI-part1 and part2 follows the legacy sub-band CSI

**FL assessment**: This proposal is scheme-B optimization for WB PUCCH reporting. Whether a two-part CSI is needed or not can be discussed, e.g. whether the difference in payload across RIs is enough to justify the use of two-part CSI on PUCCH F3/4 especially for WB.* From moderator perspective, **the difference in payload across RIs will be much larger when Nrep>1 is configured to be reported on the same PUCCH**.
	+ **[JD/Qualcomm] Nrep>1 on PUCCH is practical for CA, since only one (or optionally, two) cell can have PUCCH to convey all DL CCs’ CSI reports.**
* To minimize spec impact, PF2 is still kept 1-part (since 2-part isn’t supported for PF2 in legacy).
* Therefore, this proposal is technically sound
 | **Support/fine:** Qualcomm,Xiaomi (open), Fraunhofer IIS/HHHI (open), Samsung (ok), Tejas (open), vivo (open), Sharp, NTT DOCOMO, NTT CORP, Apple (open), TCL, **Not support:** Google, CMCC, Lenovo/MotM, OPPO, Fujitsu, ZTE, CATT, Spreadtrum, Intel, Huawei/HiSi, New H3C, |
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Table 1B SLS results: issue 1

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| **Company** | **SLS results** |
| **Issue #** | **Metric** | **Observation** |
| ZTE | 1.2 | 5%/95%/avg UPT gain | Performance comparison between Rel-19 Type-I codebook (Scheme-A) and Rel-15 Type-I codebook for RI=3-4*It is shown in the figure of SLS results above that Rel-19 Type-I codebook (Scheme-A) for rank-3/4 offers a significant UPT gain (i.e., ~21.2% for cell-edge UE, ~3.8% for near-field UE, ~8.1% in average) over Rel-15 SP Type-I codebook for PCSI-RS = 32.* |
| Samsung | 1.2 | Avg UPT gain vs overhead | *It is shown in the figures of SLS results above that Both schemes A and B yield avg UPT gain over the Rel-15 T1 for at least configurations of 32 and 16 ports. Especially, scheme B yields significant UPT gains 8% and 4.5% over both Scheme A and Rel-15 T1 in the legacy number of CSI-RS ports 32 and 16 ports, respectively.* |
| Vivo | 1.2 | Cell mean SE | Cell mean SE comparison for different CB schemes*It is shown in the figure of SLS results above that when rank adaptation up to rank 2 is enabled, Rel-19 Type-I Scheme B yields 1~2% Cell-mean SE gain over Rel-15 Type-I for 8T4R, 16T4R, and 32T4R.* |
| Nokia/NSB | 1.2 | Mean UPT gain vs overhead | Mean throughput gain vs mean overhead comparison between Rel-15 Type-I, Scheme-A and Scheme-B for maximum rank 8, with 16 (4x2) and 32 (8x2) ports.*It is observed from the SLS results above that:* *for 16 ports, Scheme-A shows about 5.6% mean throughput gain over Rel-15 Type-I with about 5 bits increase in mean overhead. Scheme-B shows about 11.5% mean throughput gain over Rel-15 Type-I with about 58 bits increase in mean overhead.* *For 32 ports, Scheme-A shows about 6% mean throughput gain over Rel-15 Type-I with about 10 bits increase in mean overhead. Scheme-B shows about 13% mean throughput gain over Rel-15 Type-I with about 59 bits increase in mean overhead.* |
| Ericsson | 1.2 | Mean UPT gain, 5% UPT gain | Comparison between Rel-15 and Rel-19 Type I codebooks for 32 ports for ranks 1-4*It is observed from the SLS results above that Rel-19 Type I Scheme A (no array splitting) shows around 3% (4%) gain at 50% RU and around 7% (8%) gain at 70% RU when compared to the Rel-15 baseline for mean user throughput (cell edge throughput). Rel-19 Type I Scheme B shows around 7% (12%) gain at 50% RU and around 16% (24%) gain at 70% RU when compared to the Rel-15 baseline for mean user throughput (cell edge throughput).* ***​*** |
| CATT | 1.2 | Mean UPT  | Average throughput performance comparison between Rel-15 Type I SP codebook and extension of scheme A and B with 32 ports, up to 4 layers. Ok to extend scheme B to <=32 ports but have concerns for scheme A. we suggest to remove scheme A from the proposal. |

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** |
| 2.6 | Proposal 2.F: For the Rel-19 CRI-based CSI refinement for up to 128 CSI-RS ports, regarding UCI omission for the UCI reported in CSI part-2, support the following method for assigning priority levels to multiple CRIs in a single CSI instance.* For the non-reported *MR* CRIs, priority order (from higher to lower) is assigned based on the RRC configured order of *MR*.
* For the reported *M*-*MR* CRIs (or *M* CRIs if *MR* is not configured), priority order (from higher to lower) is assigned based on a beam quality measure like, CRIs’ SINR or CRIs’ RSRP or a combination of resource specific RI and resource specific CQI.

**FL assessment**: The proposal introduces additional priority rules for the (M-MR) CRIs. Given the previous agreement on priority rules and packing order (along with M CRIs), it is unclear why this additional set of rules is needed.  | **Support/fine**: Tejas, IDC (open), Huawei/HiSi (open),**Not support**: Google, Qualcomm, NTT DOCOMO, NTT CORP, MediaTek, Xiaomi, CMCC (UE implementation), Lenovo/MotM, OPPO, ZTE, CATT, Spreadtrum, Intel, Apple, TCL, New H3C, |
| 2.7 | **Proposal 2.G**: For the Rel-19 CRI-based CSI refinement for up to 128 CSI-RS ports,select between the following priority functions:* Alt1: $Pri\_{iCSI}\left(y,k,c,s,m,M\right)=2∙N\_{cells}∙M\_{s}∙M\_{m}∙y+N\_{cells}∙M\_{s}∙M\_{m}∙k+M\_{s}∙M\_{m}∙c+s+M\_{s}∙M∙m$
* Alt2: $Pri\_{iCSI}\left(y,k,c,s,m,M, M\_{R}\right)=2∙N\_{cells}∙M\_{s}∙M\_{m}∙y+N\_{cells}∙M\_{s}∙M\_{m}∙k+M\_{s}∙M\_{m}∙c+s+M\_{s}∙(M-M\_{R})∙m$
* Alt3: No change to legacy $Pri\_{iCSI}\left(y,k,c,s\right)=2∙N\_{cells}∙M\_{s}∙y+N\_{cells}∙M\_{s}∙k+M\_{s}∙c+s$, and, when configured with a multi-CRI report with M>1 CRIs and *reportConfigID* “$s$”, UE does not expect to be configured with another CSI report with *reportConfigID* value from “$s+1$” to “$s+M-1$” while having the same parameter value “$y$” “$k$” and “$c$” as the multi-CRI report “$s$”

where * *m =* 0 for non-*M* CRI based CSI reports (legacy CSI reports up to Rel-18),
* *m =* 1 for *M* CRI based CSI reports. $M\_{m}$ is the maximum number of CRIs configured for multi-CRI CSI reports not carrying L1-RSRP or L1-SINR

**FL assessment**: The proposal introduces additional priority rule for the (M-MR) CRIs. Whether this is needed or not can be discussed (currently unclear to the moderator).  | **Support/fine**: Tejas (Alt1/2), Qualcomm (Alt3), MediaTek, Lenovo/MotM (Alt3), IDC, Samsung (ok), Huawei/HiSi (open), Xiaomi (Alt3)**Not support**: Google, NTT DOCOMO, NTT CORP, CMCC, OPPO, Fujitsu, ZTE, Spreadtrum, vivo, Ericsson, Apple, TCL, New H3C,  |
| 2.8 | **Proposal 2.H**: For the Rel-19 CRI-based CSI refinement for up to 128 CSI-RS ports, support dropping of CSI part-2 (PMI, LI, CQI for 2nd CW) for a CRI corresponding to out-of-range WB CQI reported in the CSI part-1**FL assessment**: The proposal intends to reduce CSI part-2 overhead | **Support/fine**: Intel, Google, NTT DOCOMO, NTT CORP, Fujitsu, Huawei/HiSi (open), Xiaomi (open), **Not support**: Spreadtrum, CATT, Lenovo/MotM, ZTE, OPPO, Apple, vivo, Ericsson,  |

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** |
| 3.2.1 | **[119] Agreement**For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, when linking CJTC Dd and Rel-18 eType-II CJT CSI reports is configured with a joint trigger, the timeline (Z/Z’) is determined as Z/Z’ associated with the Rel-18 eType-II CJT, plus Drelax * The value of Drelax is a UE capability, taken from {0, drelax}
	+ FFS: The value of drelax (>0), including whether it depends on SCS
* For linking CJTC Dd and Rel-18 eType-II CJT CSI, joint triggering is a separate UE feature group from separate triggering

**Proposal 3.B.4:** For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, when linking CJTC Dd and Rel-18 eType-II CJT CSI reports is configured with a joint trigger, drelax is Z1’ of table 5.4-2 in TS38.214 (corresponding to WB Type I CSI report with at most 4 ports)**FL assessment**: Discussed during OFFLINE-1. The FFS needs to be resolved**Question 3.B.4:** For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, when linking CJTC Dd and Rel-18 eType-II CJT CSI reports is configured with a joint trigger, please share your view, if any, on the value of drelax (>0):* Z1’ of table 5.4-2 in TS38.214 (corresponding to WB Type I CSI report with at most 4 ports): MediaTek, Google, Lenovo/MotM, ZTE,
* *Z2/Z2’:* ZTE
* $\frac{1}{2}\left(Z\_{2}/Z\_{2}^{'}\right)$*:* ZTE
* *Z1/Z1’:* ZTE
* UE feature session: Samsung, CATT, OPPO, Spreadtrum, Apple,
 | **Support/fine**: MediaTek, Google, Lenovo/MotM, ZTE, Xiaomi, NEC, OPPO, **Not support (UE feature session, or need more time):** vivo, Samsung, CATT, Spreadtrum, Apple, Ericsson, Huawei/HiSi,  |
| 3.2.2 | **Proposal 3.B.2**: For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, when linking CJTC Dd and Rel-18 eType-II CJT CSI reports is configured with a joint trigger, the UE does not perform DO compensation on the Rel-18 type II CJT CSI associated with TRP(s) that are either ‘out of range’ **FL assessment**: Since linkage assumes UE-specific PDSCH digital DO pre-compensation akin to Rel-18 Type-II CJT Mode-1, a proper use case would assume that the selection of NTRP TRPs already removes TRPs that result in dn=’outside’. So the need for this proposal is unclear. | **Support/fine**: MediaTek, Samsung, Xiaomi, NEC, Spreadtrum, vivo (open), Sharp, Sony, Apple, Google (OOR), Lenovo/MotM, Sony, **Not support**: NTT DOCOMO, NTT CORP, Nokia/NSB, OPPO, Fujitsu, ZTE, CATT, Rakuten, Huawei/HiSi, KDDI, TCL,  |
| 3.4 | **[118] Agreement**For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, to facilitate UE-specific frequency offset pre-compensation on PDSCH by the NW, *decide*, by RAN1#118, whether to support configuring a UE (via RRC ignalling) to perform PMI calculation for the Rel-18 eType-II CJT CSI report assuming pre-compensation using the UE-reported frequency offset (when ReportQuantity is ‘cjtc-F’). And if supported, whether any of the following is additionally supported or not: * NW indicates the frequency offset value to be compensated for the Rel-18 eType-II CJT CSI report, and/or
* The two separately configured reports (i.e. Rel-18 eType-II CJT CSI report and the CJTC frequency offset report) are always jointly triggered and carried on a same PUSCH (hence on a same slot)
* The frequency offset value to be compensated is the latest reported fO before the DCI triggering the CJT CSI reporting

FFS: AP-CSI-RS can be configured for the Rel-18 eType-II CJT reportThe above only applies when the CMRs do not share common QCL source for Doppler shift indication**Proposal 3.D.1**: For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, to facilitate UE-specific frequency offset pre-compensation on PDSCH by the NW, support configuring a UE (via RRC signalling) to perform PMI calculation for the Rel-18 eType-II CJT CSI report assuming pre-compensation using the UE-reported frequency offset (when ReportQuantity is ‘cjtc-F’), using the same mechanisms as that for UE-reported delay offset (when ReportQuantity is ‘cjtc-Dd’).* This implies that all the supported sub-features associated with ReportQuantity = ‘cjtc-Dd’ linked to Rel-18 eType-II CJT CSI are extended to ReportQuantity = ‘cjtc-F’ linked to Rel-18 eType-II CJT CSI

**FL assessment**: The above issue needs some discussion.  | **Support/fine**: vivo, Xiaomi, Fujitsu, Sony, Samsung, ZTE, Rakuten,**Not support (NW implementation)**: Huawei/HiSi, MediaTek, CMCC, CATT, Nokia/NSB, Qualcomm, Lenovo/MotM, NTT DOCOMO, NTT CORP, OPPO, Google, Spreadrum, Sharp, Intel, Apple, KDDI, TCL, New H3C,  |
| 3.5.1 | **Proposal 3.E.1**: For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, when linking CJTC Dd and Rel-18 eType-II CJT CSI reports is configured with two separate triggers, introduce a UE capability for the following: * The UE capability is used to inform the NW on the maximum duration of 2 sec the UE can store the latest CJTC Dd report, measured from the transmission of the linked CJTC Dd report
* When the UE does not report this UE capability, it is assumed that the UE can store a CJTC Dd report [indefinitely]

**FL assessment**: Wording is based on the outcome of Monday and Wednesday **OFFLINE** sessions in RAN1#118bis.This is intended to avoid stale Dd report from being utilized. However, it can be argued that this can be handled via NW implementation. | **Support/fine**: Lenovo/MotM, ZTE, Qualcomm, vivo, Xiaomi, Huawei/HiSi, NEC, HONOR, Sharp, KDDI, MediaTek, NTT DOCOMO, NTT CORP, Apple, Google, Spreadtrum, CATT, China Telecom, TCL, New H3C, **Not support**: Intel, Ericsson, Nokia/NSB, OPPO,  |
| 3.5.2 | **Proposal 3.E.2**: For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, when linking CJTC Dd and Rel-18 eType-II CJT CSI reports is configured with two separate triggers, when at least one of the NTRP reported delay offset (DO) values in a linked CJTC Dd report is ‘out of range’, the UE does not perform DO compensation on the triggered Rel-18 eType-II CJT CSI associated with TRP(s) that are ‘out of range’**FL assessment**: Tuesday **OFFLINE** outcome in RAN1#118bis.  | **Support/fine**: Huawei/HiSi, Qualcomm, Samsung, Ericsson, Sony, Lenovo/MotM, Xiaomi, NEC, HONOR, OPPO, Google, NTT DOCOMO, NTT CORP, MediaTek, Spreadtrum, vivo (open), Sharp, Intel (ok), Sony, Apple, KDDI, New H3C, **Not support**: Nokia/NSB, ZTE, IDC, CATT, Fujitsu, Rakuten, TCL, |
| 3.7.1 | **Proposal 3.G.1:** For the Rel-19 aperiodic standalone CJT calibration reporting, support joint Dd + phase offset (PO) reporting as follows:* Only wideband (=1) PO is supported
* No further optimization of CSI reporting format, e.g. configurability of not reporting {dn}
* The UCI parameters are captured in the table below

*When ReportQuantity is ‘cjtc-Dd-P’ (joint Doffset+d and PO)*

|  |  |
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| Parameter | Details/description |
| nref1 | Reference TRS resource set index for Doffset+d, based on the ordering from RRC configuration: $\left⌈log\left(N\_{TRP}\right)\right⌉$ bits |
| nref2 | Reference TRS resource set index for PO, based on the ordering from RRC configuration: $\left⌈log\left(N\_{TRP}\right)\right⌉$ bits |
| {Dn,offset, n=0, 1, …, NTRP – 1 n≠nref1} | Delay offset for CSI-RS resource set n:$\left(N\_{TRP}-1\right)\left⌈log\left(M\_{D}\right)\right⌉$ bits |
| {dn, n=0, 1, …, NTRP – 1, n≠nref1 } | 1-bit inside/outside indicator for CSI-RS resource set n: $\left(N\_{TRP}-1\right)$ bits |
| {POn , n=0, 1, …, NTRP –1, n≠nref2} | Wideband phase offset for CSI-RS resource n: $\left(N\_{TRP}-1\right)\left⌈log\left(M\_{Φ}\right)\right⌉$ bits |

* The UCI mapping order is as follows:
	+ nref1,
	+ nref2,
	+ {Dn,offset, n=0, 1, …, NTRP – 1, n≠nref} ordered from the lowest to highest CSI-RS resource set ID,
	+ {dn, n=0, 1, …, N TRP – 1, n≠nref} ordered from the lowest to highest CSI-RS resource set ID
	+ {POn, n=0, 1, …, NTRP – 1, n≠nref} ordered from the lowest to highest CSI-RS resource ID,

**FL assessment**: This proposal (from RAN1#118) is an optimization since each can be reported separately. | **Support/fine:** Qualcomm, Sony, Samsung (ok), Google, ZTE, Fujitsu, Sony, Ericsson (open), Apple,**Not support**: Huawei/HiSi, MediaTek, NTT DOCOMO, NTT CORP, NEC, Intel, TCL, Huawei/HiSi, Xiaomi, IDC, Sharp, KDDI, CMCC, ETRI, OPPO, Apple, vivo, New H3C, Nokia/NSB, Spreadtrum, TCL, Lenovo/MotM, Rakuten, |
| 3.7.2 | **Proposal 3.G.2:** For the Rel-19 aperiodic standalone CJT calibration reporting, support reporting, as a new ReportQuantity in one CSI reporting instance and one CSI Reporting Setting, L1-RSRPs associated with the configured NTRP CSI-RS resources and the following CJT calibration report type: * ReportQuantity is ‘cjtc-Dd’ (delay offset)

The legacy L1-RSRP is fully reused, where the L1-RSRP associated with nref is the reference for the other (NTRP-1) differential L1-RSRP(s) * The NTRP CRI(s) are not reported

**FL assessment**: This proposal (from RAN1#118) is an optimization primarily for TRP selection (which utilizes both RSRP and CJTC report). As a possible compromise, the proposal is limited to Dd only to add NW to select TRP with only one CSI Report Setting. @Those not supporting or against: please check if this helps 😊 | **Support/fine:** NEC, NTT DOCOMO, NTT CORP, Lenovo/MotM (low priority), Samsung, Sony, **Not support**: ZTE, Xiaomi, Fujitsu, Ericsson, Apple, Huawei/HiSi, OPPO, TCL, ETRI, New H3C, Google, Nokia/NSB, vivo, Sharp, Intel, KDDI, Spreadtrum, TCL, China Telecom, CMCC, IDC, Rakuten,  |
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Table 3B LLS/SLS results: issue 3

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| **Company** | **SLS results** |
| **Issue #** | **Metric** | **Observation** |
| ZTE | 3.4 | Cell-edge and average UPT gains | SLS throughput results for non-compensated CJT and UE-specific DO/FO pre-compensated CJT*It is observed in the figure of SLS results that, UE-specific FO pre-compensation CJT (130.26% performance for cell-edge UE, 107.77% performance in average) outperforms non-pre-compensated CJT (100% performance for cell-edge UE, 100% performance in average) and DO pre-compensated CJT (127.18% performance for cell-edge UE, 106.61% performance in average), and both DO and FO pre-compensated CJT provides the best performance (156.41% performance for cell-edge UE, 117.81% performance in average).* |
| Qualcomm | 3.7.1 | Relative UPT gain vs DL SNR | A graph of different types of data  Description automatically generated with medium confidencePerformance comparison between PO+delay/TAE and subband phase with MRT-precoded CSI-RSs (left figure) and non-MRT-precoded CSI-RSs (right figure)*From the SLS results, the following observations can be made:** *For MRT-precoded CSI-RSs, Opt1 (wideband/initial PO + delay/TAE) outperforms Opt2 (subband PO) for the case of all 16 subbands (which is with massive UCI overhead).*

*For non-MRT-precoded CSI-RS), the benefit of Opt1 (wideband/initial PO + delay/TAE) over Opt2 (subband PO) is reduced.* |
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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 | RP-242394 | Revised WID: NR MIMO Phase 5 | Samsung (Moderator) |
| 2 | R1-2409587 | Moderator Summary for OFFLINE discussion on Rel-19 CSI enhancements | Moderator (Samsung) |
| 3 | R1-2409371 | CSI enhancements | MediaTek Inc. |
| 4 | R1-2409378 | Discussion on CSI enhancements | ZTE Corporation, Sanechips |
| 5 | R1-2409428 | On 128 CSI-RS ports and UE reporting enhancement | Huawei, HiSilicon |
| 6 | R1-2409432 | CSI enhancements for Rel. 19 MIMO | Fraunhofer IIS, Fraunhofer HHI |
| 7 | R1-2409460 | Further Details on Rel-19 Enhancements of CSI | InterDigital, Inc. |
| 8 | R1-2409505 | Discussion on CSI enhancements | CMCC |
| 9 | [R1-2409589](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_119/Docs/R1-2409589.zip) | Views on Rel-19 CSI enhancements | Samsung |
| 10 | R1-2409630 | Discussion on CSI enhancements | Spreadtrum, UNISOC |
| 11 | R1-2409674 | Remaining issues on Rel-19 CSI enhancements | vivo |
| 12 | R1-2409747 | CSI enhancements for MIMO | Intel Corporation |
| 13 | R1-2409761 | CSI enhancements  | Tejas Networks Limited |
| 14 | R1-2409793 | Views on R19 MIMO CSI enhancement | Apple |
| 15 | R1-2409851 | Discussion on CSI enhancements | NEC |
| 16 | R1-2409889 | Further discussion on Rel-19 MIMO CSI enhancements | Xiaomi |
| 17 | R1-2410657 | Views on NR MIMO CSI enhancements Phase 5 | CATT |
| 18 | R1-2409970 | Discussion on CSI enhancements | Lenovo |
| 19 | R1-2410040 | CSI enhancements | TCL |
| 20 | R1-2410054 | Discussion on Rel-19 CSI enhancements | Fujitsu |
| 21 | R1-2410109 | CSI enhancements for Rel-19 MIMO | OPPO |
| 22 | R1-2410154 | CSI Enhancement for NR MIMO | Google |
| 23 | R1-2410176 | Discussion on CSI enhancements | HONOR |
| 24 | R1-2410220 | Further views on CSI enhancements | Sony |
| 25 | R1-2410303 | Discussion on Open Issues of CSI Enhancement | Rakuten Mobile, Inc |
| 26 | R1-2410667 | CSI enhancement for NR MIMO Phase 5 | Nokia |
| 27 | R1-2410353 | Remaining issues on CSI enhancements for large antenna arrays and CJT | Ericsson |
| 28 | R1-2410382 | Discussion on CSI enhancements | NTT DOCOMO, INC., NTT CORPORATION |
| 29 | R1-2410436 | CSI enhancements | Sharp |
| 30 | R1-2410472 | CSI enhancements for >32 ports and UE-assisted CJT | Qualcomm Incorporated |
| 31 | R1-2410549 | Discussion on CSI enhancements for NR MIMO Phase 5 | KDDI Corporation |
| 32 | R1-2410586 | Discussion on CSI enhancements | NICT |
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