**3GPP TSG RAN WG1 #118bis R1-2409060**

**Hefei, China, October 14th – 18th, 2024**

**Agenda item:** 9.2.2

**Source:** Moderator (Samsung)

**Title:** Moderator Summary#4 on Rel-19 CSI enhancements: Round 4

**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** |
| 1.1.2 | **Proposal 1.A.2:** 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, regarding the mapping between CSI-RS ports and SRS port groups, no additional specification support is introduced* Note: When SRS port grouping is configured, the UE, if capable of ‘*non-PMI-PortIndication*’, doesn’t expect reportQuantity set to ‘cri-RI-CQI’ without ‘*non-PMI-PortIndication*’

**FL assessment**: Please check the wording of the Note |
| **Not discussed in Round-4 (may revisit in RAN1#119)** |
| 1.5 | **Proposal 1.E**: 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 the legacy number of CSI-RS ports (i.e. 4, 8, 12, 16, 24, and 32 ports) for all applicable RI values (1, …, min(PCSI-RS,8)) 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).* [The following of Rel-19 Type-I SP are four separate UE features: (1) Scheme-A >32port; (2) Scheme-B >32port; (3) Scheme-A ≤32port; (4) Scheme-B ≤32 port.]

**FL assessment**: This was discussed during Monday Offline session.This proposal is sound for the completeness of Rel-19 Type-I SP codebook. Note that this doesn’t impact the legacy Rel-15 Type-I SP design.Re whether this is OOS or not, the WID says “… 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)**, …” which, strictly speaking, doesn’t preclude <=32 ports. So this extension proposal is not OOS. | **Support/fine:** ZTE, Lenovo/MotM, IDC, Samsung (ok), Xiaomi, Nokia/NSB, NEC, Fujitsu, Intel (FFS capability), NTT DOCOMO, CATT (only Scheme-B, no scheme-A), Spreadtrum, CMCC, MediaTek (ok with bullet), **Not support:** Google,OPPO,HONOR, TCL, Fraunhofer IIS/HHI, Tejas, **Concern**: Apple, vivo (ok RI=3-4 & 16, 24, 32 ports), Huawei/HiSi (same as vivo), Ericsson, Lenovo/MotM (strong)  |

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** |
| 2.3 | **[116bis] Agreement**For the Rel-19 CRI-based CSI refinement for up to 128 CSI-RS ports, on the configured KS>1 NZP CSI-RS resources, reuse the legacy CMR and IMR rules for the Rel-15 CRI-based reporting. This includes:* All the KS NZP CSI-RS resources are associated with a same CSI-RS resource set
* …

**Proposal 2.C**: For the Rel-19 CRI-based CSI refinement for up to 128 CSI-RS ports, regarding aperiodic CSI-RS resource configuration, the resource-level slot offset is supported as follows: * Reuse the same set of CSI-RS resource configuration to accommodate different DCI triggering time

**FL assessment**: The proposal is unclear. It was agreed that all the KS resources are associated with a same resource set. In this case, all the restrictions apply including the permitted resource-level slot offset | **Support/fine**: Huawei/HiSi**Not support**:  |

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** |
| 3.3.5 | **Proposal 3.C.5**: 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 for the latest CJTC Dd report, measured from the reception of the trigger for a Rel-18 eType-II CJT CSI
* One supported value of the UE capability is ‘Infinity’, and one other value X
	+ FFS: Value of X
* Introduce an RRC parameter to enable/disable this feature
* When the UE does not report this UE capability, a default value of ‘Infinity’ applies.

**FL assessment**: Wording is based on the outcome of Monday offline session.Its resolution may help confirming the WA for separate triggering (issue 3.3.1 proposal 3.C.1). 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, Samsung, Qualcom, vivo, Ericsson, OPPO, Xiaomi, Nokia/NSB, Huawei/HiSi, NEC, HONOR, Sharp, KDDI, MediaTek, NTT DOCOMO, Apple,**Not support**: Google, Spreadtrum, Intel, CATT, TCL,  |
| 3.6 | **Proposal 3.F**:For the Rel-19 aperiodic standalone CJT calibration (CJTC) reporting, when *ReportQuantity* is *‘cjtc-P’* (DL/UL phase offset), the slot offsets of NTRP CSI-RS resources are configured within X={1,2} slots, without DL/UL switching in between the NTRP resources, where X=1 implies that the NTRP resources are configured within a same slot, and X=2 implies that the NTRP resources are configured within two adjacent slots.**FL assessment**: This is analogous to legacy CMR behaviours for Rel-17 NCJT and Rel-18 Type-II CJT | **Support/fine**: Qualcomm, **Not support**: |
| **Not discussed in Round-4 (may revisit in RAN1#119)** |
| 3.3.9 | **Proposal 3.C.9**: 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.  | **Support/fine**: Huawei/HiSi, Qualcomm, Samsung, Ericsson, Sony, Lenovo/MotM, Xiaomi, NEC, HONOR, OPPO, **Not support**: Nokia/NSB, vivo, ZTE, Apple, IDC, NTT DOCOMO, CATT,  |
| 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 signaling) 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 signaling) 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. For a given issue, if there is no consensus on ‘Yes’, we will assume that the answer is ‘No’ | **Support/fine**: vivo, Xiaomi, Fujitsu, Sharp, Sony, Samsung, ZTE, **Not support (NW implementation)**: Huawei/HiSi, MediaTek, CMCC, CATT, Nokia/NSB, Qualcomm, Lenovo/MotM,  |
| 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, Lenovo/MotM, Ericsson (open), **Not support**: Huawei/HiSi, MediaTek, NTT DOCOMO, NEC, Intel, Apple, TCL, Huawei/HiSi, Xiaomi, IDC, Sharp, KDDI, CMCC, ETRI, OPPO, Apple, vivo, New H3C, Nokia/NSB, Spreadtrum, TCL, |
| 3.7.2 | **Proposal 3.G.2:** For the Rel-19 aperiodic standalone CJT calibration reporting, support reporting, in one CSI reporting instance, L1-RSRPs associated with the configured NTRP CSI-RS resources and the following CJT calibration report type:* ReportQuantity is ‘cjtc-Dd’ (delay offset), or
* ReportQuantity is ‘cjtc-F’ (frequency offset), or
* ReportQuantity is ‘cjtc-Dd-F’ (delay+frequency offset), or
* ReportQuantity is ‘cjtc-P’ (DL/UL phase offset)

Regarding the L1-RSRP:* 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
* FFS: Whether this is supported via a new ReportQuantity or a joint CSI request/triggering

**FL assessment**: This proposal (from RAN1#118) is an optimization primarily for TRP selection (which utilizes both RSRP and CJTC report) | **Support/fine:** NEC, NTT DOCOMO, Lenovo/MotM, Samsung (ok), Sony (open), **Not support**: ZTE, Xiaomi, Fujitsu, Ericsson, Apple, Huawei/HiSi, OPPO, TCL, ETRI, New H3C, Google, Nokia/NSB, vivo, Sharp, Intel, KDDI, Spreadtrum, TCL, |

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