**3GPP TSG RAN WG1 #110bis-e R1-2210507**

**e-Meeting, October 10th – 19th, 2022**

**Agenda item:** 9.1.2

**Source:** Moderator (Samsung)

**Title:** Moderator Summary#3 on Rel-18 CSI enhancements: ROUND 2

**Document for:** Discussion and Decision

## Introduction

The scope given in the Rel-18 NR Evolved MIMO WID pertaining to CSI enhancement is as follows:

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| 1. Study, and if justified, specify CSI reporting enhancement for high/medium UE velocities by exploiting time-domain correlation/Doppler-domain information to assist DL precoding, targeting FR1, as follows:
	* Rel-16/17 Type-II codebook refinement, without modification to the spatial and frequency domain basis
	* UE reporting of time-domain channel properties measured via CSI-RS for tracking
2. Study, and if justified, specify enhancements of CSI acquisition for Coherent-JT targeting FR1 and up to 4 TRPs, assuming ideal backhaul and synchronization as well as the same number of antenna ports across TRPs, as follows:
	1. Rel-16/17 Type-II codebook refinement for CJT mTRP targeting FDD and its associated CSI reporting, taking into account throughput-overhead trade-off
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## Summary of companies’ views

### Issue 1: Type-II codebook refinement for CJT

Table 1A Summary: issue 1

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| **#** | **Issue** | **Companies’ views** |
| 1.5 | [110bis-e] **Agreement** On the SD basis selection for Type-II codebook refinement for CJT mTRP, support the following on the *L* parameter:* Per-CSI-RS-resource *Ln* parameter
	+ TBD: Whether {*Ln*, *n*=1, ..., *N*} are higher-layer configured by gNB, or the total $\sum\_{n=1}^{N}L\_{n}$ is higher-layer configured by gNB while {*Ln*, *n*=1, ..., *N*} are reported by the UE, one L configured and {*Ln*} determined from configured L
	+ FFS: The value of *Ln* is taken from a pre-defined set

**Proposal 1.E.3**: On the SD basis selection for Type-II codebook refinement for CJT mTRP, on the *L* parameter, down select from the following alternatives (by RAN1#111):* Alt1. Each of the {*Ln*, *n*=1, ..., *N*} is gNB-configured via higher-layer (RRC) signaling
	+ The candidate values for follow the legacy specification
* Alt2. $L\_{tot}=\sum\_{n=1}^{N}L\_{n}$ where *Ltot* is gNB-configured via higher-layer (RRC) signaling and the relative value(s) of {*Ln*, *n*=1, ..., *N*} are reported by the UE
	+ TBD: Whether for a given configured value of *Ltot*, the possible combinations of {*Ln*, *n*=1, ..., *N*} are fixed/pre-determined or gNB-configured via higher-layer (RRC) signaling
	+ TBD: Whether the value(s) of {*Ln*, *n*=1, ..., *N*} are reported implicitly or explicitly, and whether some value(s) don’t need to be reported
* Alt3. An *L* parameter is gNB-configured via higher-layer (RRC) signaling and {*Ln*, *n*=1, ..., *N*} are determined from the value of *L*
	+ TBD: How to determine {*Ln*, *n*=1, ..., *N*} from *L*, e.g. depending on RI value

**FL Notes**: We list alternatives for further down selection. For an early temp check, please feel free to share your initial preference ☺ | **Proposal 1.E.3:** * **Support/fine:**
* **Not support:**

**Alt1:****Alt2:****Alt3:** |
| 1.7 | [110bis-e] **Agreement**For the Rel-18 Type-II codebook refinement for CJT mTRP, the constraint on the maximum number of non-zero coefficients (NZCs) per-layer (K0) is defined jointly across all N CSI-RS resources* TBD: the constraint on the total number of NZCs across all layers

**Question 1**: Is a constraint on the total number of NZCs summed across all layers needed? **Question 2**: If so, should we use the legacy constraint of 2K0?**FL Notes**: Please share your views on the answers to Q1 and Q2 | **Question 1:*** **Yes:**
* **No:**

**Question 2:*** **Yes:**
* **No:**
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Table 2 Additional inputs: issue 1

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| **Company** | **Input** |
| Mod V0 | **PLEASE READ THE FL NOTES** 1. **Check and, if needed, update your view in Table 1A especially on the moderator proposals.**
2. **Share additional inputs here, if needed**

**More moderator proposals may be added in the next revision** |
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### Issue 2: Type-II codebook refinement for high/medium UE velocities (with time/Doppler-domain compression)

Table 3A Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2.1 | [109-e] **Agreement**The work scope of Type-II codebook refinement for high/medium velocities includes refinement of the following codebooks, based on a common design framework:* Rel-16 eType-II regular codebook
* Rel-17 FeType-II port selection (PS) codebook

FFS: Whether to prioritize/down-select from the two**Proposal 2.A**: The Rel-18 Type-II codebook refinement for high/medium velocities comprises refinement of the following codebooks:* Refinement of the Rel-16 eType-II regular codebook
* Refinement of the Rel-17 FeType-II port selection (PS) codebook, based on the same design details as the Refinement of the Rel-16 eType-II regular codebook, except for the supported set of parameter combinations
	+ Time-/Doppler-domain reciprocity is not assumed

**FL Note**: This proposal has been discussed in RAN1#110  | **Support (equal priority for) both Rel-16 eType-II and Rel-17 FeType-II:** Huawei/HiSi, ZTE (Rel-16 first), Fraunhofer IIS/HHI* **Concern:** vivo, Lenovo, LG, Apple, DOCOMO, Spreadtrum

**Down-select to only Rel-16 eType-II:** Apple, DOCOMO, MediaTek, NEC, Xiaomi, Samsung, Lenovo, Intel (if Rel-17, no DD reciprocity), Xiaomi. Qualcomm, Apple, DOCOMO, Ericsson, Nokia/NSB, LG, Spreadtrum, CMCC, vivo, OPPO, Google, Sharp **Proposal 2.A:*** **Support/fine:** IDC, ZTE, Huawei/HiSi, Fraunhofer IIS/HHI
* **Not support (Rel-16 only):** vivo, Lenovo, LG, Apple, DOCOMO, Spreadtrum
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| 2.7 | [109-e] **Agreement**On the CSI reporting and measurement for the Rel-18 Type-II codebook refinement for high/medium velocities, support the following CSI-RS resource types/structures for CMR:* Time-domain behaviour for NZP CSI-RS resource: periodic (P), semi-persistent (SP), aperiodic (AP)
	+ FFS: Whether to introduce constraints on allowed configuration
* Down select from the following:
	+ Alt1. Support K>1 NZP CSI-RS resources, received via a single triggering instance, for aperiodic (AP) -CSI-RS-based channel measurement in a same CSI-RS resource set where the separation between 2 consecutive AP-CSI-RS resources is m slot(s):
	+ Alt2. Support one NZP CSI-RS resource in a CSI-RS resource set, where K>1 occasions are received via a single triggering instance, for aperiodic (AP)-CSI-RS-based channel measurement where the separation between 2 consecutive AP-CSI-RS resources is m slot(s).
	+ For any of the alternatives:
		- No CRI is reported
		- FFS: Details, e.g., supported value(s) of K, m, other use cases for the AP-CSI-RS resources (e.g., for training filter coefficients, prediction or performance monitoring)
* Support only one NZP CSI-RS resource for P or SP-CSI-RS-based channel measurement

**Proposal 2.G.2**: On the CSI reporting and measurement for the Rel-18 Type-II codebook refinement for high/medium velocities, support the following CSI-RS resource types/structures for CMR … {add later}**FL Note**: Please share your preference Alt1 vs Alt2 | **Alt1:** ZTE, LG, Xiaomi, CMCC, Qualcomm, Huawei/HiSi **Alt2:** MediaTek |
| 2.9 | [110bis-e] **Agreement** For the Type-II codebook refinement for high/medium velocities, down-select from the following alternatives: * Alt1. *Q* different 2-dimensional bitmaps are introduced for indicating the location of the NZCs, where the qth (q=1,…., *Q*) 2-dimensional bitmap corresponds to qth selected DD basis vector
	+ The number of selected DD basis vectors is denoted as *Q*
	+ This implies that for each layer, the location of NZCs in SD-FD can be different for different selected DD basis vectors.
* Alt2. A DD-basis-common per-layer 2-dimensional bitmap for indicating the location of NZCs used in Rel-16/17 Type-II is used
	+ This implies that for each layer, the location of NZCs in SD-FD is common across all the Q selected DD basis vectors

FFS: Further overhead reduction on bitmap(s)FFS: Whether the number of NZCs is upper bounded across all DD basis vectors or per DD basis vector**Proposal 2.I.2**: For the Type-II codebook refinement for high/medium velocities, ……. {add later}**FL Notes:** Please share your preference for Alt1 vs Alt2  | **Alt1:** Intel, ZTE**,** Xiaomi, Ericsson, CMCC **Alt2:** Samsung, IDC |
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Table 4 Additional inputs: issue 2

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| **Company** | **Input** |
| Mod V0 | **PLEASE READ THE FL NOTES** 1. **Check and, if needed, update your view in Table 3A especially on the moderator proposals.**
2. **Share additional inputs here, if needed**

**More moderator proposals may be added in the next revision** |
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### Issue 3: TRS-based reporting of time-domain channel properties (TDCP)

Table 5A Summary: issue 3

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| **#** | **Issue** | **Companies’ views** |
| 3.1 | [110bis-e] **Agreement**For the Rel-18 TRS-based TDCP reporting, down select one of the following alternatives by RAN1#110bis-e:* AltA. Based on Doppler profile
	+ E.g., Doppler spread derived from the 2nd moment of Doppler power spectrum, average Doppler shifts, Doppler shift per resource, maximum Doppler shift, relative Doppler shift, etc
* AltB. Based on *quantized amplitude of* time-domain correlation profile
	+ E.g. Correlation within one TRS resource, correlation across multiple TRS resources
	+ Note: The correlation over one or more lags of TRS resource may be considered.  The lags may be within one TRS burst or different TRS bursts

Note: Different alternatives may or may not apply to different use casesFFS: The need for a measure of confidence level in the TDCP report, and/or UE behaviour when the quality of TDCP measurement is not sufficiently highFFS: TDCP parameter(s) signalled with respect to each alternative**(I will add a proposal later based on the outcome of the ongoing email thread for Proposal 3.A)****FL Note**: Please check the revised proposal 3.A taking into account Ericsson’s input in breaking AltA into multiple proposalsThis is the current situation. * AltA: ZTE, vivo, Google, LG, OPPO, Huawei/HiSi, Xiaomi, Mavenir, Apple (1st pref), CATT, IDC, Spreadtrum, NEC (2nd pref), Nokia/NSB
* AltB: Samsung, Ericsson, MediaTek, vivo, Qualcomm, DOCOMO, OPPO, Sharp, Lenovo, Apple (2nd pref), IDC, NEC (1st pref), CEWiT, Fraunhofer IIS/HHI,
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Table 6 Additional inputs: issue 3

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| **Company** | **Input** |
| Mod V0 | **PLEASE READ THE FL NOTES** 1. **Check and, if needed, update your view in Table 5A especially on the moderator proposals.**
2. **Share additional inputs here, if needed**

**More moderator proposals may be added in the next revision** |
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# References

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| --- | --- | --- | --- |
| 1 | R1-2209715 | Summary of OFFLINE discussion on Rel-18 MIMO CSI | Moderator (Samsung) |
| 2 | R1-2208441 | CSI enhancement for coherent JT and mobility | Huawei, HiSilicon |
| 3 | R1-2208495 | Enhanced CSI for CJT and High Doppler Operations | InterDigital, Inc. |
| 4 | R1-2208504 | CSI enhancement for high/medium UE velocities and CJT | ZTE |
| 5 | R1-2208541 | Discussion on CSI enhancement for high/medium UE velocities and coherent JT | Spreadtrum Communications |
| 6 | R1-2208628 | Discussion on CSI enhancement for high-medium UE velocities and coherent JT | vivo |
| 7 | R1-2208742 | Discussion of CSI enhancement for high speed UE and coherent JT | Lenovo |
| 8 | R1-2208794 | CSI enhancement for high/medium UE velocities and coherent JT | OPPO |
| 9 | R1-2208872 | On CSI Enhancement | Google |
| 10 | R1-2208893 | Potential CSI enhancement for high/medium UE velocities and coherent JT | LG Electronics |
| 11 | R1-2208947 | Discussion on CSI enhancements | CATT |
| 12 | R1-2209041 | On CSI enhancements | Intel Corporation |
| 13 | R1-2209090 | Further considerations on CSI enhancement for high/medium UE velocities and CJT | Sony |
| 14 | R1-2209140 | Discussion on CSI enhancement | NEC |
| 15 | R1-2209247 | Discussion on CSI enhancement | Mavenir |
| 16 | R1-2209258 | Discussion on CSI enhancement for high/medium UE velocities and CJT | xiaomi |
| 17 | R1-2209322 | Discussion on CSI enhancement for high/medium UE velocities and CJT | CMCC |
| 18 | R1-2209381 | CSI enhancement | Sharp |
| 19 | R1-2209494 | CSI enhancement | MediaTek Inc. |
| 20 | R1-2209545 | CSI enhancements for medium UE velocities and coherent JT | Fraunhofer IIS, Fraunhofer HHI |
| 21 | R1-2209570 | Views on Rel-18 MIMO CSI enhancement | Apple |
| 22 | R1-22010241 | Views on CSI enhancements | Samsung |
| 23 | R1-2209793 | Views on CSI Enhancements for CJT | AT&T |
| 24 | R1-2209852 | On CSI enhancements for Rel-18 NR MIMO evolution | Ericsson |
| 25 | R1-2209890 | Discussion on CSI enhancement | NTT DOCOMO, INC. |
| 26 | R1-2209969 | CSI enhancements for high/medium UE velocities and Coherent-JT | Qualcomm Incorporated |
| 27 | R1-2210063 | CSI enhancement for high/medium UE velocities and CJT | Nokia, Nokia Shanghai Bell |
| 28 | R1-2210105 | Discussion on CSI Enhancements for high/medium UE velocities and coherent JT | CEWiT |
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