**3GPP TSG RAN WG1 Meeting #104bis-e R1-210abcd**

**E-meeting, April 12th – 20th, 2021**

**Agenda Item: 8.1.4**

**Source: (Moderator) Huawei, HiSilicon**

**Title: Summary of CSI enhancements for MTRP and FDD (Round 3)**

**Document for: Discussion and Decision**

# Agreements

**Agreement**

For rank=1, polarization-common based free-selection should be supported for *W1*$W\_{1}$.

* FFS: Whether there is a need to restrict the number of CSI-RS ports for which this is supported

**Agreement**

Support the indication of following RI combinations by a joint RI field for a NCJT measurement hypothesis in CSI part 1, when the maximal transmission layers is less than or equal to 4:

* {1, 1}, {1, 2}, {2,1}, {2,2}
* FFS: CBSR and/or RI restrictions per TRP or across TRPs

**Agreement**

With regarding to the maximal values of *Nmax* for *N, Ks,max* for *Ks*:

* Support of *Nmax*=2 is a UE optional feature
* Support of *Ks,max*=*X* is a UE optional feature
	+ *X* can be up to 8 and other candidate values can be discussed as part of UE features
* FFS: Default value of *Nmax*, *Ks,max*
* FFS: Which combinations of *N*<=*Nmax*, *Ks*<=*Ks,max* are supported

**Agreement**

At least for rank 1, combinatorial coefficient is used for port selection for W1.

* FFS when *Wf* is turned off

**Agreement**

Confirm following working assumption of *Wf* for R17 PS CB

* Support of *Mv*>1 is a UE optional feature if the UE supports Rel-17 PS codebook enhancement, taking into account UE complexity related to codebook parameters.

**Agreement**

With regarding to possible restriction between K1 and K2

* Alt 2: No restriction as long as K1+K2=Ks

**Agreement**

The UE may assume that QCL-Type D of CMRs associated with a NCJT measurement hypothesis are applied to the corresponding CSI-IM resource.

**Agreement**

For the UE be configured to report one CSI associated with the best one among NCJT and single-TRP measurement hypotheses (i.e. Option 2),

* Alt 1: Single CRI is reported whereas CRI bit size depends on total number of valid CMR pairs for NCJT measurement hypothesis and valid CMRs for single-TRP measurement hypotheses.
	+ FFS further mapping mechanism between each CRI codepoint and Single-TRP/NCJT measurement hypothesis.

**Agreement**

A 2-part CSI report is supported in Rel-17 for a CSI reporting configuration associated with NCJT measurement hypothesis with following clarifications:

* Within CSI part 1
	+ CRI, RI, WB CQI and SB CQI for the first CW are reported with consistent payload and zero padding (if needed). FFS further details
	+ FFS whether RI can be shared between NCJT CSI and single-TRP CSIs to reduce CSI feedback overhead
	+ FFS whether additional field is needed, at least for Option 2
* Within CSI part 2:
	+ FFS further compression/omission/Sharing of PMI among Single-TRP and NCJT hypotheses

**Agreement**

Whether a NZP CSI-RS resource *m* can be referred by two CMR pairs (*m, a*) and (*m, b*) configured for NCJT measurement hypotheses, study following Alternatives and down-select one Alternative in RAN1#105-e:

* Alt 1: It is feasible for FR1 but not for FR2.
* Alt 2: It is feasible for both FR1 and FR2 but subject to further UE capability for FR2.

**Agreement**

Whether a NZP CSI-RS resource can be referred by both a CMR pair configured for NCJT measurement hypothesis and a CMR configured for Single-TRP measurement hypothesis, study following Alternatives and down-select one Alternative in RAN1 105e:

* Alt 2: It is feasible for FR1 but it is not for FR2. For FR2, the UE is expected to have different NZP CSI-RS resources configured for all CMRs of Single-TRP and NCJT measurement hypotheses respectively.
* Alt 3: It is feasible in both FR1 and FR2 but subject to UE capability for FR2. If a UE supports and the sharing is also enabled by gNB, two CMRs from a CMR pair configured for a NCJT measurement hypothesis can be used for Single-TRP measurement hypotheses, otherwise they cannot.

**Agreement**

For the UE configured to report X CSIs (at least when X>0) associated with single-TRP measurement hypotheses and one CSI associated with NCJT measurement hypothesis, study following issues for potential CSI omission/priority/updating rules:

* Issue 1: Prioritize CSI with different measurement hypotheses within the single CSI report, when the UE is configured with CSI Option 1 with X=1 or 2.
* Issue 2: Omission of NCJT CSI in CSI part 2 depending on the corresponding CRI or RI or CQI in CSI part 1.

# Proposals

**MTRP CSI**

**Proposal 15-1:** For the UE configured to report X CSIs associated with single-TRP measurement hypotheses and one CSI associated with NCJT measurement hypothesis (i.e. Option 1),

* Alt 1: X+1 CRIs are reported, whereas X CRIs are for single-TRP measurement hypotheses and one CRI is for NCJT measurement hypothesis.  Each CRI bit size depends on the corresponding number of either valid CMR pairs for NCJT measurement hypothesis or valid CMRs for single-TRP measurement hypotheses
* For the purpose of payload construction, Alt1 does not imply that the X+1 CRIs are reported jointly as single field of one CSI report.

**Proposal 17:**For CSI measurement associated to a reporting setting CSI-ReportConfig for NCJT, an NCJT CSI hypothesis based on a pair of CMRs assumes to occupy two CPUs, two active NZP CSI-RS resources, and a number of active ports corresponding to both CMRs.

* If a NZP CSI-RS resource is referred X times by CMR pairs for NCJT measurement hypothesis and CMR for Single-TRP measurement hypothesis, the CSI-RS resource and the CSI-RS ports within the CSI-RS resource are counted X times for active resources and active ports.

**Proposal 12:** For CSI measurement associated with a CSI-ReportConfig for NC-JT, study following aspects:

* whether to support dynamic updating, e.g. by MAC-CE,  for CMR pairs for NCJT measurement hypotheses, and/or CMRs for Single-TRP measurement hypotheses, and/or TCI states in CMRs, and/or the number of single-TRP CSIs (i.e. X=0/1/2) in a NCJT CSI report
* whether additional high layer signalling is needed to configure M (M≤ Ks) CMRs from the CSI-RS resource set for CMR for Single-TRP measurement hypotheses
* For CMRs configured in the CSI-RS resource set, whether support high layer signalling to enable/disable single-TRP measurement hypothesis using CMR configured within CMR pairs for NCJT measurement hypothesis

**Proposal 14-1:** Whether a CSI-IM can be referred by both NCJT and Single-TRP measurement hypotheses, study following Alternatives and FR1/FR2 differentiation ~~in RAN1 105e~~:

* Alt 1: CSI-IM can be shared by both NCJT and Single-TRP measurement hypotheses.
* Alt 2: A CSI-IM resource is configured to be associated with either a CMR for Single-TRP measurement hypothesis or a CMR pair for NCJT measurement hypothesis
* FR1 and FR2 differentiation

**Proposal 14-3:** Whether to support interference measurement based on NZP CSI-RS outside the CMR pair configured for NCJT measurement hypothesis, in addition to CSI-IM, study following Alternatives and down-select one Alternative in RAN1 105e:

* Alt 1: Yes, it is supported, subject to limitations, e.g. N=1 CMR pair and Ks=2 CMR resources
* Alt 2: No, it is not supported

**FDD CSI**

**Proposal 8-1:** A bitmap for indication non-zero coefficients should be supported for W2 with a compression coefficient beta<=1 whereas

* Support Beta=1, FFS additional values of beta < 1, e.g. 1/8, 1/4, 1/2, 3/4
* FFS: whether/how such a bitmap can be absent for specific codebook configuration parameters
* FFS: whether a bitmap is polarization-common or polarization-specific
* FFS: possible parameter combinations/dependence for beta with other PS CB parameters.

Support: CATT, Spreadtrum, DC

**Proposal 8-2:** A bitmap for indication non-zero coefficients should be supported for W2 with a compression coefficient beta<=1 whereas

* FFS values of beta, e.g. 1/8, 1/4, 1/2, 3/4, 1
* FFS: whether/how such a bitmap can be absent for specific codebook configuration parameters
* FFS: whether a bitmap is polarization-common or polarization-specific
* FFS: possible parameter combinations/dependence for beta with other PS CB parameters.

Support: Samsung, MTK, Sony

**Proposal 3-1: At least for rank 1, regarding the value(s) of K1 for port selection matrix W1 in NP\*K1, study and down-select from the following candidate values of K1 and the maximal value of P in RAN1 105e**

* **K1 in {2, 4,8,12,16,24,32} with K1 <= P**
* **The maximal value of P as Pmax, e.g.  32**
* **FFS: possible parameter combinations/dependence for K1 with other PS CB parameters, e.g. whether candidate values of K1 can be different for different ranks.**

**Note: for Polarization-common based free-selection, it means to the same select L=K1/2 ports out of P/2 ports for both polarizations.**

**Note: for polarization-specific based free-selection, it means select K1 ports out of P ports**

**Note: P is the number of CSI-RS ports for port selection (whose value depends on the outcome of the CSI-RS related study)**

**Proposal 5-1: At least for rank 1, The FD bases used for Wf quantitation are limited within a single window/set with size N fixed/configured to the UE, study and down-select one Alternative in RAN1 105e:**

* **Alt 1: FD bases in the window must be consecutive from an orthogonal DFT matrix**
* **Alt 2: FD bases in the set can be consecutive/non-consecutive, and are selected freely by gNB from an orthogonal DFT matrix**

**Note that “at least for rank 1” does not imply for the support of rank 1 only in Rel-17 or restrictions of supporting/ not supporting additional alternatives for higher rank.**

**Proposal 6: At least for rank 1, for relationship between N and Mv, study and down-select one Alternative from following in RAN1 105e**

* **Alt 1: N= Mv always**
* **Alt 2: N >= Mv and N=2, 4**

**Note that “at least for rank 1” does not imply for the support of rank 1 only in Rel-17 or restrictions of supporting/ not supporting additional alternatives for higher rank.**

**Proposal 7: At least for rank 1, regarding the value(s) of R for Rel-17 PS codebook enhancement, study and down-select one or more than one Alternative (or a subset of corresponding values) in RAN1 105e:**

* **Alt 0:  R < 1 (e.g. 1/4, 1/2)**
* **Alt 1: R=1**
* **Alt 2: R=1 and 2**
* **Alt 3: R=1,2, 4, and 8**
* **Alt 4: R= {1,2,…, D\*NPRBSB} whereas D is the density of CSI-RS in frequency domain**

**Note that “at least for rank 1” does not imply for the support of rank 1 only in Rel-17 or restrictions of supporting/not supporting additional alternatives for higher rank.**

**Proposal 9:** For the quantization of W2 coefficient, study following Alternatives with Alt 1 as the baseline:

* Alt1: Reusing Rel-16 quantization mechanism for Rank 1 at least, which can be summarized as following:
	+ An indicator for the strongest coefficient
	+ Two polarization-specific reference amplitudes:
		- for the polarization associated with the strongest coefficient, the reference amplitude is not reported
		- for the other polarization, reference amplitude is quantized to 4 bits
	+ For coefficients other than the strongest coefficient
		- differential amplitude is calculated relative to the associated polarization-specific reference amplitude and quantized to 3 bits
		- phase is quantized to 16PSK
* Alt1-1: the ref amplitude = 0 reserved in R16 can be replaced with a new value.
* Alt2: Individual amplitude (e.g. 3 bits) and phase (e.g. 16PSK) quantization for each non-zero coefficient
	+ FFS: amplitude codebook is uniform in db or linear scale
* Alt2-1: ref amp (e.g. 4 bits), Individual amplitude (e.g. 3 bits) and phase (e.g. 16PSK) quantization for each non-zero coefficient
	+ FFS: amplitude codebook is uniform in db or linear scale
	+ FFS: reference amplitude is polarization specific or polarization common, and corresponding codebook
* Note: Other quantization schemes or enhancement on top of Alt 1 or Alt 2 are not precluded.

**Proposal 10:** For PS codebook enhancements utilizing DL/UL reciprocity of angle and/or delay, down-select ONE option for CSI-RS configurations associated with Rel-17 PS codebook, from Option 0 (No further enhancement), Option 1 (i.e. lower CSI-RS density) and Option 3 (i.e. configuring multiple CSI-RS resources)

* If there is no consensus in RAN1 105e, Option 0 is by default.