**3GPP TSG RAN WG1 Meeting #114 R1-230xxxx**

**Toulouse, France, August 21st – 25th, 2023**

**Agenda item: 9.17**

**Source: Nokia, Nokia Shanghai Bell**

**Title: Summary of email discussion on NR\_MIMO enhancements on CSI**

**Document for: Discussion and Decision**

# 1 Introduction

This thread will discuss the draft CR to 38.214 for NR MIMO CSI.

First checkpoint for this discussion: **September 5, 6:00am UTC!**

# 2 Discussion – first round

The comments in this section are based on version 0 of the the draft CR available in the **Post RAN1#114 discussion.**

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| Company | Comments | Editor reply/Notes |
| CATT | **Comment 1(TypeII Doppler):**For the following new added text, it’s better to clarify the value of$ K\_{p}$.

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| For a *CSI-ReportConfig* configured with *codebookType* set to 'typeII-Doppler-r18' or 'typeII-Doppler-PortSelection-r18', the UE reports a CSI report only if receiving at least one aperiodic or $K\_{p}$ periodic or semipersistent consecutive CSI-RS transmission occasions for each CSI-RS resource in the corresponding CSI-RS Resource Set for channel measurement and/or one CSI-IM occasion for interference measurement no later than the CSI reference resource and within the same DRX Active Time, when DRX is configured, and drops the report otherwise. The value of $K\_{p}\in \{1,2,4\}$ is indicated by UE capability. |

**Comment 2(CJT):**There is no agreement to restrict the value of restrictedCMR-Selection when NTRP=1, so we suggest to add related text according to the following agreement.**Agreement**For the Rel-18 Type-II codebook refinement for CJT mTRP, support ……* if NTRP =1, that the NTRP-bit bitmap (for dynamic TRP selection) is not reported

**Proposed change:**

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| The UE may be configured with higher layer parameter *restrictedCMR-Selection*. If *restrictedCMR-Selection* is configured, the number of selected CSI-RS resources is $N=N\_{TRP}$. Otherwise, the UE is expected to select $N$ CSI-RS resources, with $1\leq N\leq N\_{TRP}$, and the selection is reported with an $N\_{TRP}$-bit bitmap, $b\_{N\_{TRP}}, …,b\_{1}$, where the CSI-RS resources are mapped from bit $b\_{1}$ to bit $b\_{N\_{TRP}}$ by their ordering in the resource set and the first of the $N$ selected CSI-RS resources corresponds to the nonzero bit with lowest index. If NTRP=1, the $N\_{TRP}$-bit bitmap is not reported. |

**Comment 3(TypeII Doppler):**According to the following agreement, only *N4*=1 is supported for the refinement of the Rel-17 FeType-II port seletion codebook. Therefore, relevant text of the Rel-17 FeType-II port seletion codebook with *N4*>1 should be removed.

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| AgreementThe 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, with N4>=1
* Refinement of the Rel-17 FeType-II port selection (PS) codebook, based on the common design with the Refinement of the Rel-16 eType-II regular codebook, except for the supported set of parameter combinations, with N4=1
	+ Time-/Doppler-domain reciprocity is not assumed
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**Proposed change:**

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| - For Enhanced Type II for predicted PMI with $N\_{4}>1$ (see Clause 5.2.2.2.10), Part 1 contains RI (if reported), the CQI (if the higher layer parameter *TDCQI* is set to '1-1' or '1-2') or the first CQI (if the higher layer parameter *TDCQI* is set to '2') and the total number of reported non-zero amplitude coefficients across layers. The fields of Part 1 – RI (if reported), CQI, and the total number of reported non-zero amplitude coefficients across layers – are separately encoded. Part 2 contains the second CQI (if the higher layer parameter *TDCQI* is set to '2') and the PMI of the Enhanced Type II for predicted PMI ~~or Further Enhanced Type II Port Selection for predicted PMI~~. Part 1 and 2 are separately encoded. |

**Comment 4(TypeII Doppler):**According to the following agreement, the support of *l = (n – nCSI,ref )* is UE optional. Therefore, the relevant description should be added to 5.2.1.4.2 in 38.214.

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| **Agreement**On the CSI reporting and measurement for the Rel-18 Type-II codebook refinement for high/medium velocities, when UE-side prediction is assumed, support UE “predicting” channel/CSI after slot *l* where the location of slot *l* is configured (from multiple candidate values) by gNB via higher-layer signalling* Candidates of slot *l* location include the legacy CSI reference resource location (*n* – *nCSI,ref* ) and slot (*n*+*δ*) where *δ* ≥ 0
* FFS: Possible value(s) of *δ* and possible value(s) of WCSI

Note: Per legacy behavior, the legacy CSI reference resource, i.e., (*n* – *nCSI,ref* ), is reused for locating the last CSI-RS occasion used for a CSI reportFor a UE that supports UE-side prediction, the support of *l* = (*n* – *nCSI,ref* ) is UE optional |

**Proposed change:**

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| Subject to UE capability, a UE configured with a *CSI-ReportConfig* with the higher layer parameter *N4* and *reportQuantity* set to 'cri-RI-PMI-CQI' is assumed to support UE-side CSI prediction. The reported PMI indicates predicted precoder matrices associated with $N\_{4}$ consecutive slot intervals, each with duration of $d$ slots, where the value of $N\_{4}\in \{1,2,4,8\}$ is configured by *N4*. If the UE is configured with an aperiodic CSI-RS resource set for channel measurement, the value, in number of slots, of the time unit $d\in \{1,m\}$ is configured by higher layer parameter *d*, where $m$ is defined in Clause 5.2.1.4.1. If the UE is configured with a periodic or semi-persistent CSI-RS resource set for channel measurement, the value of $d$ is equal to the periodicity of the CSI-RS resource. The earliest of the $N\_{4}$ slot intervals starts at slot $l=n+δ$, where $n$ is the uplink slot in which the CSI is reported and the slot offset $δ$ is configured by higher layer parameter *delta* and $δ\in \{-n\_{CSI\\_ref},0,1,2\}$ with $n\_{CSI\\_ref}$ defined in Clause 5.2.2.5. The value $δ=-n\_{CSI\\_ref}$ can be configured subject to UE capability.- For $N\_{4}=1$, the UE is expected to report a predicted PMI for slot interval $[l,l+d-1]$, ~~where the initial slot~~ $l$ ~~is configured by the slot offset~~ $δ\in \{-n\_{CSI\\_ref},0,1,2\}$ ~~and~~ the value $δ=-n\_{CSI\\_ref}$ can be configured only for $d>1$. A UE can be configured with $N\_{4}=1$ if the higher layer parameter *codebookType* is set to 'typeII-Doppler-r18', or 'typeII-Doppler-PortSelection-r18'.- The reported CQI is associated with slot $l$ and the reported PMI.- For $N\_{4}>1$, the UE is expected to report a PMI which indicates predicted precoder matrices associated with slot intervals $[l+j⋅d, l+(j+1)⋅d-1]$, for $j=0,…,N\_{4}-1$~~, where the initial slot~~ $l$ ~~is configured by the slot offset~~ $δ\in \{-n\_{CSI\\_ref},0,1,2\}$~~, with~~ $n\_{CSI\\_ref}$ ~~defined in Clause 5.2.2.5~~. A UE can be configured with $N\_{4}>1$ if the higher layer parameter *codebookType* is set to 'typeII-Doppler-r18'. |

**Comment 5(TypeII Doppler):**For *N4*=1, both *d*=1 and *d*>1 are supported with $δ=-n\_{CSI\\_ref}$. Hence, the text of ‘the value $δ=-n\_{CSI\\_ref}$ can be configured only for $d>1$’ is not inaccurate. According to the following conclusion, if $δ=-n\_{CSI\\_ref}$ and *d*=1, there is no enhancement to UE measurement and CSI calculation. Therefore, the relevant description in 5.2.1.4.2 of 38.214 should be revised.

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| **Conclusion** On the usage of CSI reporting and measurement for the Rel-18 Type-II codebook refinement for high/medium velocities, there is no consensus in *supporting any specification enhancement* for the following assumptions:* Legacy UE procedure for CSI measurement/calculation (equivalent to the combination of *l* = (*n* – *nCSI,ref* ) and WCSI=1)
* gNB-side prediction
	+ Note: This doesn’t preclude any gNB implementation
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**Proposed change:**

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| Subject to UE capability, a UE configured with a *CSI-ReportConfig* with the higher layer parameter *N4* and *reportQuantity* set to 'cri-RI-PMI-CQI' is assumed to support UE-side CSI prediction. The reported PMI indicates predicted precoder matrices associated with $N\_{4}$ consecutive slot intervals, each with duration of $d$ slots, where the value of $N\_{4}\in \{1,2,4,8\}$ is configured by *N4*. If the UE is configured with an aperiodic CSI-RS resource set for channel measurement, the value, in number of slots, of the time unit $d\in \{1,m\}$ is configured by higher layer parameter *d*, where $m$ is defined in Clause 5.2.1.4.1. If the UE is configured with a periodic or semi-persistent CSI-RS resource set for channel measurement, the value of $d$ is equal to the periodicity of the CSI-RS resource. The earliest of the $N\_{4}$ slot intervals starts at slot $l=n+δ$, where $n$ is the uplink slot in which the CSI is reported and the slot offset $δ$ is configured by higher layer parameter *delta*.- For $N\_{4}=1$, the UE is expected to report a predicted PMI for slot interval $[l,l+d-1]$, where the initial slot $l$ is configured by the slot offset $δ\in \{-n\_{CSI\\_ref},0,1,2\}$ ~~and the value~~ $δ=-n\_{CSI\\_ref}$ ~~can be configured only for~~ $d>1$~~.~~ , except for $δ=-n\_{CSI\\_ref}$ and *d*=1, the UE is expected to report a non-predicted PMI as described in Clause 5.2.2.2.5 or Clause 5.2.2.2.6. A UE can be configured with $N\_{4}=1$ if the higher layer parameter *codebookType* is set to 'typeII-Doppler-r18', or 'typeII-Doppler-PortSelection-r18'. |

**Comment 6(TypeII Doppler):**For Rel-18 TypeII codebook, $2\leq K\leq 8$ resources in one NZP CSI-RS Resource set are supported, but can’t be configured with two Resource Groups. Therefore, the following paragraph in 5.2.1.4.1 of 38.214 is not applicable to Rel-18 TypeII codebook.**Proposed change:**

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| Except for a *CSI-ReportConfig* configured with *reportQuantity* set to 'cri-RI-PMI-CQI' and *codebookType* set to 'typeII-CJT-r18', 'typeII-CJT-PortSelection-r18', 'typeII-Doppler-r18', or 'typeII-Doppler-PortSelection-r18', An NZP CSI-RS Resource Set for channel measurement with $2\leq K\_{s}\leq 8$ resources can be configured with two Resource Groups, with $K\_{1}\geq 1$ resources in Group 1 and $K\_{2}\geq 1$ resources in Group 2, such that $K\_{1}+K\_{2}=K\_{s}$, and with $N\in \{1,2\}$ Resource Pairs. Each Resource Pair consists of one resource from Group 1 and one resource from Group 2. The same resource can be associated with two Resource Pairs in frequency range 1 but not in frequency range 2. |

**Comment 7(TypeII Doppler):**For Rel-18 CJT, the parameter *codebookType* is used to enable this feature. For Rel-18 predicting CSI, some texts in 38.214 use the parameter *codebookType* to enable this feature, and some texts use the parameter *N4* to identify this feature. We think it is better to use only one RRC parameter to identify one feature. Therefore, we suggest that the RRC parameter *codebookType* should be used to enable Rel-18 predicting CSI for all texts in 38.214.**Proposed change:**

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| 5.2.1.4.1Subject to UE capability, a UE configured with a *CSI-ReportConfig* with the higher layer parameter *~~N4~~**codebookType* set to 'typeII-Doppler-r18', or 'typeII-Doppler-PortSelection-r18' and *reportQuantity* set to 'cri-RI-PMI-CQI' is assumed to support UE-side CSI prediction. The reported PMI indicates predicted precoder matrices associated with $N\_{4}$ consecutive slot intervals, each with duration of $d$ slots, where the value of $N\_{4}\in \{1,2,4,8\}$ is configured by *N4*. If the UE is configured with an aperiodic CSI-RS resource set for channel measurement, the value, in number of slots, of the time unit $d\in \{1,m\}$ is configured by higher layer parameter *d*, where $m$ is defined in Clause 5.2.1.4.1. If the UE is configured with a periodic or semi-persistent CSI-RS resource set for channel measurement, the value of $d$ is equal to the periodicity of the CSI-RS resource. The earliest of the $N\_{4}$ slot intervals starts at slot $l=n+δ$, where $n$ is the uplink slot in which the CSI is reported and the slot offset $δ$ is configured by higher layer parameter *delta*.5.2.1.4.2Subject to UE capability, a UE configured with a *CSI-ReportConfig* with the higher layer parameter *~~N4~~* *codebookType* set to 'typeII-Doppler-r18', or 'typeII-Doppler-PortSelection-r18' and *reportQuantity* set to 'cri-RI-PMI-CQI' is assumed to support UE-side CSI prediction. The reported PMI indicates predicted precoder matrices associated with $N\_{4}$ consecutive slot intervals, each with duration of $d$ slots, where the value of $N\_{4}\in \{1,2,4,8\}$ is configured by *N4*. If the UE is configured with an aperiodic CSI-RS resource set for channel measurement, the value, in number of slots, of the time unit $d\in \{1,m\}$ is configured by higher layer parameter *d*, where $m$ is defined in Clause 5.2.1.4.1. If the UE is configured with a periodic or semi-persistent CSI-RS resource set for channel measurement, the value of $d$ is equal to the periodicity of the CSI-RS resource. The earliest of the $N\_{4}$ slot intervals starts at slot $l=n+δ$, where $n$ is the uplink slot in which the CSI is reported and the slot offset $δ$ is configured by higher layer parameter *delta*.If the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *reportQuantity* set to 'cri-RI-PMI-CQI', ' cri-RI-i1', 'cri-RI-i1-CQI', 'cri-RI-CQI' or 'cri-RI-LI-PMI-CQI', then the UE is not expected to be configured with more than 8 CSI-RS resources in a CSI-RS resource set contained within a resource setting that is linked to the *CSI-ReportConfig*, except when the UE is configured with a *CSI-ReportConfig* with the higher layer parameter *~~N4~~ codebookType* set to 'typeII-Doppler-r18', or 'typeII-Doppler-PortSelection-r18', *reportQuantity* set to 'cri-RI-PMI-CQI' and the corresponding CSI-RS resource set for channel measurement is aperiodic with $K=12$ resources. |

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