**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 uTCI\_STxMP\_DMRS\_SRS\_8Tx\_2TA**

**Document for: Discussion and Decision**

# 1 Introduction

This thread will discuss the draft CR to 38.214 for NR MIMO: uTCI, STxMP, DMRS, SRS, 8TX, 2TA

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.**

### 2.1 uTCI

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| Company | Comments | Editor reply/Notes |
| Samsung | Comment 1: Based on the following agreement made in RAN1#114, we would like to suggest the following text updates for the configuration of the [TCI selection field].**Agreement**Support joint configuration of the presence of “TCI states selection” field for DCI format 1\_1 and DCI format 1\_2 in the same DL BWP

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| - When the UE is configured with *tciSelection-PresentInDCI* jointly for both DCI formats 1\_1 and 1\_2 in the same DL BWP, and when the UE receives a DCI format 1\_1/1\_2 that schedules or activates PDSCH reception, the UE shall determine the indicated joint/DL TCI state(s) for the PDSCH reception according to the following: |

Comment 2: for aperiodic CSI-RS reception in both S-DCI and M-DCI, we do not think the texts “If the UE reports its capability of [two default beams for S-DCI based MTRP] in frequency range 2, the UE uses both indicated joint/DL TCI states to buffer the received signal before a threshold.” are needed. To our understanding, (1) the note in the corresponding agreement is only for clarification purpose, (2) similar UE assumptions were in Rel-15/16, but were not captured in the specifications, (3) “buffer” is unclear. Hence, we suggest the following modifications for both SDCI and MDCI.

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| -if the UE is in frequency range 1, or the UE reports its capability of [two default beams for S-DCI based MTRP] in frequency range 2, the UE shall apply the first or the second indicated joint/DL TCI state to the aperiodic CSI-RS according to the higher layer configuration(s) provided to the aperiodic CSI-RS resource or to the aperiodic CSI-RS resource set. ~~If the UE reports its capability of [two default beams for S-DCI based MTRP] in frequency range 2, the UE uses both indicated joint/DL TCI states to buffer the received signal before a threshold.~~ |

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| -if the UE is in frequency range 1, or the UE reports its capability of [default beam per *coresetPoolIndex* for M-DCI based MTRP] in frequency range 2, the UE shall apply the first or the second indicated joint/DL TCI state to the aperiodic CSI-RS according to the higher layer configuration(s) provided to the aperiodic CSI-RS resource or aperiodic CSI-RS resource set. ~~If the UE reports its capability of [default beam per coresetPoolIndex for M-DCI based MTRP] in frequency range 2, the UE uses both indicated joint/DL TCI states to buffer the received signal before a threshold.~~ |

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| ZTE | **Comment-1**Regarding group based reporting in Rel-18, we prefer to use the description for UL SRS (as we mentioned in June spec-review), and then we may need to clarifying that the spatial filter is applied to UL simultaneous transmission, rather than DL-RS(s) in the group based report. So, we have the following suggestion.**Proposed change** (Section 5.2.1.4.2 Report Quantity Configurations)------------------------------ if the UE is configured with the higher layer parameter *groupBasedBeamReporting-v18* set to *JointULandDL*, the UE is not required to update measurements for more than 64 CSI-RS and/or SSB resources, and the UE shall report in a single reporting instance *nrofReportedGroups-r18,* if configured, group(s) of two CRIs or SSBRIs selecting one CSI-RS or SSB from each of the two CSI Resource Sets for the report setting, where CSI-RS and/or SSB resources of each group can be received simultaneously for DL transmission(s) and applied as reference RSs used for determining simultaneous TX spatial filters for UL transmission by the UE subject to UE capability.- if the UE is configured with the higher layer parameter *groupBasedBeamReporting-v18* set to *ULOnly,* the UE is not required to update measurements for more than 64 CSI-RS and/or SSB resources, and the UE shall report in a single reporting instance *nrofReportedGroups-r18,* if configured, group(s) of two CRIs or SSBRIs selecting one CSI-RS or SSB from each of the two CSI Resource Sets for the report setting, where CSI-RS and/or SSB resources of each group can be applied as reference RSs used for determining simultaneous TX spatial filters for UL transmission by the UE subject to UE capability.<omitted text>----------------------------- |  |
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### 2.2 STxMP

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| Company | Comments | Editor reply/Notes |
|  | Thank you, Mihai, for the great efforts. Please see some initial comments from our side:**Comment 1**: For all cases where two SRS resource sets can be configured (including Rel-17 single-DCI based TDM scheme, Rel-18 single-DCI based STxMP SDM/SFN schemes, and Rel-18 multi-DCI based STxMP PUSCH+PUSCH), it is already agreed that the two SRS resource sets have the same number of SRS resources. This condition is currently captured for all cases above except for Rel-18 multi-DCI based STxMP PUSCH+PUSCH. Hence, we suggest the following change in Section 6.1, which in addition to addressing this, also makes the description more clear (and removes some redundancy as well).~~When~~ If a UE - is configured with two SRS resource sets ~~are configured~~ in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'nonCodebook' and - is configured with the higher layer parameter *enableSTx2PofmDCI* ~~is configured~~*-* is configured with *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet* for the active BWP of a serving cell, the UE- ~~and PDCCHs that~~ can be scheduled/configured to transmit two fully/partially overlapping PUSCHs in time domain and fully/partially/non-overlapping in frequency domain, where the two PUSCHs- are associated with ~~to different~~ *~~ControlResourceSets~~* ~~having~~ different values of *coresetPoolIndex*~~.~~, and- ~~Two fully/partially overlapping PUSCH transmissions~~ can be dynamically scheduled by UL grant(s) in DCI(s) and/or transmission(s) corresponding to configured grant(s) Type 1 or Type 2. *-* is not expected to be configured with different number of SRS resources in the two SRS resource sets.*-* the DCI codepoint SRS Resource Set Indicator is not present.**Comment 2**: Section 6.1.1.1 / 6.1.1.2: The following condition for SFN, should be captured under the bullet that is only specific to SFN (When codepoint “10” of *SRS Resource Set* *indicator* is indicated …) since this condition is not applicable to sTRP (e.g., when codepoint 00 or 01 are indicated).- maximum number of layers is up to 2.**Comment 3**: Section 6.2.3.1: The following (newly) added texts seem to belong to 38.212, and our understanding is that the corresponding agreements are already captured by the editor of 38.212 in the draft spec:When the higher layer parameter *multipanelScheme* is set to ‘sdmscheme’ and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook'/’nonCodebook’ and the higher layer parameter *maxNrofPorts* in *PTRS-UplinkConfig* is set to *n1*, the association between UL PT-RS port(s) and DM-RS port(s) is signalled by *PTRS-DMRS association* field(s) in DCI format 0\_1 and DCI format 0\_2 according to Table 7.3.1.1.2-25 described in Clause 7.3.1.1.2 [TS 38.212].… When the number of UL PT-RS port(s) is one, the association between UL PT-RS port(s) and DM-RS port(s) is signalled by *PTRS-DMRS association* field(s) in DCI format 0\_1 and DCI format 0\_2 according to Table 7.3.1.1.2-25 described in Clause 7.3.1.1.2 of [5, TS 38.212]. When the number of UL PT-RS port(s) is two, the association between UL PT-RS port(s) and DM-RS port(s) is signalled by *PTRS-DMRS association* field(s) in DCI format 0\_1 and DCI format 0\_2 according to Table 7.3.1.1.2-26 described in Clause 7.3.1.1.2 of [5, TS 38.212].When the higher layer parameter *multipanelScheme* is set to ‘SFNscheme’ and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook'/’nonCodebook’ and the higher layer parameter *maxNrofPorts* in *PTRS-UplinkConfig* is set to *n1*, the association between UL PT-RS port(s) and DM-RS port(s) is signalled by *PTRS-DMRS association* field(s) in DCI format 0\_1 and DCI format 0\_2 according to Table 7.3.1.1.2-25 described in Clause 7.3.1.1.2 of [5, TS 38.212].**Comment 4**: Section 6.1: We suggest the following change to capture the agreement copied below:**Agreement**When multi-DCI based STxMP PUSCH+PUSCH is configured, the existing rules for resolving overlapping PUSCH for the cases of one PUSCH overlapping with another PUSCH in time in one serving cell specified in legacy specifications ~~at least for CG+DG overlap, CG+CG overlap, CG+PUSCH with SP-CSI overlap, or PUSCH with SP-CSI + PUSCH with SP-CSI overlap~~ are performed separately for each coresetPoolIndex value. A UE is not expected to be scheduled by a PDCCH ending in symbol $i$ to transmit a PUSCH on a given serving cell overlapping in time with a transmission occasion, where the UE is allowed to transmit a PUSCH with configured grant according to [10, TS38.321], starting in a symbol $j$ on the same serving cell if the end of symbol $i$ is not at least $N\_{2}$ symbols before the beginning of symbol $j$, if - the UE is not provided *prioLowDG-HighCG* or *prioHighDG-LowCG*, or the UE is provided *prioLowDG-HighCG* or *prioHighDG-LowCG* and the two PUSCHs have the same priority index as described in Clause 9 of [6, TS 38.213]~~.~~, and- the UE is not provided *enableSTx2PofmDCI*, or is provided *enableSTx2PofmDCI* and the two PUSCHs are associated with the same *coresetPoolIndex* value.The value $N\_{2}$ in symbols is determined according to the UE processing capability defined in Clause 6.4, and $N\_{2} $and the symbol duration are based on the minimum of the subcarrier spacing corresponding to the PUSCH with configured grant and the subcarrier spacing of the PDCCH scheduling the PUSCH.  |  |
| CATT | We thank the editor for the great effort and nice work. Some comments follow.**Comment 1:** Section 6.1.1.1: When codepoint “10” of *SRS Resource Set* *indicator* is indicated, the correspondence between TPMI fields and layers are described twice. Therefore, the following modification is suggested:

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| When the higher layer parameter *multipanelScheme* is set to ‘SDMScheme’ and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook', two SRI(s), and two TPMI(s) are given by the DCI fields of two SRS resource indicator and two Precoding information and number of layers in clause 7.3.1.1.2 and 7.3.1.1.3 of [5, TS 38.212] for DCI format 0\_1 and 0\_2: - When codepoint “10” of *SRS Resource Set* *indicator* is indicated*,* the first TPMI is used to indicate the precoder to be applied over layers {0…v1-1}, where v1 is the number of layers indicated by the first TPMI, that corresponds to the SRS resource selected by the corresponding SRI when multiple SRS resources are configured for the applicable SRS resource set or if single SRS resource is configured for the applicable SRS resource set, ~~the first TPMI is used to indicate precoder to be applied over layers {0…v~~~~1~~~~-1}~~ the second TPMI is used to indicate the precoder to be applied over layers {v1…. v2+v1-1}, where v2 is the number of layers indicated by the second TPMI, that corresponds to the SRS resource selected by the corresponding SRI when multiple SRS resources are configured for the applicable SRS resource set or if single SRS resource is configured for the applicable SRS resource set ~~the second TPMI is used to indicate precoder to be applied over layers {v~~~~1~~~~….v~~~~2~~~~+v~~~~1~~~~-1}~~, v1 ≤ *maxRankSdm* andv2 ≤ *maxRankSdm* or *maxRankSdmDCI-0-2* is defining the maximum number of layers applied over the first and the second SRS resource sets, separately.~~.~~  |

**Comment 2:** Section 6.2.3.1: According to the agreement, the following text is related to SDM scheme not SFN scheme, which is not captured correctly.**Agreement**· For single-DCI based STxMP PUSCH SFN transmission, reuse Table 7.3.1.1.2-25 and Table 7.3.1.1.2-26 of 38.212 to indicate the association between PTRS port(s) and DMRS port(s) when one PTRS port and two PTRS ports are configured for the SFN scheme, respectively.· For single-DCI based STxMP PUSCH SDM scheme, when maxNrofPortsforSdm = 1, the 2-bit “PTRS-DMRS association” DCI field indicates the association between PTRS-DMRS port and the DMRS port according to the existing Table 7.3.1.1.2-25 in 38.212.

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| When the higher layer parameter *multipanelScheme* is set to ‘~~SFNscheme~~SDMscheme’ and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook'/’nonCodebook’ and the higher layer parameter *maxNrofPorts* in *PTRS-UplinkConfig* is set to *n1*, the association between UL PT-RS port(s) and DM-RS port(s) is signalled by *PTRS-DMRS association* field(s) in DCI format 0\_1 and DCI format 0\_2 according to Table 7.3.1.1.2-25 described in Clause 7.3.1.1.2 of [5, TS 38.212]. |

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### 2.3 DM-RS

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| Company | Comments | Editor reply/Notes |
| Huawei, HiSilicon | Thanks Mihai for the great effort! Regarding the modification, we have the following comments:Regarding the MU restriction for 1CW in section 5.1.6.2, we’d like to check whether MR. Editor plan to inherit the similar organisation logic (i.e., each sub-bullet represents either sTRP or mTRP case under a certain DMRS configuration type). Depending on Mr. Editor’s preference, the current version may need to be adjusted in different way. Furthermore, seems the indentation of the MU restriction for 2CWs can be cancelled. Regarding the PUSCH to PT-RS power ratio in section 6.2.3.1, seems the current version hasn’t entirely reflect the agreements. By the way, the yellow part (although agreed) is modified just for the correctness of grammar.- For partial coherent codebook for 8TX PUSCH transmission, *Lx* is the number of PUSCH layers in the antenna group ~~with~~ which are precoded coherently with the PUSCH layer/DMRS port ~~where~~ that PTRS port x is associated with, and *Qp* is the number of PTRS ports scheduled to the UE.**Table 6.2.3.1-3A: Factor related to PUSCH to PT-RS power ratio per layer per RE for 8TX PUSCH transmission**

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| ***UL-PTRS-power /***  | **The number of PUSCH layers (**$n\_{layer}^{PUSCH}$**)** |
| **1-8** |
| Full coherent | Partial coherent | Non-coherent and non-codebook based |
| 00 | $$10log\_{10}\left(n\_{layer}^{PUSCH}\right)$$ | $$10log\_{10}\left(L\_{x}\right)+ 10log\_{10}\left(Q\_{p}\right)$$ | $$10log\_{10}\left(Q\_{p}\right)$$ |
| 01 | $$10log\_{10}\left(n\_{layer}^{PUSCH}\right)$$ | $$10log\_{10}\left(n\_{layer}^{PUSCH}\right)$$ | $$10log\_{10}\left(n\_{layer}^{PUSCH}\right)$$ |
| 10 | Reserved |
| 11 | Reserved |

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| CATT(UL 8Tx) | We thank the editor for the great effort and nice work. Some comments follow.**Comment 1**: We suggest to capture the following agreement on PTRS power boosting for UL 8Tx in RAN1 #114 meeting in Table 6.2.3.1-3A:

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| **Agreement**For 8Tx PUSCH, when the *ptrs-Power* configures 00, Alt.2 is supported for the factor () for partial coherent TPMIs:* + Alt.2:$10 log10(L\_{x}) +10 log10(Q\_{p})$, where $L\_{x}$ is the number of PUSCH layers in the antenna group which are precoded coherently with the PUSCH layer / DMRS port where PTRS port *x* is associated with, and *Qp* is the number of PTRS ports scheduled to the UE.
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### 2.4 SRS

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| Company | Comments | Editor reply/Notes |
| Futurewei | We thank the editor for the great effort and nice work. Some comments follow.**Comment 1**: The current draft CR 38.214 describes the TDM can be supported. It does not specify that TDM can only be supported for 8-port SRS with usage CB/AS. In fact, it seems no RAN1 specification clearly specifies this restriction. Therefore, we suggest that this be captured in 38.214.*Agreement**For an 8-port SRS resource in a SRS resource set with usage ‘codebook’ or ‘antennaSwitching’ and resource mapping based on TDM onto m ≥ 2 OFDM symbols in a slot and with TDM factor s, support the 8 ports equally partitioned into s subsets with each subset having 8/s different ports.*- Support of time division mapping subsets of ports of ~~the~~ an 8-port SRS resource in an SRS resource set with the usage configured as ‘codebook’ or ‘*antennaSwitching’*, into *S* symbols (*S=2)*, as defined by the higher layer parameter [*tdm*], where the SRS ports are evenly distributed in two symbols.**Comment 2**: Clause 6.2.1.1 describes the SRS frequency hopping procedure. However, the description covers only the cases without TDM. It is suggested to either refer to 211 for the detailed behaviors/equations if TDM is configured, or add more descriptions as below examples:6.2.1.1 UE SRS frequency hopping procedureFor a given SRS resource, the UE is configured with repetition factor R∈{1,2,4} or R∈{1,2,3,4,5,6,7,8,10,12,14} by higher layer parameter *resourceMapping* in *SRS-Resource* where *R*≤*Ns/S*, where S=2 if the higher-layer parameter [*tdm*] is configured, otherwise S$=1$. When frequency hopping within an SRS resource in each slot is not configured and comb offset hopping is not configured and *S*=1 (*R=Ns*), each of the antenna ports of the SRS resource in each slot is mapped in all the  symbols to the same set of subcarriers in the same set of PRBs. When frequency hopping within an SRS resource in each slot is not configured and comb offset hopping is not configured and S=2 (*R=Ns*/S), antenna ports {1000, 1001, 1004, 1005} of the SRS resource in each slot is mapped in half of the  symbols and antenna ports {1000, 1002, 1004, 1006} of the SRS resource in each slot is mapped in the other half of the  symbols to the same set of subcarriers in the same set of PRBs according to clause 6.4.1.4.2 of [4, TS 38.211]. When frequency hopping within an SRS resource in each slot is not configured and comb offset hopping is configured and *S*=1 (*R=Ns*), each of the antenna ports of the SRS resource in each slot is mapped in all the  symbols to the subcarriers in the same set of PRBs according to clause 6.4.1.4.3 of [4, TS 38.211]. When frequency hopping within an SRS resource in each slot is configured without repetition (*R=1*), according to the SRS hopping parameters , and defined in clause 6.4.1.4 of [4, TS 38.211], each of the antenna ports of the SRS resource in each slot is mapped to different sets of subcarriers in each OFDM symbol, where the same transmission comb value is assumed for different sets of subcarriers. When both frequency hopping and repetition within an SRS resource in each slot are configured (*Ns*≥ *4, R* ≥ *2*), each of the antenna ports of the SRS resource in each slot is mapped to the same set of subcarriers within each set of SR adjacent OFDM symbols, and frequency hopping across the $\frac{N\_{s}}{SR}$ sets is according to the SRS hopping parameters , and , where $N\_{s}$ should be divisible by $SR$.For operation with shared spectrum channel access in FR1, the UE does not expect that multiple hops of an SRS resource transmission are in different RB sets.A UE may be configured $N\_{s}=2,4,8,10,12 or 14 $ adjacent symbol aperiodic SRS resource with intra-slot frequency hopping within a bandwidth part, where the full hopping bandwidth is sounded with an equal-size subband across  symbols when frequency hopping is configured with *R=1*. A UE may be configured *Ns*≥ *4* adjacent symbols aperiodic SRS resource with intra-slot frequency hopping within a bandwidth part, where the full hopping bandwidth is sounded with an equal-size subband across $\frac{N\_{s}}{SR}$ sets of S*R* adjacent OFDM symbols, when frequency hopping is configured with *R* ≥ *2, Ns*≥ *R* and *Ns*should be divisible by *SR*. Each of the antenna ports of the SRS resource is mapped to the same set of subcarriers within each set of SR adjacent OFDM symbols of the resource if comb offset hopping is not configured.A UE may be configured symbol periodic or semi-persistent SRS resource with inter-slot hopping within a bandwidth part, where the SRS resource occupies the same symbol location in each slot. A UE may be configured $N\_{s}=2,4,8,10,12 or 14$ symbol periodic or semi-persistent SRS resource with intra-slot and inter-slot hopping within a bandwidth part, where the SRS resource occupies the same symbol location(s) in each slot. For *Ns*≥ *4*, when frequency hopping is configured with *R* ≥ *2*, intra-slot and inter-slot hopping is supported with each of the antenna ports of the SRS resource mapped to different sets of subcarriers across $\frac{N\_{s}}{sR}$ sets of *SR* adjacent OFDM symbol(s) of the resource in each slot, where $N\_{s}$ should be divisible by *SR*. Each of the antenna ports of the SRS resource is mapped to the same set of subcarriers within each set of *SR* adjacent OFDM symbols of the resource in each slot. For *Ns= SR*, when frequency hopping is configured, inter-slot frequency hopping is supported with each of the antenna ports of the SRS resource mapped to the same set of subcarriers in *SR* adjacent OFDM symbol(s) of the resource in each slot if comb offset hopping is not configured. |  |
| Huawei, HiSilicon | Thanks Mihai for the great effort! Regarding the modification, we have the following comment:Agree with the comments proposed by Futurewei, while the detailed modification towards Comment 2 may need further discussion. |  |
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### 2.5 8TX

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| Company | Comments | Editor reply/Notes |
| ZTE | **Comment #1 (Section 6.1.1.1)**The following description for codebookType seems wired: codebookType is up to the value of ULcodebookFC-N1N2. In logic, ULcodebookFC-N1N2 can be provided, if ‘codebook1 corresponding to Ng=11 is enabled by ‘CodebookType’. Please review the following RRC parameter as agreed.

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| ULcodebookFC-N1N2 | Supported combination of a pair of parameters (N1, N2Only applicable to CodebookType='Codebook1' | (4,1), (2,2) |
| CodebookType | Codebook typeCodebook1 corresponds to Ng=1Codebook2 corresponds to Ng=2Codebook3 corresponds to Ng=4Codebook4 corresponds to Ng=8Ng represents the number of antenna port-groups | {Codebook1, Codebook2, Codebook3, Codebook4} |

Then, based on the above RRC parameter, we have the following suggestion:

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| A UE does not expect to be configured by *CodebookType* with a value of *CodebookType* that does not correspond to one of the values of *UL\_8TX\_Ng* reported in its capability. A UE can be configured by *ULcodebookFC-N1N2* subjective to UE capability, when higher layer parameter *CodebookType* is set to 'Codebook1’ corresponding to Ng=1, where Ng represents the number of antenna port-groups. |

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### 2.6 2TA

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| Company | Comments | Editor reply/Notes |
| Samsung | **Comment 1:**The agreement made in RAN1#114 says: “when the PDCCH order is transmitted from a TRP associated with additionalPCI”, we prefer to use wording that is aligned with the agreement as follows:“when receiving a PDSCH scheduled with RA-RNTI in response to a random access procedure triggered by a PDCCH order which triggers contention-free random access procedure for the SpCell [10, TS 38.321], and if the ~~CORESET~~ TCI state used for the PDCCH order transmission is ~~not~~ associated with ~~the serving~~ additional PCI different from the serving PCI, ~~cell physical cell ID~~ **Comment 2:**We prefer to leave the QCL of PDCCH RAR for 38.213, as it is already described there for other use cases of the PDCCH order.“when receiving a PDSCH scheduled with RA-RNTI in response to a random access procedure triggered by a PDCCH order which triggers contention-free random access procedure for the SpCell [10, TS 38.321], and if the CORESET used for the PDCCH order transmission is not associated with the serving cell physical cell ID, the UE may assume that ~~the DM-RS port of the PDCCH that includes the DCI format 1\_0 and~~ the DM-RS ports of the received PDSCH are quasi co-located with the DM-RS antenna port associated with PDCCH receptions in the CORESET for Type1-PDCCH CSS set with respect to Doppler shift, Doppler spread, average delay, delay spread, and spatial RX parameters when applicable.” |  |
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