**3GPP TSG RAN WG1 #117 R1-2403854**

**Fukuoka, China, April 20th – 24th, 2024**

**Agenda Item: 8.1**

**Source: Moderator (InterDigital, Inc.)**

**Title:** **FL Summary on Maintenance of 8TX (NR\_MIMO\_evo\_DL\_UL); 1st Round**

**Document for: Discussion and Decision**

# Background

In RAN plenary #94, the WID for Rel-18 MIMO enhancements was finalized [1]. According to the WID, some enhancements for SRI/TPMI are necessary to enable 8 TX UE transmission.

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| *Objective 5: Study, and if justified, specify UL DMRS, SRS, SRI, and TPMI (including codebook) enhancements to enable 8 Tx UL operation to support 4 and more layers per UE in UL targeting CPE/FWA/vehicle/Industrial devices*  *- Note: Potential restrictions on the scope of this objective (including coherence assumption, full/non-full power modes) will be identified as part of the study.* |

To accomplish the objective, the scope of this agenda item centers on codebook design for 8TX, enhancements for dual CW operation, enhancements on SRS configuration, impacts resulted from coherency characteristics of such UEs as well as UE operation with full power. All related Rel-18 agreements are captured in [2].

# Maintenance Issues

**Source: NTT DOCOMO, ASUSTek, Ericsson**

***Proposal 2.1:***

*Adopt the following correction to TS 38.212*

* *Reason for change:* 
  + *According to the latest agreed version of 38.331, maxRank-v1810 and maxMIMO-Layers-v1810, are used to configure 5-8 layers, while maxRank and maxMIMO-Layers are used for 1-4 layers. Therefore, maxRank-n8 and maxMIMO-Layers-n8 need to be replaced by maxRank-v1810 and maxMIMO-Layers-v1810, respectively.*
  + *In the current version of 38.212, some functionality that should support >4 layer transmission does not function because either or both of maxRank-n8 and/or maxMIMO-Layers-n8 are not used, including:*
    - *The maximum number of layers in for one TB in UL-SCH is undefined when the maximum rank or number of layers is 5-8.*
    - *UE cannot determine when to zero pad DCI fields for TB2 with bandwidth part switching since maxMIMO-Layers never meets the conditions for the zero padding.*
    - *UE cannot be configured with a maximum number of MIMO layers of more than 4 for non-codebook based operation.*
    - *CBGTI field size determination references only maxRank and maxMIMO-Layers, which does not address when maximum 5-8 layers are configured.*
* *Summary of change:* 
  + *The number of layers for one TB for UL-SCH is determined by maxMIMO-Layers or maxMIMO-Layers-v1810 and by maxRank or maxRank-v1810.*
  + *maxRank-v1810 and maxMIMO-Layers-v1810 replace maxRank-n8 and maxMIMO-Layers-n8 to determine if TB2 is present.*
  + *Whether maxRank-v1810 and maxMIMO-Layers-v1810 are configured for the indicated BW part and maxRank and maxMIMO-Layers are configured for the active BW part determines if the UE zero pads fields for TB2 in DCI.*
  + *maxMIMO-Layers or maxMIMO-Layers-v1810 can set the maximum number of non-codebook based PUSCH layers*
  + *CBGTI field size references maxRank, maxRank-v1810, maxMIMO-Layers, or maxMIMO-Layers-v1810.*
  + *maxRank-n8 is replaced by maxRank-v1810 in precoding information and number of layers field size determination and tables for 8 antenna ports.*
* *Consequences if not approved:* 
  + *Inconsistency between specifications on parameter name and usage.*
  + *The UE may not be able to be operate properly for > 4 layers with respect to determining the no. of layers in one TB, zero pading of DCI field sizes for TB2 when using BWP switching, being configured with a max no. of MIMO layers greater than 4 in NCB-based operation, and CBGTI operation when maximum 5-8 layers are configured.*

***38.212***

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| 5.4.2.1 Bit selection  -------------------------------------------Unchanged parts are omitted-------------------------------------------  For one TB for UL-SCH, or for one TB for DL-SCH/PCH except for DL-SCH with PDSCH scheduled by DCI format 4\_0/4\_1/4\_2:  - maximum number of layers for one TB for UL-SCH is given by the minimum of X and 4, where:  - if the higher layer parameter *maxMIMO-Layers* or *maxMIMO-Layers-v1810* of *PUSCH-ServingCellConfig* of the serving cell is configured, X is given by that parameter;  - elseif the higher layer parameter *maxRank* or *maxRank-v1810* of *pusch-Config* of the serving cell is configured, X is given by the maximum value of *maxRank* or *maxRank-v1810* across all BWPs of the serving cell;  - otherwise, X is given by the maximum number of layers for PUSCH supported by the UE for the serving cell;  -------------------------------------------Unchanged parts are omitted-------------------------------------------  7.3.1.1.2 Format 0\_1  -------------------------------------------Unchanged parts are omitted-------------------------------------------  For transport block 2 (only present if *maxRank~~-n8-~~v1810* is configured or *maxMIMO-Layers~~-n8-~~v1810* is configured):  - Modulation and coding scheme - 5 bits as defined in Clause 6.1.4.1 of [6, TS 38.214]  - New data indicator - 1 bit  - Redundancy version - 2 bits as defined in Table 7.3.1.1.1-2  If "Bandwidth part indicator" field indicates a bandwidth part other than the active bandwidth part, *maxRank~~-n8-~~v1810* is configured or the value of *maxMIMO-Layers-v1810* is configured for the indicated bandwidth part ~~is larger than 4~~ and ~~the value of~~ *maxRank* or *maxMIMO-Layers* is configured for the active bandwidth part ~~is no more than 4~~, the UE assumes zeros are padded when interpreting the "Modulation and coding scheme", "New data indicator", and "Redundancy version" fields for transport block 2 according to Clause 12 of [5, TS38.213], and the UE ignores the "Modulation and coding scheme", "New data indicator", and "Redundancy version" fields of transport block 2 for the indicated bandwidth part.  -------------------------------------------Unchanged parts are omitted-------------------------------------------  and  - if UE supports operation with *maxMIMO-Layers* and the higher layer parameter *maxMIMO-Layers* or *maxMIMO-Layers-v1810* of *PUSCH-ServingCellConfig* of the serving cell is configured,  - Lmax is given by max{*maxMIMO-Layers*, *maxMIMO-LayersforSdm*} if *maxMIMO-LayersforSdm* is configured  - Lmax is given by max{*maxMIMO-Layers*, *maxMIMO-LayersforSfn*} if *maxMIMO-LayersforSfn* is configured  - Lmax is given by *maxMIMO-Layers* or *maxMIMO-Layers-v1810* otherwise  - otherwise, *Lmax* is given by the maximum number of layers for PUSCH supported by the UE for the serving cell for non-codebook based operation.  -------------------------------------------Unchanged parts are omitted-------------------------------------------  - 7 bits according to Table 7.3.1.1.2-5B for 8 antenna ports, if *CodebookTypeUL=Codebook1*, transform precoder is disabled, *maxRank~~-n8-~~v1810* = 8, and according to *ULcodebookFC-N1N2*;  - 7 bits according to Table 7.3.1.1.2-5C for 8 antenna ports, if *CodebookTypeUL=Codebook1*, transform precoder is disabled, *maxRank~~-n8-~~v1810* =7, and according to *ULcodebookFC-N1N2*;  - 7 bits according to Table 7.3.1.1.2-5D for 8 antenna ports, if *CodebookTypeUL=Codebook1*, transform precoder is disabled, *maxRank~~-n8-~~v1810* =4, 5 or 6, and according to *maxRank~~-n8-~~v1810*;  - 4, 6 or 7 bits according to Table 7.3.1.1.2-5E for 8 antenna ports, if *CodebookTypeUL=Codebook1*, transform precoder is enabled or *maxRank* =1, 2 or 3 if transform precoder is disabled, and according to transform precoder and *maxRank*;  - 8 bits according to Table 7.3.1.1.2-5F for 8 antenna ports, if *CodebookTypeUL=Codebook4*, transform precoder is disabled, *maxRank~~-n8-~~v1810* =5, 6, 7 or 8, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, and according to *maxRank~~-n8-~~v1810*;  - 6 or 7 or 8 bits according to Table 7.3.1.1.2-5G for 8 antenna ports, if *CodebookTypeUL=Codebook4*, transform precoder is disabled, *maxRank*=2, 3 or 4, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, and according to *maxRank*;  - 3 bits according to Table 7.3.1.1.2-5H for 8 antenna ports, if *CodebookTypeUL=Codebook4*, transform precoder is enabled or *maxRank*=1 if transform precoder is disabled, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*.  - 10 bits according to Table 7.3.1.1.2-5I for 8 antenna ports, if *CodebookTypeUL=Codebook2*, transform precoder is disabled, *maxRank~~-n8-~~v1810* =5, 6, 7 or 8, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower,* and according to *maxRank~~-n8-~~v1810*;  - 5, 9 or 10 bits according to Table 7.3.1.1.2-5J for 8 antenna ports, if *CodebookTypeUL=Codebook2*, transform precoder is enabled or *maxRank* =1, 2, 3 or 4 if transform precoder is disabled, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, and according to transform precoder and *maxRank*;  - 10 bits according to Table 7.3.1.1.2-5K for 8 antenna ports, if *CodebookTypeUL=Codebook3*, transform precoder is disabled, *maxRank~~-n8-~~v1810* =5, 6, 7 or 8, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower,* and according to *maxRank~~-n8-~~v1810*;  - 4, 7, 9 or 10 bits according to Table 7.3.1.1.2-5L for 8 antenna ports, if *CodebookTypeUL=Codebook3*, transform precoder is enabled or *maxRank* =1, 2, 3 or 4 if transform precoder is disabled, *ul-FullPowerTransmission* is not configured or configured to *fullpowerMode2* or configured to *fullpower*, and according to transform precoder and *maxRank*;  - 6 or 7 or 8 bits according to Table 7.3.1.1.2-5M for 8 antenna ports, if *CodebookTypeUL=Codebook4*, transform precoder is disabled, *maxRank*=2, 3 or 4, *ul-FullPowerTransmission* is configured to *fullpowerMode1*, and according to *maxRank*;  - 4 bits according to Table 7.3.1.1.2-5N for 8 antenna ports, if *CodebookTypeUL=Codebook4*, transform precoder is enabled or *maxRank*=1 if transform precoder is disabled, *ul-FullPowerTransmission* is configured to *fullpowerMode1*.  - 6, 9 or 10 bits according to Table 7.3.1.1.2-5O for 8 antenna ports, if *CodebookTypeUL=Codebook2*, transform precoder is enabled or *maxRank* =1, 2, 3 or 4 if transform precoder is disabled, *ul-FullPowerTransmission* is configured to *fullpowerMode1*, and according to transform precoder and *maxRank*;  - 5, 7, 9 or 10 bits according to Table 7.3.1.1.2-5P for 8 antenna ports, if *CodebookTypeUL=Codebook3*, transform precoder is enabled or *maxRank* =1, 2, 3, or 4 if transform precoder is disabled, *ul-FullPowerTransmission* is configured to *fullpowerMode1*, and according to transform precoder and *maxRank*;  - 8 or 9 bits according to Table 7.3.1.1.2-5Q for 8 antenna ports, if *CodebookTypeUL*=*Codebook4*, transform precoder is disabled, *maxRank~~-n8-~~v1810* =5, 6, 7 or 8, *ul-FullPowerTransmission* is configured to *fullpowerMode1*, and according to *maxRank-v1810*;  - 10 bits according to Table 7.3.1.1.2-5R for 8 antenna ports, if *CodebookTypeUL*=*Codebook2*, transform precoder is disabled, *maxRank~~-n8-~~v1810* =5, 6, 7 or 8, *ul-FullPowerTransmission* is configured to *fullpowerMode1*, and according to *maxRank~~-n8-~~v1810*;  - 10 bits according to Table 7.3.1.1.2-5S for 8 antenna ports, if *CodebookTypeUL*=*Codebook3*, transform precoder is disabled, *maxRank~~-n8-~~v1810* =5, 6, 7, or 8, *ul-FullPowerTransmission* is configured to *fullpowerMode1*, and according to *maxRank~~-n8-~~v1810*;  For the higher layer parameter *txConfig=codebook*, if *ul-FullPowerTransmission* is configured to *fullpowerMode2*, maxRank is configured to be larger than 2, and at least one SRS resource with 4 antenna ports or 8 antenna ports is configured in the SRS resource set indicated by SRS resource set indicator field if present, otherwise in an SRS resource set with usage set to 'codebook', and an SRS resource with 2 antenna ports is indicated via SRI in the same SRS resource set, then Table 7.3.1.1.2-4 is used.  For the higher layer parameter *txConfig=codebook*, if *ul-FullPowerTransmission* is configured to *fullpowerMode2*, *maxRank-v1810* is configured ~~to be larger than 4~~, and at least one SRS resource with 8 antenna ports is configured in the SRS resource set with usage set to 'codebook', and an SRS resource with 4 antenna ports is indicated via SRI in the same SRS resource set, then Table 7.3.1.1.2-2 is used.  For the higher layer parameter *txConfig = codebook*, if different SRS resources with different number of antenna ports are configured, the bitwidth is determined according to the maximum number of ports in an SRS resource among the configured SRS resources in all SRS resource set(s) with usage set to 'codebook'. If the number of ports for a configured SRS resource in the set is less than the maximum number of ports in an SRS resource among the configured SRS resources, a number of most significant bits with value set to '0' are inserted to the field.  -------------------------------------------Unchanged parts are omitted-------------------------------------------  - CSI request - 0, 1, 2, 3, 4, 5, or 6 bits determined by higher layer parameter *reportTriggerSize*.  - CBG transmission information (CBGTI) - 0 bit if higher layer parameter *codeBlockGroupTransmission* for PUSCH is not configured or if the number of scheduled PUSCH indicated by the Time domain resource assignment field is larger than 1; otherwise, 2, 4, 6, or 8 bits as defined in Clause 6.1.5 of [6, TS38.214], determined by higher layer parameter *maxCodeBlockGroupsPerTransportBlock* and *maxRank*, *maxRank-v1810*, ~~or~~ *maxMIMO-Layers*, or *maxMIMO-Layers-v1810* for PUSCH.  - PTRS-DMRS association - number of bits determined as follows  -------------------------------------------Unchanged parts are omitted-------------------------------------------  **Table 7.3.1.1.2-5B: Precoding information and number of layers, for 8 antenna ports, if transform precoder is disabled, *maxRank~~-n8~~-v1810* = 8, and *CodebookTypeUL*=*Codebook1***  -------------------------------------------Unchanged parts are omitted-------------------------------------------  **Table 7.3.1.1.2-5C: Precoding information and number of layers, for 8 antenna ports, if transform precoder is disabled, *maxRank~~-n8~~-v1810* = 7, and *CodebookTypeUL=Codebook1***  -------------------------------------------Unchanged parts are omitted-------------------------------------------  **Table 7.3.1.1.2-5D: Precoding information and number of layers, for 8 antenna ports, if transform precoder is disabled, *maxRank~~-n8~~-v1810* = 4, 5 or 6, *CodebookTypeUL=Codebook1, ULcodebookFC-N1N2 = (4,1) or (2,2)***   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* =4** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* =5** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *=6*** | | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | | 1 | 1 layer: TPMI=1 | 1 | 1 layer: TPMI=1 | 1 | 1 layer: TPMI=1 | | … | … | … | … | … | … | | 15 | 1 layer: TPMI=15 | 15 | 1 layer: TPMI=15 | 15 | 1 layer: TPMI=15 | | 16 | 2 layers: TPMI=0 | 16 | 2 layers: TPMI=0 | 16 | 2 layer2: TPMI=0 | | 17 | 2 layers: TPMI=1 | 17 | 2 layers: TPMI=1 | 17 | 2 layer2: TPMI=1 | | … | … | … | … | … | … | | 47 | 2 layers: TPMI=31 | 47 | 2 layers: TPMI=31 | 47 | 2 layers: TPMI=31 | | 48 | 3 layers: TPMI=0 | 48 | 3 layers: TPMI=0 | 48 | 3 layers: TPMI=0 | | 49 | 3 layers: TPMI=1 | 49 | 3 layers: TPMI=1 | 49 | 3 layers: TPMI=1 | | … | … | … | … | … | … | | 71 | 3 layers: TPMI=23 | 71 | 3 layers: TPMI=23 | 71 | 3 layers: TPMI=23 | | 72 | 4 layers: TPMI=0 | 72 | 4 layers: TPMI=0 | 72 | 4 layers: TPMI=0 | | 73 | 4 layers: TPMI=1 | 73 | 4 layers: TPMI=1 | 73 | 4 layers: TPMI=1 | | … | … | … | … | … | … | | 95 | 4 layers: TPMI=23 | 95 | 4 layers: TPMI=23 | 95 | 4 layers: TPMI=23 | | 96-127 | reserved | 96 | 5 layers: TPMI=0 | 96 | 5 layers: TPMI=0 | |  |  | 97 | 5 layers: TPMI=1 | 97 | 5 layers: TPMI=1 | |  |  | … | … | … | … | |  |  | 103 | 5 layers: TPMI=7 | 103 | 5 layers: TPMI=7 | |  |  | 104-127 | reserved | 104 | 6 layers: TPMI=0 | |  |  |  |  | 105 | 6 layers: TPMI=1 | |  |  |  |  | … | … | |  |  |  |  | 111 | 6 layers: TPMI=7 | |  |  |  |  | 112-127 | reserved |   -------------------------------------------Unchanged parts are omitted-------------------------------------------  **Table 7.3.1.1.2-5F: Precoding information and number of layers, for 8 antenna ports, if transform precoder is disabled, *maxRank~~-n8~~-v1810* = 5, 6, 7 or 8, and *CodebookTypeUL=Codebook4***   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 5*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 6*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810 = 7*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 8*** | | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | | … | … | … | … | … | … | … | … | | 7 | 1 layer: TPMI=7 | 7 | 1 layer: TPMI=7 | 7 | 1 layer: TPMI=7 | 7 | 1 layer: TPMI=7 | | 8 | 2 layers: TPMI=8 | 8 | 2 layers: TPMI=8 | 8 | 2 layers: TPMI=8 | 8 | 2 layers: TPMI=8 | | … | … | … | … | … | … | … | … | | 35 | 2 layers: TPMI=35 | 35 | 2 layers: TPMI=35 | 35 | 2 layers: TPMI=35 | 35 | 2 layers: TPMI=35 | | 36 | 3 layers: TPMI=36 | 36 | 3 layers: TPMI=36 | 36 | 3 layers: TPMI=36 | 36 | 3 layers: TPMI=36 | | … | … | … | … | … | … | … | … | | 91 | 3 layers: TPMI=91 | 91 | 3 layers: TPMI=91 | 91 | 3 layers: TPMI=91 | 91 | 3 layers: TPMI=91 | | 92 | 4 layers: TPMI=92 | 92 | 4 layers: TPMI=92 | 92 | 4 layers: TPMI=92 | 92 | 4 layers: TPMI=92 | | … | … | … | … | … | … | … | … | | 161 | 4 layers: TPMI=161 | 161 | 4 layers: TPMI=161 | 161 | 4 layers: TPMI=161 | 161 | 4 layers: TPMI=161 | | 162 | 5 layers: TPMI=162 | 162 | 5 layers: TPMI=162 | 162 | 5 layers: TPMI=162 | 162 | 5 layers: TPMI=162 | | … | … | … | … | … | … | … | … | | 217 | 5 layers: TPMI=217 | 217 | 5 layers: TPMI=217 | 217 | 5 layers: TPMI=217 | 217 | 5 layers: TPMI=217 | | 218-255 | reserved | 218 | 6 layers: TPMI=218 | 218 | 6 layers: TPMI=218 | 218 | 6 layers: TPMI=218 | |  |  | … | … | … | … | … | … | |  |  | 245 | 6 layers: TPMI=245 | 245 | 6 layers: TPMI=245 | 245 | 6 layers: TPMI=245 | |  |  | 246-255 | reserved | 246 | 7 layers: TPMI=246 | 246 | 7 layers: TPMI=246 | |  |  |  |  | … | … | … | … | |  |  |  |  | 253 | 7 layers: TPMI=253 | 253 | 7 layers: TPMI=253 | |  |  |  |  | 254-255 | reserved | 254 | 8 layers: TPMI=254 | |  |  |  |  |  |  | 255 | reserved |   -------------------------------------------Unchanged parts are omitted-------------------------------------------  **Table 7.3.1.1.2-5I: Precoding information and number of layers, for 8 antenna ports, if transform precoder is disabled, *maxRank~~-n8~~-v1810* = 5, 6, 7 or 8, and *CodebookTypeUL=Codebook2***   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 5*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 6*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810 = 7*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 8*** | | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | | … | … | … | … | … | … | … | … | | 31 | 1 layer: TPMI=31 | 31 | 1 layer: TPMI=31 | 31 | 1 layer: TPMI=31 | 31 | 1 layer: TPMI=31 | | 32 | 2 layers: TPMI=0 | 32 | 2 layers: TPMI=0 | 32 | 2 layers: TPMI=0 | 32 | 2 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 303 | 2 layers: TPMI=271 | 303 | 2 layers: TPMI=271 | 303 | 2 layers: TPMI=271 | 303 | 2 layers: TPMI=271 | | 304 | 3 layers: TPMI=0 | 304 | 3 layers: TPMI=0 | 304 | 3 layers: TPMI=0 | 304 | 3 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 567 | 3 layers: TPMI=263 | 567 | 3 layers: TPMI=263 | 567 | 3 layers: TPMI=263 | 567 | 3 layers: TPMI=263 | | 568 | 4 layers: TPMI=0 | 568 | 4 layers: TPMI=0 | 568 | 4 layers: TPMI=0 | 568 | 4 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 635 | 4 layers: TPMI=67 | 635 | 4 layers: TPMI=67 | 635 | 4 layers: TPMI=67 | 635 | 4 layers: TPMI=67 | | 636 | 5 layers: TPMI=0 | 636 | 5 layers: TPMI=0 | 636 | 5 layers: TPMI=0 | 636 | 5 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 667 | 5 layers: TPMI=31 | 667 | 5 layers: TPMI=31 | 667 | 5 layers: TPMI=31 | 667 | 5 layers: TPMI=31 | | 698-1023 | reserved | 668 | 6 layers: TPMI=0 | 668 | 6 layers: TPMI=0 | 668 | 6 layers: TPMI=0 | |  |  | … | … | … | … | … | … | |  |  | 683 | 6 layers: TPMI=15 | 683 | 6 layers: TPMI=15 | 683 | 6 layers: TPMI=15 | |  |  | 684-1023 | reserved | 684 | 7 layers: TPMI=0 | 684 | 7 layers: TPMI=0 | |  |  |  |  | … | … | … | … | |  |  |  |  | 691 | 7 layers: TPMI=7 | 691 | 7 layers: TPMI=7 | |  |  |  |  | 692-1023 | reserved | 692 | 8 layers: TPMI=0 | |  |  |  |  |  |  | … | … | |  |  |  |  |  |  | 695 | 8 layers: TPMI=3 | |  |  |  |  |  |  | 696-1023 | reserved |   -------------------------------------------Unchanged parts are omitted-------------------------------------------  **Table 7.3.1.1.2-5K: Precoding information and number of layers, for 8 antenna ports, if transform precoder is disabled, *maxRank~~-n8~~-v1810* = 5, 6, 7 or 8, and *CodebookTypeUL=Codebook3***   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 5*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 6*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 7*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810 = 8*** | | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | | … | … | … | … | … | … | … | … | | 15 | 1 layer: TPMI=15 | 15 | 1 layer: TPMI=15 | 15 | 1 layer: TPMI=15 | 15 | 1 layer: TPMI=15 | | 16 | 2 layers: TPMI=0 | 16 | 2 layers: TPMI=0 | 16 | 2 layers: TPMI=0 | 16 | 2 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 119 | 2 layers: TPMI=103 | 119 | 2 layers: TPMI=103 | 119 | 2 layers: TPMI=103 | 119 | 2 layers: TPMI=103 | | 120 | 3 layers: TPMI=0 | 120 | 3 layers: TPMI=0 | 120 | 3 layers: TPMI=0 | 120 | 3 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 423 | 3 layers: TPMI=303 | 423 | 3 layers: TPMI=303 | 423 | 3 layers: TPMI=303 | 423 | 3 layers: TPMI=303 | | 424 | 4 layers: TPMI=0 | 424 | 4 layers: TPMI=0 | 424 | 4 layers: TPMI=0 | 424 | 4 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 703 | 4 layers: TPMI=279 | 703 | 4 layers: TPMI=279 | 703 | 4 layers: TPMI=279 | 703 | 4 layers: TPMI=279 | | 704 | 5 layers: TPMI=0 | 704 | 5 layers: TPMI=0 | 704 | 5 layers: TPMI=0 | 704 | 5 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 863 | 5 layers: TPMI=159 | 863 | 5 layers: TPMI=159 | 863 | 5 layers: TPMI=159 | 863 | 5 layers: TPMI=159 | | 864-1023 | reserved | 864 | 6 layers: TPMI=0 | 864 | 6 layers: TPMI=0 | 864 | 6 layers: TPMI=0 | |  |  | … | … | … | … | … | … | |  |  | 943 | 6 layers: TPMI=79 | 943 | 6 layers: TPMI=79 | 943 | 6 layers: TPMI=79 | |  |  | 944-1023 | reserved | 944 | 7 layers: TPMI=0 | 944 | 7 layers: TPMI=0 | |  |  |  |  | … | … | … | … | |  |  |  |  | 975 | 7 layers: TPMI=31 | 975 | 7 layers: TPMI=31 | |  |  |  |  | 976-1023 | reserved | 976 | 8 layers: TPMI=0 | |  |  |  |  |  |  | … | … | |  |  |  |  |  |  | 991 | 8 layers: TPMI=15 | |  |  |  |  |  |  | 992-1023 | reserved |   -------------------------------------------Unchanged parts are omitted-------------------------------------------  **Table 7.3.1.1.2-5Q: Precoding information and number of layers, for 8 antenna ports, if transform precoder is disabled, *maxRank~~-n8~~-v1810* = 5, 6, 7, 8, *CodebookTypeUL=Codebook4,* and *ul-FullPowerTransmission* is configured to *fullpowerMode1***   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810 = 5*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810 = 6*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 7*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810 = 8*** | | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | | … | … | … | … | … | … | … | … | | 7 | 1 layer: TPMI=7 | 7 | 1 layer: TPMI=7 | 7 | 1 layer: TPMI=7 | 7 | 1 layer: TPMI=7 | | 8 | 2 layers: TPMI=8 | 8 | 2 layers: TPMI=8 | 8 | 2 layers: TPMI=8 | 8 | 2 layers: TPMI=8 | | … | … | … | … | … | … | … | … | | 35 | 2 layers: TPMI=35 | 35 | 2 layers: TPMI=35 | 35 | 2 layers: TPMI=35 | 35 | 2 layers: TPMI=35 | | 36 | 3 layers: TPMI=36 | 36 | 3 layers: TPMI=36 | 36 | 3 layers: TPMI=36 | 36 | 3 layers: TPMI=36 | | … | … | … | … | … | … | … | … | | 91 | 3 layers: TPMI=91 | 91 | 3 layers: TPMI=91 | 91 | 3 layers: TPMI=91 | 91 | 3 layers: TPMI=91 | | 92 | 4 layers: TPMI=92 | 92 | 4 layers: TPMI=92 | 92 | 4 layers: TPMI=92 | 92 | 4 layers: TPMI=92 | | … | … | … | … | … | … | … | … | | 161 | 4 layers: TPMI=161 | 161 | 4 layers: TPMI=161 | 161 | 4 layers: TPMI=161 | 161 | 4 layers: TPMI=161 | | 162 | 5 layers: TPMI=162 | 162 | 5 layers: TPMI=162 | 162 | 5 layers: TPMI=162 | 162 | 5 layers: TPMI=162 | | … | … | … | … | … | … | … | … | | 217 | 5 layers: TPMI=217 | 217 | 5 layers: TPMI=217 | 217 | 5 layers: TPMI=217 | 217 | 5 layers: TPMI=217 | | 218 | 1 layer: TPMI=255 | 218 | 6 layers: TPMI=218 | 218 | 6 layers: TPMI=218 | 218 | 6 layers: TPMI=218 | | 219 | 2 layers: TPMI=256 | … | … | … | … | … | … | | 220 | 3 layers: TPMI=257 | 245 | 6 layers: TPMI=245 | 245 | 6 layers: TPMI=245 | 245 | 6 layers: TPMI=245 | | 221 | 4 layers: TPMI=258 | 246 | 1 layer: TPMI=255 | 246 | 7 layers: TPMI=246 | 246 | 7 layers: TPMI=246 | | 222-255 | reserved | 247 | 2 layers: TPMI=256 | … | … | … | … | |  |  | 248 | 3 layers: TPMI=257 | 253 | 7 layers: TPMI=253 | 253 | 7 layers: TPMI=253 | |  |  | 249 | 4 layers: TPMI=258 | 254 | 1 layer: TPMI=255 | 254 | 8 layers: TPMI=254 | |  |  | 250-255 | reserved | 255 | 2 layers: TPMI=256 | 255 | 1 layer: TPMI=255 | |  |  |  |  | 256 | 3 layers: TPMI=257 | 256 | 2 layers: TPMI=256 | |  |  |  |  | 257 | 4 layers: TPMI=258 | 257 | 3 layers: TPMI=257 | |  |  |  |  | 258-511 | reserved | 258 | 4 layers: TPMI=258 | |  |  |  |  |  |  | 259-511 | reserved |   -------------------------------------------Unchanged parts are omitted-------------------------------------------  **Table 7.3.1.1.2-5R: Precoding information and number of layers, for 8 antenna ports, if transform precoder is disabled, *maxRank~~-n8~~-v1810* = 5, 6, 7, 8, *CodebookTypeUL=Codebook2,* and *ul-FullPowerTransmission* is configured to *fullpowerMode1***   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 5*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810 = 6*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 7*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 8*** | | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | | … | … | … | … | … | … | … | … | | 31 | 1 layer: TPMI=31 | 31 | 1 layer: TPMI=31 | 31 | 1 layer: TPMI=31 | 31 | 1 layer: TPMI=31 | | 32 | 2 layers: TPMI=0 | 32 | 2 layers: TPMI=0 | 32 | 2 layers: TPMI=0 | 32 | 2 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 303 | 2 layers: TPMI=271 | 303 | 2 layers: TPMI=271 | 303 | 2 layers: TPMI=271 | 303 | 2 layers: TPMI=271 | | 304 | 3 layers: TPMI=0 | 304 | 3 layers: TPMI=0 | 304 | 3 layers: TPMI=0 | 304 | 3 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 567 | 3 layers: TPMI=263 | 567 | 3 layers: TPMI=263 | 567 | 3 layers: TPMI=263 | 567 | 3 layers: TPMI=263 | | 568 | 4 layers: TPMI=0 | 568 | 4 layers: TPMI=0 | 568 | 4 layers: TPMI=0 | 568 | 4 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 635 | 4 layers: TPMI=67 | 635 | 4 layers: TPMI=67 | 635 | 4 layers: TPMI=67 | 635 | 4 layers: TPMI=67 | | 636 | 5 layers: TPMI=0 | 636 | 5 layers: TPMI=0 | 636 | 5 layers: TPMI=0 | 636 | 5 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 667 | 5 layers: TPMI=31 | 667 | 5 layers: TPMI=31 | 667 | 5 layers: TPMI=31 | 667 | 5 layers: TPMI=31 | | 668 | 1 layer: TPMI=32 | 668 | 6 layers: TPMI=0 | 668 | 6 layers: TPMI=0 | 668 | 6 layers: TPMI=0 | | 669-1023 | reserved | … | … | … | … | … | … | |  |  | 683 | 6 layers: TPMI=15 | 683 | 6 layers: TPMI=15 | 683 | 6 layers: TPMI=15 | |  |  | 684 | 1 layer: TPMI=32 | 684 | 7 layers: TPMI=0 | 684 | 7 layers: TPMI=0 | |  |  | 685-1023 | reserved | … | … | … | … | |  |  |  |  | 691 | 7 layers: TPMI=7 | 691 | 7 layers: TPMI=7 | |  |  |  |  | 692 | 1 layer: TPMI=32 | 692 | 8 layers: TPMI=0 | |  |  |  |  | 693-1023 | reserved | … | … | |  |  |  |  |  |  | 695 | 8 layers: TPMI=3 | |  |  |  |  |  |  | 696 | 1 layer: TPMI=32 | |  |  |  |  |  |  | 697-1023 | reserved |   -------------------------------------------Unchanged parts are omitted-------------------------------------------  **Table 7.3.1.1.2-5S: Precoding information and number of layers, for 8 antenna ports, if transform precoder is disabled, *maxRank~~-n8~~-v1810* = 5, 6, 7, 8, *CodebookTypeUL=Codebook3,* and *ul-FullPowerTransmission* is configured to *fullpowerMode1***   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 5*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810 = 6*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 7*** | **Bit field mapped to index** | ***maxRank~~-n8~~-v1810* *= 8*** | | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | 0 | 1 layer: TPMI=0 | | … | … | … | … | … | … | … | … | | 15 | 1 layer: TPMI=15 | 15 | 1 layer: TPMI=15 | 15 | 1 layer: TPMI=15 | 15 | 1 layer: TPMI=15 | | 16 | 2 layers: TPMI=0 | 16 | 2 layers: TPMI=0 | 16 | 2 layers: TPMI=0 | 16 | 2 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 119 | 2 layers: TPMI=103 | 119 | 2 layers: TPMI=103 | 119 | 2 layers: TPMI=103 | 119 | 2 layers: TPMI=103 | | 120 | 3 layers: TPMI=0 | 120 | 3 layers: TPMI=0 | 120 | 3 layers: TPMI=0 | 120 | 3 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 423 | 3 layers: TPMI=303 | 423 | 3 layers: TPMI=303 | 423 | 3 layers: TPMI=303 | 423 | 3 layers: TPMI=303 | | 424 | 4 layers: TPMI=0 | 424 | 4 layers: TPMI=0 | 424 | 4 layers: TPMI=0 | 424 | 4 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 703 | 4 layers: TPMI=279 | 703 | 4 layers: TPMI=279 | 703 | 4 layers: TPMI=279 | 703 | 4 layers: TPMI=279 | | 704 | 5 layers: TPMI=0 | 704 | 5 layers: TPMI=0 | 704 | 5 layers: TPMI=0 | 704 | 5 layers: TPMI=0 | | … | … | … | … | … | … | … | … | | 863 | 5 layers: TPMI=159 | 863 | 5 layers: TPMI=159 | 863 | 5 layers: TPMI=159 | 863 | 5 layers: TPMI=159 | | 864 | 1 layer: TPMI=16 | 864 | 6 layers: TPMI=0 | 864 | 6 layers: TPMI=0 | 864 | 6 layers: TPMI=0 | | 865 | 2 layers: TPMI=104 | … | … | … | … | … | … | | 866 | 3 layers: TPMI=304 | 943 | 6 layers: TPMI=79 | 943 | 6 layers: TPMI=79 | 943 | 6 layers: TPMI=79 | | 867-1023 | reserved | 944 | 1 layer: TPMI=16 | 944 | 7 layers: TPMI=0 | 944 | 7 layers: TPMI=0 | |  |  | 945 | 2 layers: TPMI=104 | … | … | … | … | |  |  | 946 | 3 layers: TPMI=304 | 975 | 7 layers: TPMI=31 | 975 | 7 layers: TPMI=31 | |  |  | 944-1023 | reserved | 976 | 1 layer: TPMI=16 | 976 | 8 layers: TPMI=0 | |  |  |  |  | 977 | 2 layers: TPMI=104 | … | … | |  |  |  |  | 978 | 3 layers: TPMI=304 | 991 | 8 layers: TPMI=15 | |  |  |  |  | 979-1023 | reserved | 992 | 1 layer: TPMI=16 | |  |  |  |  |  |  | 993 | 2 layers: TPMI=104 | |  |  |  |  |  |  | 994 | 3 layers: TPMI=304 | |  |  |  |  |  |  | 995-1023 | reserved |   -------------------------------------------Unchanged parts are omitted------------------------------------------- |

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**Source: ASUSTek, Ericsson**

***Proposal 2.2:***

*Adopt the following correction to TS 38.214*

* *Reason for change:*
  + *Configured grant operation for PUSCH supports at most 4 layers. However, configured grant operation can be controlled with both maxRank and maxRank-n8, which configure the UE for 1-4 and 5-8 layers, respectively, thereby allowing up to rank 8. This also conflicts with the statement in this section ‘A configured grant PUSCH can be transmitted with at most 4 layers’. The specification is therefore ambiguous at present, and may conflict with the agreed behavior from RAN1#113.*
  + *According to the latest agreed version of 38.331 for MIMO, a new version of the parameter maxMIMO-Layers for PUSCH is used for 5-8 layers, ‘maxMIMO-Layers-v1810’, while ‘maxMIMO-Layers’ is used for 1-4 layers. Also, the parameter ‘maxRank-n8’ is now named ‘maxRank-v1810’, but still is used for 5-8 layers, while ‘maxRank’ is used for 1-4 layers.*
* *Summary of change:*
  + *Configured grant operation is limited to 4 layers by removing maxRank-n8.*
  + *maxMIMO-Layers-v1810 is used for the greater than 4 layer case, and the redundant phrase ‘is greater than 4’ is removed.*
  + *‘maxRank-n8’ is renamed to ‘maxRank-v1810’*
* *Consequences if not approved:*
  + *Whether the UE should support more than 4 PUSCH layers for configured grant is unclear, which could result in the UE being configured for this case and subsequent unspecified behavior.*
  + *The UE may not be able to be configured for more than 4 PUSCH layers, since the incorrect RRC parameters are used.*

***38.214***

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| 6.1 UE procedure for transmitting the physical uplink shared channel  -------------------------------------------Unchanged parts are omitted-------------------------------------------  For the PUSCH transmission corresponding to a Type 1 configured grant or a Type 2 configured grant activated by DCI format 0\_0 or 0\_1, the parameters applied for the transmission are provided by *configuredGrantConfig* except for *dataScramblingIdentityPUSCH*, *txConfig*, *codebookSubset*, *maxRank*, *~~maxRank-n8,~~* *scaling* of *UCI-OnPUSCH,* which are provided by *pusch-Config*. A configured grant PUSCH can be transmitted with at most 4 layers. For the PUSCH transmission corresponding to a Type 2 configured grant activated by DCI format 0\_2, the parameters applied for the transmission are provided by *configuredGrantConfig* except for *dataScramblingIdentityPUSCH*, *txConfig*, *codebookSubsetDCI-0-2*, *maxRankDCI-0-2*, *scaling* of *UCI-OnPUSCH*, *resourceAllocationType1GranularityDCI-0-2* provided by *pusch-Config*.If the UE is provided with *transformPrecoder* in *configuredGrantConfig*, the UE applies the higher layer parameter *tp-pi2BPSK*, if provided in *pusch-Config*, according to the procedure described in clause 6.1.4 for the PUSCH transmission corresponding to a configured grant.  -------------------------------------------Unchanged parts are omitted-------------------------------------------  6.1.1.1 Codebook based UL transmission  -------------------------------------------Unchanged parts are omitted-------------------------------------------  When higher layer parameter *ul-FullPowerTransmission* is set to 'fullpowerMode2*'* and the higher layer parameter *CodebookTypeUL* is set to *'*Codebook2' or *'*Codebook3', and the *SRS-resourceSet* with *usage* set to 'codebook' includes one SRS resource with 8 ports, and at least one SRS resource with 2 ports or 4 ports, subject to UE capability,  - when *CodebookTypeUL* is set to *'*Codebook2', the *codebookSubset* associated with the 2-port SRS resource is 'nonCoherent'.  - when *CodebookTypeUL* is set to *'*Codebook2', the *codebookSubset* associated with the 4-port SRS resource can be configured as 'partialAndNonCoherent' or 'nonCoherent', subject to UE capability.  - when *CodebookTypeUL* is set to *'*Codebook3', the *codebookSubset* associated with 4 ports SRS resources is 'nonCoherent'.  The maximum transmission rank may be configured by the higher layer parameter *maxRank* *or maxRank-~~n8~~v1810* in *pusch-Config* for PUSCH scheduled with DCI format 0\_1 or 0\_3 and *maxRankDCI-0-2* for PUSCH scheduled with DCI format 0\_2*.*  -------------------------------------------Unchanged parts are omitted-------------------------------------------  6.1.4.2 Transport block size determination  For eight antenna ports PUSCH transmission, when the number of PUSCH transmission layers is greater than 4, two codewords are transmitted.  If the higher layer parameter *maxRank-v1810~~n8~~* ~~is configured~~or *maxMIMO-Layers-v1810* in *PUSCH-config* ~~is greater than 4~~ is configured, then one of the two transport blocks is disabled by DCI format 0\_1 if *IMCS* = 26 and if *rvid* = 1 for the corresponding transport block. If both transport blocks are enabled, transport block 1 and 2 are mapped to codeword 0 and 1 respectively. If only one transport block is enabled, then the enabled transport block is always mapped to the first codeword. |

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**Source: Ericsson**

***Proposal 2.3:***

*Adopt the following correction to TS 38.214*

* *Reason for change:*
  + *According to 38.306 v18.0, UE capabilities for 8 antenna port codebooks are ‘codebook1-8TxPUSCH-r18’ (support for one of two codebooks with values n4-1 and n2-2), ‘codebook2-8TxPUSCH-r18’, ‘codebook3-8TxPUSCH-r18’, and ‘codebook4-8TxPUSCH-r18’, and there is no capability named ‘UL\_8TX\_Ng’.*
* *Summary of change:*
  + *Removing the reference to ‘UL\_8TX\_Ng’, and revise the text that UE should expect to be configured according its reported capabilities, which addresses both the number of port groups and the supported codebooks.*
* *Consequences if not approved:*
  + *Incorrect referencing to a non-existing capability.*

**38.214**

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| 6.1.1.1 Codebook based UL transmission  -------------------------------------------Unchanged parts are omitted-------------------------------------------  A UE does not expect to be configured ~~by~~ *~~CodebookTypeUL~~* with a value of *CodebookTypeUL* that does not correspond to one of the values ~~of~~ *~~UL\_8TX\_Ng~~* reported in its capability for codebook based transmission with eight antenna ports.  -------------------------------------------Unchanged parts are omitted------------------------------------------- |

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4. R1-2405203, Parameter name alignment on 8Tx PUSCH, ASUSTeK
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6. R1-2405292, Corrections for When UL 8 Tx Layer Limits Exceed 4 Layers, Ericsson
7. R1-2405293, Corrections on UL 8 Tx Configured Grant Layer Limits and 8 Tx Layer Configuration, Ericsson
8. R1-2405294, Correction on 8 Tx UL MIMO Codebook Configuration Constraints, Ericsson