**3GPP TSG-RAN WG1 Meeting #120. R1-241XXXX**

**Athens, Greece, February 17 – 21, 2025**

**Agenda item:** 9.14

**Source:** Moderator (NTT DOCOMO, INC.)

**Title:** FL Summary #1 on Rel-19 TEIs

**Document for:** Discussion and Decision

1. Introduction

This contribution summarizes the discussions and proposals in AI 9.14 for Rel-19 TEI related discussion and following email discussion.

Based on the discussions summarized in Section 2, following TEI proposals are identified in AI 9.14. According to the guidance in [10], it should be checked first whether each TEI proposal is supported by at least 1 operator, 1 infra vendor and 1 UE vendor so that the discussion on the TEI proposal can be prioritized over other TEI proposals. **Companies are encouraged to clarify which TEI proposal can be supported in the list below with red color, i.e., please add your company name if you support the TEI proposal. Detailed feedback/question on each TEI proposal can also be provided in Section 2.**

* **TEI proposal #1: Flexible DMRS port allocation**
  + Supported by Tejas Network, Reliance Jio, WiSig Networks, CEWiT, Indian Institute of Science, Bangalore, IIT Madras, IIT Kanpur & IIT Hyderabad
* **TEI proposal #2: UE frequency hopping enhancement for positioning**
  + Supported by ZTE Corporation, China Unicom, Sanechips, Huawei, HiSilicon.
* **TEI proposal #3: Counting of active P/SP CSI-RS resources**
  + Supported by Nokia, Apple, Ericsson, MediaTek, NTT DOCOMO, Spreadtrum.
* **TEI proposal #4: SRS-CS + uplink Tx switching**
  + Supported by Apple
* **TEI proposal #5: Counting of the same active CSI-RS resources for *N* CSI reporting**
  + Supported by MediaTek, Nokia, Apple, NTT DOCOMO, Ericsson.
* **TEI proposal #6: SR triggered SSSG switching**
  + Supported by Qualcomm
* **TEI proposal #7: SRS beamforming for FR2 positioning**
  + Supported by Huawei, HiSilicon, China Unicom, ZTE, Sanechips, CATT

1. Discussion on Rel-19 TEI proposals
   1. Flexible DMRS port allocation

Following proposal is made in the contribution.

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--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [1] | ***Observation 1: In the current specification port combinations specified for uplink PUSCH (Tables 7.3.1.1.2-6 to 7.3.1.1.2-23D & 7.3.1.1.2-38 to 7.3.1.1.2-69) and downlink PDSCH (Tables 7.3.1.2.2-1 to 7.3.1.2.2-10A) in TS 38.212, the majority of port allocations for a user are limited to the same CDM group or near symmetrically distributed across CDM groups. This approach doesn’t allow certain CDM port allocation combinations that could potentially enhance performance for specific subsets of layers assigned to users.***  By introducing the port allocation strategy illustrated in Figure 4, ports for layer assignment are chosen across CDM groups such that at least one port is allocated to each group before additional ports are assigned within the same group. This approach provides a mean square error (MSE) advantage in channel estimation for layers that belong to the partially allocated CDM groups.    Figure 4 Proposed strategy for port allocation  To gain the mean square error benefit in channel estimation for partially allocated CDM groups, the de-spreading step at the receiver must be bypassed. This can be accomplished by treating the references in both the time domain (TD) and frequency domain (FD) as distinct references, instead of handling them as Orthogonal Cover Codes (OCC). This would result in higher resolution channel estimates, as shown in Figure 5, which are further subjected to interpolation and/or filtering.    Figure 5 Illustration of an example port allocation for an user across CDM groups demonstrating increased Channel estimation (CE) resolution  As a design principle, across all the tables, the rows are added to provide a 1-layer, 2-layer, or 3-layer MSE advantage. When a single-layer MSE advantage is provided, an unused CDM group can be occupied by data. In case of 2 or more-layer MSE (for Channel estimate) advantage, the allocation is purely SU-MIMO. The proposed modifications for all the tables are covered in Annex A.  From a downlink perspective, we suggest introducing a new capability parameter for User Equipment (UE) that allows it to indicate its ability to take advantage of performance improvements from partial port occupancy within the Code Domain Multiplexing (CDM) group. This information will enable the gNB to make informed decisions about utilizing the enhanced rows in the Antenna port allocation tables as well as accounting it for MCS adaptation.  For the uplink, from the UE's perspective there is the need to generate references based on the enhanced rows. The gNB can leverage the performance benefits by selectively disabling the de-spreading operation for partially allocated CDM groups. Further the co-scheduling rules defined in 38.214 are impacted due to additional tables and restricting the co-scheduling of the users in a group.  The TEI proposal is updated as follows:  ***Proposal 2: Propose the Enhancements to Antenna port allocation tables in 3GPP TS 38.212 as captured in Annex A.***  ***Proposal 3: Propose the Enhancements to co-scheduling rules for UEs in 3GPP TS 38.214 as captured in Annex B.***  ***Proposal 4: Introduce an additional UE capability parameter (DMRS-PartialPortEnh-DL) in 3GPP TS 38.306 that allows the UE to indicate its ability to leverage the performance benefits provided by partial port occupancy in the CDM group when using an advanced receiver.*** Annex A Changes to 38.212 Modified Sections  <Start of Change Request> 7 Downlink transport channels and control information7.3 Downlink control information < Unchanged parts are omitted > 7.3.1 DCI formats < Unchanged parts are omitted > 7.3.1.1 DCI formats for scheduling of PUSCH < Unchanged parts are omitted >  Table 7.3.1.1.2-15: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *dmrs-TypeEnh* is not configured, *maxLength*=2, rank = 4   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 2 | 0-3 | 1 | | 1 | 2 | 0,1,4,5 | 2 | | 2 | 2 | 2,3,6,7 | 2 | | 3 | 2 | 0,2,4,6 | 2 | | 4 | 2 | 0,2,4,5 | 2 | | 5-15 | Reserved | Reserved | Reserved |   < Unchanged parts are omitted >  Table 7.3.1.1.2-18: Antenna port(s), transform precoder is disabled, *multipanelSchemeSDM* is not configured, *dmrs-Type*=2, *dmrs-TypeEnh* is not configured, *maxLength*=1, rank =3   |  |  |  | | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 2 | 0-2 | | 1 | 3 | 0-2 | | 2 | 3 | 3-5 | | 3 | 3 | 0,2,4 | | 4-15 | Reserved | Reserved |   Table 7.3.1.1.2-18A: Antenna port(s), transform precoder is disabled, *multipanelSchemeSDM* is configured, *dmrs-Type*=2, *dmrs-TypeEnh* is not configured, *maxLength*=1, rank =3   |  |  |  | | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 2 | 0-2 | | 1 | 3 | 0-2 | | 2 | 3 | 3-5 | | 3 | 2 | 0,2,3 | | 4 | 3 | 0,2,4 | | 5-15 | Reserved | Reserved |   Table 7.3.1.1.2-19: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is not configured, *maxLength*=1, rank =4   |  |  |  | | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 2 | 0-3 | | 1 | 3 | 0-3 | | 2 | 3 | 0,1,2,4 | | 3-15 | Reserved | Reserved |   < Unchanged parts are omitted >  Table 7.3.1.1.2-22: Antenna port(s), transform precoder is disabled, *multipanelSchemeSDM* is not configured*, dmrs-Type*=2, *dmrs-TypeEnh* is not configured, *maxLength*=2, rank=3   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 2 | 0-2 | 1 | | 1 | 3 | 0-2 | 1 | | 2 | 3 | 3-5 | 1 | | 3 | 3 | 0,1,6 | 2 | | 4 | 3 | 2,3,8 | 2 | | 5 | 3 | 4,5,10 | 2 | | 6 | 3 | 0,2,4 | 2 | | 7-31 | Reserved | Reserved | Reserved |   Table 7.3.1.1.2-22A: Antenna port(s), transform precoder is disabled, *multipanelSchemeSDM* is configured, *dmrs-Type*=2, *dmrs-TypeEnh* is not configured, *maxLength*=2, rank=3   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 2 | 0-2 | 1 | | 1 | 3 | 0-2 | 1 | | 2 | 3 | 3-5 | 1 | | 3 | 3 | 0,1,6 | 2 | | 4 | 3 | 2,3,8 | 2 | | 5 | 3 | 4,5,10 | 2 | | 6 | 2 | 0,2,3 | 1 | | 7 | 3 | 0,2,3 | 1 | | 8 | 3 | 0,2,4 | 2 | | 9-31 | Reserved | Reserved | Reserved |   Table 7.3.1.1.2-23: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is not configured, *maxLength*=2, rank=4   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 2 | 0-3 | 1 | | 1 | 3 | 0-3 | 1 | | 2 | 3 | 0,1,6,7 | 2 | | 3 | 3 | 2,3,8,9 | 2 | | 4 | 3 | 4,5,10,11 | 2 | | 5 | 3 | 0,1,2,4 | 2 | | 6-31 | Reserved | Reserved | Reserved |   Table 7.3.1.1.2-23A: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is not configured, *maxLength*=2, rank = 5   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 3 | 0-4 | 1 | | 1 | 2 | 0,1,2,3,6 | 2 | | 2 | 3 | 0,1,2,4,6 | 2 | | 3-31 | Reserved | Reserved | Reserved |   Table 7.3.1.1.2-23B Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is not configured, *maxLength*=2, rank = 6   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 3 | 0-5 | 1 | | 1 | 2 | 0,1,2,3,6,8 | 2 | | **3** | **3** | **0,1,2,4,6,7** | **2** | | 4-31 | Reserved | Reserved | Reserved |   < Unchanged parts are omitted >  Table 7.3.1.1.2-41: Antenna port(s), transform precoder is disabled, dmrs-Type=1, *dmrs-TypeEnh* is configured, maxLength=1, rank = 4   |  |  |  | | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 2 | 0-3 | | 1 | 2 | 8-11 | | 2 | 1 | 0,1,8,9 | | 3 | 2 | 0,1,8,9 | | 4 | 2 | 2,3,10,11 | | 5 | 2 | 0,1,2,8 | | 6-15 | Reserved | Reserved |   ========================= Unchanged parts =========================  Table 7.3.1.1.2-49: Antenna port(s), transform precoder is disabled, *dmrs-Type*=1, *dmrs-TypeEnh* is configured, *maxLength*=2, rank = 4   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 2 | 0-3 | 1 | | 1 | 2 | 0,1,4,5 | 2 | | 2 | 2 | 2,3,6,7 | 2 | | 3 | 2 | 0,2,4,6 | 2 | | 4 | 2 | 8-11 | 1 | | 5 | 2 | 8,9,12,13 | 2 | | 6 | 2 | 10,11,14,15 | 2 | | 7 | 2 | 1,3,5,7 | 2 | | 8 | 1 | 0,1,8,9 | 1 | | 9 | 2 | 0,1,8,9 | 1 | | 10 | 2 | 2,3,10,11 | 1 | | 11 | 1 | 0,1,8,9 | 2 | | 12 | 1 | 4,5,12,13 | 2 | | 13 | 2 | 0,1,8,9 | 2 | | 14 | 2 | 4,5,12,13 | 2 | | 15 | 2 | 2,3,10,11 | 2 | | 16 | 2 | 6,7,14,15 | 2 | | 17 | 2 | 0,1,2,4 | 2 | | 18-31 | Reserved | Reserved | Reserved |   ========================= Unchanged parts =========================  Table 7.3.1.1.2-57: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is configured, *maxLength*=1, rank = 4   |  |  |  | | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 2 | 0-3 | | 1 | 3 | 0-3 | | 2 | 1 | 0,1,12,13 | | 3 | 2 | 0,1,12,13 | | 4 | 2 | 2,3,14,15 | | 5 | 3 | 0,1,12,13 | | 6 | 3 | 2,3,14,15 | | 7 | 3 | 4,5,16,17 | | 8 | 2 | 0,1,2,12 | | 9 | 3 | 0,1,2,4 | | 10-31 | Reserved | Reserved |   Table 7.3.1.1.2-58: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is configured, *maxLength*=1, rank = 5   |  |  |  | | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 3 | 0-4 | | 1 | 2 | 0,1,2,3,12 | | 2 | 3 | 0,1,2,3,12 | | 3 | 3 | 0,1,2,4,12 | | 4-31 | Reserved | Reserved |   Table 7.3.1.1.2-59: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is configured, *maxLength*=1, rank = 6   |  |  |  | | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 3 | 0-5 | | 1 | 2 | 0,1,2,3,12,14 | | 2 | 3 | 0,1,2,3,12,14 | | 3 | 3 | 0,1,2,4,12,13 | | 4-31 | Reserved | Reserved |   ========================= Unchanged parts =========================  < Unchanged parts are omitted >  Table 7.3.1.1.2-65: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is configured, *maxLength*=2, rank = 4   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 2 | 0-3 | 1 | | 1 | 3 | 0-3 | 1 | | 2 | 3 | 0,1,6,7 | 2 | | 3 | 3 | 2,3,8,9 | 2 | | 4 | 3 | 4,5,10,11 | 2 | | 5 | 3 | 12,13,18,19 | 2 | | 6 | 3 | 14,15,20,21 | 2 | | 7 | 3 | 16,17,22,23 | 2 | | 8 | 1 | 0,1,12,13 | 1 | | 9 | 2 | 0,1,12,13 | 1 | | 10 | 2 | 2,3,14,15 | 1 | | 11 | 3 | 0,1,12,13 | 1 | | 12 | 3 | 2,3,14,15 | 1 | | 13 | 3 | 4,5,16,17 | 1 | | 14 | 3 | 0,1,2,4 | 2 | | 15 | 2 | 0,1,2,6 | 2 | | 16-63 | Reserved | Reserved | Reserved |   Table 7.3.1.1.2-66: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is configured, *maxLength*=2, rank = 5   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 3 | 0-4 | 1 | | 1 | 2 | 0,1,2,3,6 | 2 | | 2 | 2 | 0,1,2,3,12 | 1 | | 3 | 3 | 0,1,2,3,12 | 1 | | 4 | 1 | 0,1,6,7,12 | 2 | | 5 | 2 | 0,1,6,7,12 | 2 | | 6 | 3 | 0,1,6,7,12 | 2 | | 7 | 3 | 0,1,2,4,6 | 2 | | 8-63 | Reserved | Reserved | Reserved |   Table 7.3.1.1.2-67: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is configured, *maxLength*=2, rank = 6   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 3 | 0-5 | 1 | | 1 | 2 | 0,1,2,3,6,8 | 2 | | 2 | 2 | 0-3,12,14 | 1 | | 3 | 3 | 0-3,12,14 | 1 | | 4 | 1 | 0,1,6,7,12,18 | 2 | | 5 | 2 | 0,1,6,7,12,18 | 2 | | 6 | 3 | 0,1,6,7,12,18 | 2 | | 7 | 2 | 0,1,2,4,6,7 | 2 | | 8-63 | Reserved | Reserved | Reserved |   Table 7.3.1.1.2-68: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is configured, *maxLength*=2, rank = 7   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 2 | 0,1,2,3,6,7,8 | 2 | | 1 | 2 | 0-3,12-14 | 1 | | 2 | 3 | 0-3,12-14 | 1 | | 3 | 1 | 0,1,6,7,12,13,18 | 2 | | 4 | 2 | 0,1,6,7,12,13,18 | 2 | | 5 | 3 | 0,1,6,7,12,13,18 | 2 | | 6 | 3 | 0,1,2,4,6,7,12 | 2 | | 7-63 | Reserved | Reserved | Reserved |   Table 7.3.1.1.2-69: Antenna port(s), transform precoder is disabled, *dmrs-Type*=2, *dmrs-TypeEnh* is configured, *maxLength*=2, rank = 8   |  |  |  |  | | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 2 | 0,1,2,3,6,7,8,9 | 2 | | 1 | 2 | 0-3,12-15 | 1 | | 2 | 3 | 0-3,12-15 | 1 | | 3 | 1 | 0,1,6,7,12,13,18,19 | 2 | | 4 | 2 | 0,1,6,7,12,13,18,19 | 2 | | 5 | 3 | 0,1,6,7,12,13,18,19 | 2 | | 6 | 3 | 0,1,2,4,6,7,12,13 | 2 | | 7-63 | Reserved | Reserved | Reserved |   < Unchanged parts are omitted > 7.3.1.2.2 Format 1\_1 < Unchanged parts are omitted >  Antenna port(s) - 4, 5, 6, 7 or 8 bits as defined by Tables 7.3.1.2.2-1/2/3/4/7/8/9/10 ~~and~~ Tables 7.3.1.2.2-1A/2A/3A/4A/7A/8A/9A/10A and ~~and~~ Tables 7.3.1.2.2-1/2B/3B/4B/7B/8B/9B/10B, where the number of CDM groups without data of values 1, 2, and 3 refers to CDM groups {0}, {0,1}, and {0, 1,2} respectively. The antenna ports  shall be determined according to the ordering of DMRS port(s) given by Tables 7.3.1.2.2-1/2/3/4/7/8/9/10 or Tables 7.3.1.2.2-1A/2A/3A/4A/7A/8A/9A/10A or Tables 7.3.1.2.2-1/2B/3B/4B/7B/8B/9B/10B. When a UE not configured with *dl-OrJointTCI-StateList* receives an activation command that maps at least one codepoint of DCI field '*Transmission Configuration Indication*' to two TCI states, or when a UE configured with *dl-OrJointTCI-StateList* is having two indicated TCI states, the UE shall use Table 7.3.1.2.2-1A/2A/3A/4A/7A/8A/9A/10A; if UE capability parameter ***DMRS-PartialPortEnh-DL*** is supported then it shall use Tables 7.3.1.2.2-1/2B/3B/4B/7B/8B/9B/10B, otherwise, it shall use Tables 7.3.1.2.2-1/2/3/4/7/8/9/10. The UE can receive an entry with DMRS ports equals to 1000, 1002, 1003 when two the UE is not configured with *dl-OrJointTCI-StateList* and TCI states are indicated in a codepoint of DCI field '*Transmission Configuration Indication*', or when the UE configured with *dl-OrJointTCI-StateList* is having two indicated TCI states to be applied to PDSCH.  If a UE is configured with both *dmrs-DownlinkForPDSCH-MappingTypeA* and *dmrs-DownlinkForPDSCH-MappingTypeB*, the bitwidth of this field equals , where  is the "Antenna ports" bitwidth derived according to *dmrs-DownlinkForPDSCH-MappingTypeA* and  is the "Antenna ports" bitwidthderived according to *dmrs-DownlinkForPDSCH-MappingTypeB*. A number of  zeros are padded in the MSB of this field, if the mapping type of the PDSCH corresponds to the smaller value of  and .  < Unchanged parts are omitted >  **Table 7.3.1.2.2-2B: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=1, *dmrs-TypeEnh* is not configured, *maxLength*=2**   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **One Codeword:**  **Codeword 0 enabled,**  **Codeword 1 disabled** | | | | **Two Codewords:**  **Codeword 0 enabled,**  **Codeword 1 enabled** | | | | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 1 | 0 | 1 | 0 | 2 | 0-4 | 2 | | 1 | 1 | 1 | 1 | 1 | 2 | 0,1,2,3,4,6 | 2 | | 2 | 1 | 0,1 | 1 | 2 | 2 | 0,1,2,3,4,5,6 | 2 | | 3 | 2 | 0 | 1 | 3 | 2 | 0,1,2,3,4,5,6,7 | 2 | | 4 | 2 | 1 | 1 | 4 | 2 | 0,1,2,4,5 | 2 | | 5 | 2 | 2 | 1 | 5-31 | reserved | reserved | reserved | | 6 | 2 | 3 | 1 |  |  |  |  | | 7 | 2 | 0,1 | 1 |  |  |  |  | | 8 | 2 | 2,3 | 1 |  |  |  |  | | 9 | 2 | 0-2 | 1 |  |  |  |  | | 10 | 2 | 0-3 | 1 |  |  |  |  | | 11 | 2 | 0,2 | 1 |  |  |  |  | | 12 | 2 | 0 | 2 |  |  |  |  | | 13 | 2 | 1 | 2 |  |  |  |  | | 14 | 2 | 2 | 2 |  |  |  |  | | 15 | 2 | 3 | 2 |  |  |  |  | | 16 | 2 | 4 | 2 |  |  |  |  | | 17 | 2 | 5 | 2 |  |  |  |  | | 18 | 2 | 6 | 2 |  |  |  |  | | 19 | 2 | 7 | 2 |  |  |  |  | | 20 | 2 | 0,1 | 2 |  |  |  |  | | 21 | 2 | 2,3 | 2 |  |  |  |  | | 22 | 2 | 4,5 | 2 |  |  |  |  | | 23 | 2 | 6,7 | 2 |  |  |  |  | | 24 | 2 | 0,4 | 2 |  |  |  |  | | 25 | 2 | 2,6 | 2 |  |  |  |  | | 26 | 2 | 0,1,4 | 2 |  |  |  |  | | 27 | 2 | 2,3,6 | 2 |  |  |  |  | | 28 | 2 | 0,1,4,5 | 2 |  |  |  |  | | 29 | 2 | 2,3,6,7 | 2 |  |  |  |  | | 30 | 2 | 0,2,4,6 | 2 |  |  |  |  | | 31 | 2 | 0,2,3 | 1 |  |  |  |  |   < Unchanged parts are omitted >  **Table 7.3.1.2.2-3B: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=2, *dmrs-TypeEnh* is not configured, *maxLength*=1**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **One codeword:**  **Codeword 0 enabled,**  **Codeword 1 disabled** | | | **Two codewords:**  **Codeword 0 enabled,**  **Codeword 1 enabled** | | | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 1 | 0 | 0 | 3 | 0-4 | | 1 | 1 | 1 | 1 | 3 | 0-5 | | 2 | 1 | 0,1 | 2-31 | reserved | reserved | | 3 | 2 | 0 |  |  |  | | 4 | 2 | 1 |  |  |  | | 5 | 2 | 2 |  |  |  | | 6 | 2 | 3 |  |  |  | | 7 | 2 | 0,1 |  |  |  | | 8 | 2 | 2,3 |  |  |  | | 9 | 2 | 0-2 |  |  |  | | 10 | 2 | 0-3 |  |  |  | | 11 | 3 | 0 |  |  |  | | 12 | 3 | 1 |  |  |  | | 13 | 3 | 2 |  |  |  | | 14 | 3 | 3 |  |  |  | | 15 | 3 | 4 |  |  |  | | 16 | 3 | 5 |  |  |  | | 17 | 3 | 0,1 |  |  |  | | 18 | 3 | 2,3 |  |  |  | | 19 | 3 | 4,5 |  |  |  | | 20 | 3 | 0-2 |  |  |  | | 21 | 3 | 3-5 |  |  |  | | 22 | 3 | 0-3 |  |  |  | | 23 | 2 | 0,2 |  |  |  | | 24 | 2 | 0,2,3 |  |  |  | | 25 | 3 | 0,2,4 |  |  |  | | 26 | 3 | 0,1,2,4 |  |  |  | | 27-31 | Reserved | Reserved |  |  |  |   < Unchanged parts are omitted >  **Table 7.3.1.2.2-4B: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=2, *dmrs-TypeEnh* is not configured, *maxLength*=2**   | **One codeword:**  **Codeword 0 enabled,**  **Codeword 1 disabled** | | | | **Two Codewords:**  **Codeword 0 enabled,**  **Codeword 1 enabled** | | | | | --- | --- | --- | --- | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 1 | 0 | 1 | 0 | 3 | 0-4 | 1 | | 1 | 1 | 1 | 1 | 1 | 3 | 0-5 | 1 | | 2 | 1 | 0,1 | 1 | 2 | 2 | 0,1,2,3,6 | 2 | | 3 | 2 | 0 | 1 | 3 | 2 | 0,1,2,3,6,8 | 2 | | 4 | 2 | 1 | 1 | 4 | 2 | 0,1,2,3,6,7,8 | 2 | | 5 | 2 | 2 | 1 | 5 | 2 | 0,1,2,3,6,7,8,9 | 2 | | 6 | 2 | 3 | 1 | 6 | 3 | 0,1,2,4,6 | 2 | | 7 | 2 | 0,1 | 1 | 7-63 | Reserved | Reserved | Reserved | | 8 | 2 | 2,3 | 1 |  |  |  |  | | 9 | 2 | 0-2 | 1 |  |  |  |  | | 10 | 2 | 0-3 | 1 |  |  |  |  | | 11 | 3 | 0 | 1 |  |  |  |  | | 12 | 3 | 1 | 1 |  |  |  |  | | 13 | 3 | 2 | 1 |  |  |  |  | | 14 | 3 | 3 | 1 |  |  |  |  | | 15 | 3 | 4 | 1 |  |  |  |  | | 16 | 3 | 5 | 1 |  |  |  |  | | 17 | 3 | 0,1 | 1 |  |  |  |  | | 18 | 3 | 2,3 | 1 |  |  |  |  | | 19 | 3 | 4,5 | 1 |  |  |  |  | | 20 | 3 | 0-2 | 1 |  |  |  |  | | 21 | 3 | 3-5 | 1 |  |  |  |  | | 22 | 3 | 0-3 | 1 |  |  |  |  | | 23 | 2 | 0,2 | 1 |  |  |  |  | | 24 | 3 | 0 | 2 |  |  |  |  | | 25 | 3 | 1 | 2 |  |  |  |  | | 26 | 3 | 2 | 2 |  |  |  |  | | 27 | 3 | 3 | 2 |  |  |  |  | | 28 | 3 | 4 | 2 |  |  |  |  | | 29 | 3 | 5 | 2 |  |  |  |  | | 30 | 3 | 6 | 2 |  |  |  |  | | 31 | 3 | 7 | 2 |  |  |  |  | | 32 | 3 | 8 | 2 |  |  |  |  | | 33 | 3 | 9 | 2 |  |  |  |  | | 34 | 3 | 10 | 2 |  |  |  |  | | 35 | 3 | 11 | 2 |  |  |  |  | | 36 | 3 | 0,1 | 2 |  |  |  |  | | 37 | 3 | 2,3 | 2 |  |  |  |  | | 38 | 3 | 4,5 | 2 |  |  |  |  | | 39 | 3 | 6,7 | 2 |  |  |  |  | | 40 | 3 | 8,9 | 2 |  |  |  |  | | 41 | 3 | 10,11 | 2 |  |  |  |  | | 42 | 3 | 0,1,6 | 2 |  |  |  |  | | 43 | 3 | 2,3,8 | 2 |  |  |  |  | | 44 | 3 | 4,5,10 | 2 |  |  |  |  | | 45 | 3 | 0,1,6,7 | 2 |  |  |  |  | | 46 | 3 | 2,3,8,9 | 2 |  |  |  |  | | 47 | 3 | 4,5,10,11 | 2 |  |  |  |  | | 48 | 1 | 0 | 2 |  |  |  |  | | 49 | 1 | 1 | 2 |  |  |  |  | | 50 | 1 | 6 | 2 |  |  |  |  | | 51 | 1 | 7 | 2 |  |  |  |  | | 52 | 1 | 0,1 | 2 |  |  |  |  | | 53 | 1 | 6,7 | 2 |  |  |  |  | | 54 | 2 | 0,1 | 2 |  |  |  |  | | 55 | 2 | 2,3 | 2 |  |  |  |  | | 56 | 2 | 6,7 | 2 |  |  |  |  | | 57 | 2 | 8,9 | 2 |  |  |  |  | | 58 | 2 | 0,2,3 | 1 |  |  |  |  | | 59 | 2 | 0-2,6 | 2 |  |  |  |  | | 60 | 3 | 0-2,4 | 2 |  |  |  |  | | 61-63 | Reserved | Reserved | Reserved |  |  |  |  |   < Unchanged parts are omitted >  **Table 7.3.1.2.2-7B: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=1, *dmrs-TypeEnh* is configured, *maxLength*=1**   | **One Codeword:**  **Codeword 0 enabled,**  **Codeword 1 disabled** | | | **Two Codewords:**  **Codeword 0 enabled,**  **Codeword 1 enabled** | | | | --- | --- | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 1 | 0 | 0 | 2 | 0,1,2,3,8 | | 1 | 1 | 1 | 1 | 2 | 0,1,2,3,8,10 | | 2 | 1 | 0,1 | 2 | 2 | 0,1,2,3,8,9,10 | | 3 | 2 | 0 | 3 | 2 | 0,1,2,3,8,9,10,11 | | 4 | 2 | 1 | 4-31 | Reserved | Reserved | | 5 | 2 | 2 |  |  |  | | 6 | 2 | 3 |  |  |  | | 7 | 2 | 0,1 |  |  |  | | 8 | 2 | 2,3 |  |  |  | | 9 | 2 | 0-2 |  |  |  | | 10 | 2 | 0-3 |  |  |  | | 11 | 2 | 0,2 |  |  |  | | 12 | 1 | 8 |  |  |  | | 13 | 1 | 9 |  |  |  | | 14 | 1 | 8,9 |  |  |  | | 15 | 2 | 8 |  |  |  | | 16 | 2 | 9 |  |  |  | | 17 | 2 | 10 |  |  |  | | 18 | 2 | 11 |  |  |  | | 19 | 2 | 8,9 |  |  |  | | 20 | 2 | 10,11 |  |  |  | | 21 | 1 | 0,1,8 |  |  |  | | 22 | 1 | 0,1,8,9 |  |  |  | | 23 | 2 | 0,1,8 |  |  |  | | 24 | 2 | 0,1,8,9 |  |  |  | | 25 | 2 | 2,3,10 |  |  |  | | 26 | 2 | 2,3,10,11 |  |  |  | | 27 | 2 | 0,2,3 |  |  |  | | 28 | 2 | 0,1,2,8 |  |  |  | | 29-31 | Reserved | Reserved |  |  |  |   < Unchanged parts are omitted >  **Table 7.3.1.2.2-8B: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=1, *dmrs-TypeEnh* is configured, *maxLength*=2**   | **One Codeword:**  **Codeword 0 enabled,**  **Codeword 1 disabled** | | | | **Two Codewords:**  **Codeword 0 enabled,**  **Codeword 1 enabled** | | | | | --- | --- | --- | --- | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 1 | 0 | 1 | 0 | 2 | 0,1,2,3,8 | 1 | | 1 | 1 | 1 | 1 | 1 | 2 | 0,1,2,3,8,10 | 1 | | 2 | 1 | 0,1 | 1 | 2 | 2 | 0,1,2,3,8,9,10 | 1 | | 3 | 2 | 0 | 1 | 3 | 2 | 0,1,2,3,8,9,10,11 | 1 | | 4 | 2 | 1 | 1 | 4 | 2 | 0-4 | 2 | | 5 | 2 | 2 | 1 | 5 | 2 | 0,1,2,3,4,6 | 2 | | 6 | 2 | 3 | 1 | 6 | 2 | 0,1,2,3,4,5,6 | 2 | | 7 | 2 | 0,1 | 1 | 7 | 2 | 0,1,2,3,4,5,6,7 | 2 | | 8 | 2 | 2,3 | 1 | 8 | 1 | 0,1,4,5,8 | 2 | | 9 | 2 | 0-2 | 1 | 9 | 1 | 0,1,4,5,8,12 | 2 | | 10 | 2 | 0-3 | 1 | 10 | 1 | 0,1,4,5,8,9,12 | 2 | | 11 | 2 | 0,2 | 1 | 11 | 1 | 0,1,4,5,8,9,12,13 | 2 | | 12 | 1 | 8 | 1 | 12 | 2 | 0,1,4,5,8 | 2 | | 13 | 1 | 9 | 1 | 13 | 2 | 0,1,4,5,8,12 | 2 | | 14 | 1 | 8,9 | 1 | 14 | 2 | 0,1,4,5,8,9,12 | 2 | | 15 | 2 | 8 | 1 | 15 | 2 | 0,1,4,5,8,9,12,13 | 2 | | 16 | 2 | 9 | 1 | 16 | 2 | 0,1,2,4,5 | 2 | | 17 | 2 | 10 | 1 | 17~127 | Reserved | Reserved | Reserved | | 18 | 2 | 11 | 1 |  |  |  |  | | 19 | 2 | 8,9 | 1 |  |  |  |  | | 20 | 2 | 10,11 | 1 |  |  |  |  | | 21 | 1 | 0,1,8 | 1 |  |  |  |  | | 22 | 1 | 0,1,8,9 | 1 |  |  |  |  | | 23 | 2 | 0,1,8 | 1 |  |  |  |  | | 24 | 2 | 0,1,8,9 | 1 |  |  |  |  | | 25 | 2 | 2,3,10 | 1 |  |  |  |  | | 26 | 2 | 2,3,10,11 | 1 |  |  |  |  | | 27 | 2 | 0 | 2 |  |  |  |  | | 28 | 2 | 1 | 2 |  |  |  |  | | 29 | 2 | 2 | 2 |  |  |  |  | | 30 | 2 | 3 | 2 |  |  |  |  | | 31 | 2 | 4 | 2 |  |  |  |  | | 32 | 2 | 5 | 2 |  |  |  |  | | 33 | 2 | 6 | 2 |  |  |  |  | | 34 | 2 | 7 | 2 |  |  |  |  | | 35 | 2 | 0,1 | 2 |  |  |  |  | | 36 | 2 | 2,3 | 2 |  |  |  |  | | 37 | 2 | 4,5 | 2 |  |  |  |  | | 38 | 2 | 6,7 | 2 |  |  |  |  | | 39 | 2 | 0,4 | 2 |  |  |  |  | | 40 | 2 | 2,6 | 2 |  |  |  |  | | 41 | 2 | 0,1,4 | 2 |  |  |  |  | | 42 | 2 | 2,3,6 | 2 |  |  |  |  | | 43 | 2 | 0,1,4,5 | 2 |  |  |  |  | | 44 | 2 | 2,3,6,7 | 2 |  |  |  |  | | 45 | 2 | 0,2,4,6 | 2 |  |  |  |  | | 46 | 2 | 8 | 2 |  |  |  |  | | 47 | 2 | 9 | 2 |  |  |  |  | | 48 | 2 | 10 | 2 |  |  |  |  | | 49 | 2 | 11 | 2 |  |  |  |  | | 50 | 2 | 12 | 2 |  |  |  |  | | 51 | 2 | 13 | 2 |  |  |  |  | | 52 | 2 | 14 | 2 |  |  |  |  | | 53 | 2 | 15 | 2 |  |  |  |  | | 54 | 2 | 8,9 | 2 |  |  |  |  | | 55 | 2 | 10,11 | 2 |  |  |  |  | | 56 | 2 | 12,13 | 2 |  |  |  |  | | 57 | 2 | 14,15 | 2 |  |  |  |  | | 58 | 2 | 0,1,8 | 2 |  |  |  |  | | 59 | 2 | 0,1,8,9 | 2 |  |  |  |  | | 60 | 2 | 4,5,12 | 2 |  |  |  |  | | 61 | 2 | 4,5,12,13 | 2 |  |  |  |  | | 62 | 2 | 2,3,10 | 2 |  |  |  |  | | 63 | 2 | 2,3,10,11 | 2 |  |  |  |  | | 64 | 2 | 6,7,14 | 2 |  |  |  |  | | 65 | 2 | 6,7,14,15 | 2 |  |  |  |  | | 66 | 2 | 0,2,3 | 1 |  |  |  |  | | 67 | 2 | 0,1,2,4 | 2 |  |  |  |  | | 68-127 | Reserved | Reserved | Reserved |  |  |  |  |   < Unchanged parts are omitted >  **Table 7.3.1.2.2-9B: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=2, *dmrs-TypeEnh* is configured, *maxLength*=1**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **One codeword:**  **Codeword 0 enabled,**  **Codeword 1 disabled** | | | **Two codewords:**  **Codeword 0 enabled,**  **Codeword 1 enabled** | | | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | | 0 | 1 | 0 | 0 | 3 | 0-4 | | 1 | 1 | 1 | 1 | 3 | 0-5 | | 2 | 1 | 0,1 | 2 | 2 | 0,1,2,3,12 | | 3 | 2 | 0 | 3 | 2 | 0,1,2,3,12,14 | | 4 | 2 | 1 | 4 | 2 | 0-3,12-14 | | 5 | 2 | 2 | 5 | 2 | 0-3,12-15 | | 6 | 2 | 3 | 6 | 3 | 0,1,2,3,12 | | 7 | 2 | 0,1 | 7 | 3 | 0,1,2,3,12,14 | | 8 | 2 | 2,3 | 8 | 3 | 0-3,12-14 | | 9 | 2 | 0-2 | 9 | 3 | 0-3,12-15 | | 10 | 2 | 0-3 | 10 | 3 | 0,1,2,4,12 | | 11 | 3 | 0 | 11 | 3 | 0,1,2,4,12,13 | | 12 | 3 | 1 | 12~63 | Reserved | Reserved | | 13 | 3 | 2 |  |  |  | | 14 | 3 | 3 |  |  |  | | 15 | 3 | 4 |  |  |  | | 16 | 3 | 5 |  |  |  | | 17 | 3 | 0,1 |  |  |  | | 18 | 3 | 2,3 |  |  |  | | 19 | 3 | 4,5 |  |  |  | | 20 | 3 | 0-2 |  |  |  | | 21 | 3 | 3-5 |  |  |  | | 22 | 3 | 0-3 |  |  |  | | 23 | 2 | 0,2 |  |  |  | | 24 | 1 | 12 |  |  |  | | 25 | 1 | 13 |  |  |  | | 26 | 1 | 12,13 |  |  |  | | 27 | 2 | 12 |  |  |  | | 28 | 2 | 13 |  |  |  | | 29 | 2 | 14 |  |  |  | | 30 | 2 | 15 |  |  |  | | 31 | 2 | 12,13 |  |  |  | | 32 | 2 | 14,15 |  |  |  | | 33 | 3 | 12 |  |  |  | | 34 | 3 | 13 |  |  |  | | 35 | 3 | 14 |  |  |  | | 36 | 3 | 15 |  |  |  | | 37 | 3 | 16 |  |  |  | | 38 | 3 | 17 |  |  |  | | 39 | 3 | 12,13 |  |  |  | | 40 | 3 | 14,15 |  |  |  | | 41 | 3 | 16,17 |  |  |  | | 42 | 1 | 0,1,12 |  |  |  | | 43 | 1 | 0,1,12,13 |  |  |  | | 44 | 2 | 0,1,12 |  |  |  | | 45 | 2 | 0,1,12,13 |  |  |  | | 46 | 2 | 2,3,14 |  |  |  | | 47 | 2 | 2,3,14,15 |  |  |  | | 48 | 3 | 0,1,12 |  |  |  | | 49 | 3 | 0,1,12,13 |  |  |  | | 50 | 3 | 2,3,14 |  |  |  | | 51 | 3 | 2,3,14,15 |  |  |  | | 52 | 3 | 4,5,16 |  |  |  | | 53 | 3 | 4,5,16,17 |  |  |  | | 54 | 2 | 0,2,3 |  |  |  | | 55 | 3 | 0,2,4 |  |  |  | | 56 | 3 | 0,1,2,4 |  |  |  | | 57 | 3 | 0,1,2,12 |  |  |  | | 59-63 | Reserved | Reserved |  |  |  |   < Unchanged parts are omitted >  **Table 7.3.1.2.2-10B: Antenna port(s) (1000 + DMRS port), *dmrs-Type*=2, *dmrs-TypeEnh* is configured, *maxLength*=2**   | **One codeword:**  **Codeword 0 enabled,**  **Codeword 1 disabled** | | | | **Two Codewords:**  **Codeword 0 enabled,**  **Codeword 1 enabled** | | | | | --- | --- | --- | --- | --- | --- | --- | --- | | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | **Value** | **Number of DMRS CDM group(s) without data** | **DMRS port(s)** | **Number of front-load symbols** | | 0 | 1 | 0 | 1 | 0 | 3 | 0-4 | 1 | | 1 | 1 | 1 | 1 | 1 | 3 | 0-5 | 1 | | 2 | 1 | 0,1 | 1 | 2 | 2 | 0,1,2,3,12 | 1 | | 3 | 2 | 0 | 1 | 3 | 2 | 0-3,12,14 | 1 | | 4 | 2 | 1 | 1 | 4 | 2 | 0-3,12-14 | 1 | | 5 | 2 | 2 | 1 | 5 | 2 | 0-3,12-15 | 1 | | 6 | 2 | 3 | 1 | 6 | 3 | 0,1,2,3,12 | 1 | | 7 | 2 | 0,1 | 1 | 7 | 3 | 0-3,12,14 | 1 | | 8 | 2 | 2,3 | 1 | 8 | 3 | 0-3,12-14 | 1 | | 9 | 2 | 0-2 | 1 | 9 | 3 | 0-3,12-15 | 1 | | 10 | 2 | 0-3 | 1 | 10 | 2 | 0,1,2,3,6 | 2 | | 11 | 3 | 0 | 1 | 11 | 2 | 0,1,2,3,6,8 | 2 | | 12 | 3 | 1 | 1 | 12 | 2 | 0,1,2,3,6,7,8 | 2 | | 13 | 3 | 2 | 1 | 13 | 2 | 0,1,2,3,6,7,8,9 | 2 | | 14 | 3 | 3 | 1 | 14 | 1 | 0,1,6,7,12 | 2 | | 15 | 3 | 4 | 1 | 15 | 1 | 0,1,6,7,12,18 | 2 | | 16 | 3 | 5 | 1 | 16 | 1 | 0,1,6,7,12,13,18 | 2 | | 17 | 3 | 0,1 | 1 | 17 | 1 | 0,1,6,7,12,13,18,19 | 2 | | 18 | 3 | 2,3 | 1 | 18 | 2 | 0,1,6,7,12 | 2 | | 19 | 3 | 4,5 | 1 | 19 | 2 | 0,1,6,7,12,18 | 2 | | 20 | 3 | 0-2 | 1 | 20 | 2 | 0,1,6,7,12,13,18 | 2 | | 21 | 3 | 3-5 | 1 | 21 | 2 | 0,1,6,7,12,13,18,19 | 2 | | 22 | 3 | 0-3 | 1 | 22 | 3 | 0,1,6,7,12 | 2 | | 23 | 2 | 0,2 | 1 | 23 | 3 | 0,1,6,7,12,18 | 2 | | 24 | 1 | 12 | 1 | 24 | 3 | 0,1,6,7,12,13,18 | 2 | | 25 | 1 | 13 | 1 | 25 | 3 | 0,1,6,7,12,13,18,19 | 2 | | 26 | 1 | 12,13 | 1 | 26 | 3 | 0,1,2,4,6 | 2 | | 27 | 2 | 12 | 1 | 27 | 3 | 0,1,2,4,6,7 | 2 | | 28 | 2 | 13 | 1 | 28 | 3 | 0,1,2,4,6,7,12 | 2 | | 29 | 2 | 14 | 1 | 29 | 2 | 0,1,2,4,6,7,12,13 | 2 | | 30 | 2 | 15 | 1 | 30 | 2 | 0,1,2,6,7,12,13,18 | 2 | | 31 | 2 | 12,13 | 1 | 31~255 | Reserved | Reserved | Reserved | | 32 | 2 | 14,15 | 1 |  |  |  |  | | 33 | 3 | 12 | 1 |  |  |  |  | | 34 | 3 | 13 | 1 |  |  |  |  | | 35 | 3 | 14 | 1 |  |  |  |  | | 36 | 3 | 15 | 1 |  |  |  |  | | 37 | 3 | 16 | 1 |  |  |  |  | | 38 | 3 | 17 | 1 |  |  |  |  | | 39 | 3 | 12,13 | 1 |  |  |  |  | | 40 | 3 | 14,15 | 1 |  |  |  |  | | 41 | 3 | 16,17 | 1 |  |  |  |  | | 42 | 1 | 0,1,12 | 1 |  |  |  |  | | 43 | 1 | 0,1,12,13 | 1 |  |  |  |  | | 44 | 2 | 0,1,12 | 1 |  |  |  |  | | 45 | 2 | 0,1,12,13 | 1 |  |  |  |  | | 46 | 2 | 2,3,14 | 1 |  |  |  |  | | 47 | 2 | 2,3,14,15 | 1 |  |  |  |  | | 48 | 3 | 0,1,12 | 1 |  |  |  |  | | 49 | 3 | 0,1,12,13 | 1 |  |  |  |  | | 50 | 3 | 2,3,14 | 1 |  |  |  |  | | 51 | 3 | 2,3,14,15 | 1 |  |  |  |  | | 52 | 3 | 4,5,16 | 1 |  |  |  |  | | 53 | 3 | 4,5,16,17 | 1 |  |  |  |  | | 54 | 3 | 0 | 2 |  |  |  |  | | 55 | 3 | 1 | 2 |  |  |  |  | | 56 | 3 | 2 | 2 |  |  |  |  | | 57 | 3 | 3 | 2 |  |  |  |  | | 58 | 3 | 4 | 2 |  |  |  |  | | 59 | 3 | 5 | 2 |  |  |  |  | | 60 | 3 | 6 | 2 |  |  |  |  | | 61 | 3 | 7 | 2 |  |  |  |  | | 62 | 3 | 8 | 2 |  |  |  |  | | 63 | 3 | 9 | 2 |  |  |  |  | | 64 | 3 | 10 | 2 |  |  |  |  | | 65 | 3 | 11 | 2 |  |  |  |  | | 66 | 3 | 0,1 | 2 |  |  |  |  | | 67 | 3 | 2,3 | 2 |  |  |  |  | | 68 | 3 | 4,5 | 2 |  |  |  |  | | 69 | 3 | 6,7 | 2 |  |  |  |  | | 70 | 3 | 8,9 | 2 |  |  |  |  | | 71 | 3 | 10,11 | 2 |  |  |  |  | | 72 | 3 | 0,1,6 | 2 |  |  |  |  | | 73 | 3 | 2,3,8 | 2 |  |  |  |  | | 74 | 3 | 4,5,10 | 2 |  |  |  |  | | 75 | 3 | 0,1,6,7 | 2 |  |  |  |  | | 76 | 3 | 2,3,8,9 | 2 |  |  |  |  | | 77 | 3 | 4,5,10,11 | 2 |  |  |  |  | | 78 | 1 | 0 | 2 |  |  |  |  | | 79 | 1 | 1 | 2 |  |  |  |  | | 80 | 1 | 6 | 2 |  |  |  |  | | 81 | 1 | 7 | 2 |  |  |  |  | | 82 | 1 | 0,1 | 2 |  |  |  |  | | 83 | 1 | 6,7 | 2 |  |  |  |  | | 84 | 2 | 0,1 | 2 |  |  |  |  | | 85 | 2 | 2,3 | 2 |  |  |  |  | | 86 | 2 | 6,7 | 2 |  |  |  |  | | 87 | 2 | 8,9 | 2 |  |  |  |  | | 88 | 3 | 12 | 2 |  |  |  |  | | 89 | 3 | 13 | 2 |  |  |  |  | | 90 | 3 | 14 | 2 |  |  |  |  | | 91 | 3 | 15 | 2 |  |  |  |  | | 92 | 3 | 16 | 2 |  |  |  |  | | 93 | 3 | 17 | 2 |  |  |  |  | | 94 | 3 | 18 | 2 |  |  |  |  | | 95 | 3 | 19 | 2 |  |  |  |  | | 96 | 3 | 20 | 2 |  |  |  |  | | 97 | 3 | 21 | 2 |  |  |  |  | | 98 | 3 | 22 | 2 |  |  |  |  | | 99 | 3 | 23 | 2 |  |  |  |  | | 100 | 3 | 12,13 | 2 |  |  |  |  | | 101 | 3 | 14,15 | 2 |  |  |  |  | | 102 | 3 | 16,17 | 2 |  |  |  |  | | 103 | 3 | 18,19 | 2 |  |  |  |  | | 104 | 3 | 20,21 | 2 |  |  |  |  | | 105 | 3 | 22,23 | 2 |  |  |  |  | | 106 | 1 | 12 | 2 |  |  |  |  | | 107 | 1 | 13 | 2 |  |  |  |  | | 108 | 1 | 18 | 2 |  |  |  |  | | 109 | 1 | 19 | 2 |  |  |  |  | | 110 | 1 | 12,13 | 2 |  |  |  |  | | 111 | 1 | 18,19 | 2 |  |  |  |  | | 112 | 2 | 12,13 | 2 |  |  |  |  | | 113 | 2 | 14,15 | 2 |  |  |  |  | | 114 | 2 | 18,19 | 2 |  |  |  |  | | 115 | 2 | 20,21 | 2 |  |  |  |  | | 116 | 2 | 0,1,12 | 2 |  |  |  |  | | 117 | 2 | 0,1,12,13 | 2 |  |  |  |  | | 118 | 2 | 6,7,18 | 2 |  |  |  |  | | 119 | 2 | 6,7,18,19 | 2 |  |  |  |  | | 120 | 2 | 2,3,14 | 2 |  |  |  |  | | 121 | 2 | 2,3,14,15 | 2 |  |  |  |  | | 122 | 2 | 8,9,20 | 2 |  |  |  |  | | 123 | 2 | 8,9,20,21 | 2 |  |  |  |  | | 124 | 3 | 0,1,12 | 2 |  |  |  |  | | 125 | 3 | 0,1,12,13 | 2 |  |  |  |  | | 126 | 3 | 6,7,18 | 2 |  |  |  |  | | 127 | 3 | 6,7,18,19 | 2 |  |  |  |  | | 128 | 3 | 2,3,14 | 2 |  |  |  |  | | 129 | 3 | 2,3,14,15 | 2 |  |  |  |  | | 130 | 3 | 8,9,20 | 2 |  |  |  |  | | 131 | 3 | 8,9,20,21 | 2 |  |  |  |  | | 132 | 3 | 4,5,16 | 2 |  |  |  |  | | 133 | 3 | 4,5,16,17 | 2 |  |  |  |  | | 134 | 3 | 10,11,22 | 2 |  |  |  |  | | 135 | 3 | 10,11,22,23 | 2 |  |  |  |  | | 136 | 2 | 0,2,3 | 1 |  |  |  |  | | 137 | 3 | 0,2,4 | 2 |  |  |  |  | | 138 | 3 | 0,1,2,4 | 2 |  |  |  |  | | 139 | 2 | 0,1,2,6 | 2 |  |  |  |  | | 140-255 | Reserved | Reserved | Reserved |  |  |  |  |   < Unchanged parts are omitted >  <End of Change Request> 7.3.1.2.3 Format 1\_2 < Unchanged parts are omitted >  - Antenna port(s) - 0, 4, 5, 6, 7 or 8 bits  - 0 bit if higher layer parameter *antennaPortsFieldPresenceDCI-1-2* is notconfigured;  - Otherwise, 4, 5, 6, 7 or 8 bits as defined by Tables 7.3.1.2.2-1/2/3/4/7/8/9/10 ~~and~~ Tables 7.3.1.2.2-1A/2A/3A/4A/7A/8A/9A/10A and ~~and~~ Tables 7.3.1.2.2-1/2B/3B/4B/7B/8B/9B/10B, where the number of CDM groups without data of values 1, 2, and 3 refers to CDM groups {0}, {0,1}, and {0, 1,2} respectively. The antenna ports shall be determined according to the ordering of DMRS port(s) given by Tables 7.3.1.2.2-1/2/3/4/7/8/9/10 or Tables 7.3.1.2.2-1A/2A/3A/4A/7A/8A/9A/10A. When a UE not configured with *dl-OrJointTCI-StateList* receives an activation command that maps at least one codepoint of DCI field '*Transmission Configuration Indication*' to two TCI states, or when a UE configured with *dl-OrJointTCI-StateList* is having two indicated TCI states, the UE shall use Table 7.3.1.2.2-1A/2A/3A/4A/7A/8A/9A/10A; otherwise, if UE capability parameter ***DMRS-PartialPortEnh-DL*** is supported then it shall use Tables 7.3.1.2.2-1/2B/3B/4B/7B/8B/9B/10B, otherwise, it shall use Tables 7.3.1.2.2-1/2/3/4/7/8/9/10.  - If a UE is configured with both *dmrs-DownlinkForPDSCH-MappingTypeA-DCI-1-2* and *dmrs-DownlinkForPDSCH-MappingTypeB-DCI-1-2* andis configured with higher layer parameter *antennaPortsFieldPresenceDCI-1-2*, the bitwidth of this field equals, where is the "Antenna ports" bitwidth derived according to *dmrs-DownlinkForPDSCH-MappingTypeA-DCI-1-2* and is the "Antenna ports" bitwidthderived according to *dmrs-DownlinkForPDSCH-MappingTypeB-DCI-1-2*. A number of zeros are padded in the MSB of this field, if the mapping type of the PDSCH corresponds to the smaller value of and .  If a UE is not configured with higher layer parameter *antennaPortsFieldPresenceDCI-1-2*, antenna port(s) are defined assuming bit field index value 0 in Tables 7.3.1.2.2-1/2/3/4/7/8/9/10.  < Unchanged parts are omitted > 7.3.1.2.4 Format 1\_3 < Unchanged parts are omitted >  Antenna ports - number of bits determined by the following:  - If *antennaPortsDCI-1-3= type1a* is configured by higher layer,  - bits applying to the scheduled cells independently, where is the number of cells configured by higher layer parameter *scheduledCellListDCI-1-3* in the scheduled cell set, is mapped to the cells according to an ascending order of a serving cell index with corresponding to the cell with the smallest serving cell index, and is defined below.  - If *antennaPortsDCI-1-3= type2* is configured by higher layer,  - block number 1, block number 2,…, block number  Each block corresponds to the Antenna ports information for a cell, and the blocks are placed according to an ascending order of a serving cell index, with block number 1 corresponding to the Antenna ports information for the cell with the smallest serving cell index. Each block is defined below.  above for the case of *antennaPortsDCI-1-3= type1A* or each block above for the case of *antennaPortsDCI-1-3= type2* is defined by the following:  - 4, 5, or 6 bits as defined by Tables 7.3.1.2.2-1/2/3/4 ~~and~~ Tables 7.3.1.2.2-1A/2A/3A/4A and Tables 7.3.1.2.2-1B/2B/3B/4B, where the number of CDM groups without data of values 1, 2, and 3 refers to CDM groups {0}, {0,1}, and {0, 1,2} respectively. The antenna ports shall be determined according to the ordering of DMRS port(s) given by Tables 7.3.1.2.2-1/2/3/4 or Tables 7.3.1.2.2-1A/2A/3A/4A or Tables 7.3.1.2.2-1B/2B/3B/4B.  If a UE is configured with both *dmrs-DownlinkForPDSCH-MappingTypeA* and *dmrs-DownlinkForPDSCH-MappingTypeB*, the bitwidth of this field equals , where is the "Antenna ports" bitwidth derived according to *dmrs-DownlinkForPDSCH-MappingTypeA* and is the "Antenna ports" bitwidthderived according to *dmrs-DownlinkForPDSCH-MappingTypeB*. A number of zeros are padded in the MSB of this field, if the mapping type of the PDSCH corresponds to the smaller value of and .  < Unchanged parts are omitted >  **< End of Change Request >** Annex B Changes to 38.214 Highlighted portions are the changes required  <Start of Change Request>  < Unchanged parts are omitted >  5.1.6 UE procedure for receiving reference signals  < Unchanged parts are omitted >  5.1.6.2 DM-RS reception procedure  The DM-RS reception procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 1\_2, by applying the parameters of dmrs-DownlinkForPDSCH-MappingTypeA-DCI-1-2 and dmrs-DownlinkForPDSCH-MappingTypeB-DCI-1-2 instead of dmrs-DownlinkForPDSCH-MappingTypeA and dmrs-DownlinkForPDSCH-MappingTypeB. The DM-RS reception procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 1\_3.  The DM-RS reception procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 4\_2, by applying the parameters of dmrs-DownlinkForPDSCH-MappingTypeA and dmrs-DownlinkForPDSCH-MappingTypeB in pdsch-ConfigMulticast instead of dmrs-DownlinkForPDSCH-MappingTypeA and dmrs-DownlinkForPDSCH-MappingTypeB in PDSCH-Config.  When receiving PDSCH scheduled by DCI format 1\_0, 4\_0, or 4\_1, or receiving PDSCH before dedicated higher layer configuration of any of the parameters dmrs-AdditionalPosition, maxLength and dmrs-Type, the UE shall assume that the PDSCH is not present in any symbol carrying DM-RS except for PDSCH with allocation duration of 2 symbols with PDSCH mapping type B (described in clause 7.4.1.1.2 of [4, TS 38.211]), and a single symbol front-loaded DM-RS of configuration type 1 on DM-RS port 1000 is transmitted, and that all the remaining orthogonal antenna ports are not associated with transmission of PDSCH to another UE and in addition  - For PDSCH with mapping type A and type B, the UE shall assume dmrs-AdditionalPosition='pos2' and up to two additional single-symbol DM-RS present in a slot according to the PDSCH duration indicated in the DCI as defined in Clause 7.4.1.1 of [4, TS 38.211], and  - For PDSCH with allocation duration of 2 symbols with mapping type B, the UE shall assume that the PDSCH is present in the symbol carrying DM-RS.  When receiving PDSCH scheduled by DCI format 1\_1 or 1\_3 by PDCCH with CRC scrambled by C-RNTI, MCS-C-RNTI, or CS-RNTI or DCI format 4\_2 by PDCCH with CRC scrambled by G-RNTI for multicast or G-CS-RNTI,  - the UE may be configured with the higher layer parameter dmrs-Type and/or dmrs-TypeEnh, and the configured DM-RS configuration type is used for receiving PDSCH in as defined in Clause 7.4.1.1 of [4, TS 38.211].  - the UE may be configured with the maximum number of front-loaded DM-RS symbols for PDSCH by higher layer parameter maxLength given by DMRS-DownlinkConfig..  - if maxLength is set to 'len1', single-symbol DM-RS can be scheduled for the UE by DCI, and the UE can be configured with a number of additional DM-RS for PDSCH by higher layer parameter dmrs-AdditionalPosition, which can be set to 'pos0', 'pos1', 'pos2' or 'pos3'.  - if maxLength is set to 'len2', both single-symbol DM-RS and double symbol DM-RS can be scheduled for the UE by DCI, and the UE can be configured with a number of additional DM-RS for PDSCH by higher layer parameter dmrs-AdditionalPosition, which can be set to 'pos0' or 'pos1'.  - and the UE shall assume to receive additional DM-RS as specified in Table 7.4.1.1.2-3 and Table 7.4.1.1.2-4 as described in Clause 7.4.1.1.2 of [4, TS 38.211].  For the UE-specific reference signals generation as defined in Clause 7.4.1.1 of [4, TS 38.211], a UE can be configured by higher layers with one or two scrambling identity(s), i = 0,1 which are the same for both PDSCH mapping Type A and Type B.  A UE may be scheduled with a number of DM-RS ports by the antenna port index in DCI format 1\_1 as described in Clause 7.3.1.2 of [5, TS 38.212].  For DM-RS configuration type 1,  - if a UE is scheduled with one codeword and assigned with the antenna port mapping with indices of {2, 9, 10, 11 or 30} in Table 7.3.1.2.2-1 and Table 7.3.1.2.2-2 of Clause 7.3.1.2 of [5, TS 38.212], or  - if a UE is scheduled with one codeword and assigned with the antenna port mapping with indices of {2, 9, 10, 11 or 12} in Table 7.3.1.2.2-1A and {2, 9, 10, 11, 30 or 31} in Table 7.3.1.2.2-2A and Table 7.3.1.2.2-2B of Clause 7.3.1.2 of [5, TS 38.212], or  - if a UE is scheduled with two codewords,  the UE may assume that all the remaining orthogonal antenna ports are not associated with transmission of PDSCH to another UE.  For DM-RS configuration type 2,  - if a UE is scheduled with one codeword and assigned with the antenna port mapping with indices of {2, 10 or 23} in Table 7.3.1.2.2-3 and Table 7.3.1.2.2-4 of Clause 7.3.1.2 of [5, TS 38.212], or  - if a UE is scheduled with one codeword and assigned with the antenna port mapping with indices of {2, 10, 23 or 24 ,25 and 26 when applicable} in Table 7.3.1.2.2-3A/3B and {2, 10, 23 or 58,59 and 60 when applicable} in Table 7.3.1.2.2-4A/4B of Clause 7.3.1.2 of [5, TS 38.212], or  - if a UE is scheduled with two codewords,  the UE may assume that all the remaining orthogonal antenna ports are not associated with transmission of PDSCH to another UE.  For DM-RS configuration enhanced type 1,  - if a UE is scheduled with one codeword and assigned with the antenna port mapping with indices of {9, 10, 11,27 and 28 when applicable} in Table 7.3.1.2.2-7 and Table 7.3.1.2.2-7A/7B of Clause 7.3.1.2 of [5, TS 38.212], or  - if a UE is scheduled with one codeword and assigned with the antenna port mapping with indices of {9, 10, 11, 39, 40, 41, 42, 43, 44, 45 , 66 and 67 when applicable} in Table 7.3.1.2.2-8 and Table 7.3.1.2.2-8A/8B of Clause 7.3.1.2 of [5, TS 38.212],  the UE may assume that all the remaining orthogonal antenna ports of the CDM groups, from which the antenna ports are indicated to the UE, are not associated with transmission of PDSCH to another UE, or  - if a UE is scheduled with two codewords, the UE may assume that all the remaining orthogonal antenna ports are not associated with transmission of PDSCH to another UE.  For DM-RS configuration enhanced type 2,  - if a UE is scheduled with one codeword and assigned with the antenna port mapping with indices of {9, 10, 20, 21, 22, 23 and 54,55,56,57 when applicable} in Table 7.3.1.2.2-9 and Table 7.3.1.2.2-9A/9B of Clause 7.3.1.2 of [5, TS 38.212], or  - if a UE is scheduled with one codeword and assigned with the antenna port mapping with indices of {9, 10, 20, 21, 22, 23, 72, 73, 74, 75, 76, 77 and 136,137,138,139 when applicable} in Table 7.3.1.2.2-10 and in Table 7.3.1.2.2-10A/10B of Clause 7.3.1.2 of [5, TS 38.212],  The UE may assume that all the remaining orthogonal antenna ports of CDM groups, from which the antenna ports are indicated to the UE, are not associated with transmission of PDSCH to another UE, or  - if a UE is scheduled with two codewords, the UE may assume that all the remaining orthogonal antenna ports are not associated with transmission of PDSCH to another UE.  For DM-RS configuration enhanced type 1,  - if a UE is configured with the higher layer parameter repetitionScheme set to 'fdmSchemeA' or 'fdmSchemeB', and is indicated with two TCI states to be applied to the PDSCH, and DM-RS port(s) within one CDM group in the DCI field 'Antenna Port(s)',  - if a UE is not indicating UE capability of pdsch-ReceptionSchemeA or pdsch-ReceptionSchemeB, the UE shall assume that the number of consecutively scheduled PRBs for PDSCH for each TCI-state is even, and the offset of each set of consecutively scheduled PRB from common resource block 0 for PDSCH for each TCI-state is even number.  - otherwise,  - if the UE is not indicating UE capability of pdsch-ReceptionWithoutSchedulingRestriction, the UE shall assume the number of consecutively scheduled PRBs for PDSCH is even, and the offset of each set of consecutively scheduled PRB for PDSCH from common resource block 0 is even number.  If a UE receiving PDSCH scheduled by DCI format 1\_2 is configured with the higher layer parameter phaseTrackingRS in dmrs-DownlinkForPDSCH-MappingTypeA-DCI-1-2 or dmrs-DownlinkForPDSCH-MappingTypeB-DCI-1-2 or a UE receiving PDSCH scheduled by DCI format 1\_0, 1\_1 or 1\_3 is configured with the higher layer parameter phaseTrackingRS in dmrs-DownlinkForPDSCH-MappingTypeA or dmrs-DownlinkForPDSCH-MappingTypeB, the UE may assume that the following configurations are not occurring simultaneously for the received PDSCH:  - any DM-RS ports among  1004-1007 or 1006-1011 for DM-RS configurations type 1 and type 2, respectively or,  1004-1007 or 1012-1015 for DM-RS configuration enhanced type 1 or,  1006-1011 or 1018-1023 for DM-RS configuration enhanced type 2,  are scheduled for the UE and the other UE(s) sharing the DM-RS REs on the same CDM group(s), and  - PT-RS is transmitted to the UE.  The UE is not expected to simultaneously be configured with the maximum number of front-loaded DM-RS symbols for PDSCH by higher layer parameter maxLength being set equal to 'len2' and more than one additional DM-RS symbol as given by the higher layer parameter dmrs-AdditionalPosition.  The UE is not expected to assume co-scheduled UE(s) with different DM-RS configuration with respect to the actual number of front-loaded DM-RS symbol(s), the actual number of additional DM-RS, the DM-RS symbol locationas described in Clause 7.4.1.1 of [4, TS 38.211]. The UE configured with DM-RS configuration type 1 or enhanced type 1 is not expected to assume co-scheduled UE(s) with DM-RS configuration type 2 or enhanced type 2. The UE configured with DM-RS configuration type 2 or enhanced type 2 is not expected to assume co-scheduled UE(s) with DM-RS configuration type 1 or enhanced type 1.  The UE does not expect the precoding of the potential co-scheduled UE(s) in other DM-RS ports of the same CDM group to be different in the PRG-level grid configured to this UE with PRG =2 or 4.  When the UE is configured with the higher layer parameter dmrs-TypeEnh and indicated with at least one DM-RS ports 1008-1015 for enhanced Type 1 DM-RS or DM-RS ports 1012-1023 for enhanced Type 2 DM-RS, the UE does not expect that any co-scheduled UE(s) in the same CDM group is not configured with the higher layer- parameter dmrs-TypeEnh. When the UE is not configured with the higher layer parameter dmrs-TypeEnh, the UE does not expect that any co-scheduled UE(s) in the same CDM group(s) is configured with the higher layer parameter dmrs-TypeEnh8 and indicated with at least one of DMRS ports 1008-1015 for enhanced Type 1 DMRS or DMRS ports 1012-1023 for enhanced Type 2 DMRS.  The UE does not expect the resource allocation of the potential co-scheduled UE(s) in other DM-RS ports of the same CDM group to be misaligned in the PRG-level grid to this UE with PRG=2 or 4.  When receiving PDSCH scheduled by DCI format 1\_1, the UE shall assume that the CDM groups indicated in the configured index from Tables 7.3.1.2.2-1, 7.3.1.2.2-1A, 7.3.1.2.2-7, 7.3.1.2.2-7A/7B, 7.3.1.2.2-2, 7.3.1.2.2-2A/2B, 7.3.1.2.2-8, 7.3.1.2.2-8A/8B, 7.3.1.2.2-3, 7.3.1.2.2-3A/3B, 7.3.1.2.2-9, 7.3.1.2.2-9A/9B, 7.3.1.2.2-4, 7.3.1.2.2-4A/4B, 7.3.1.2.2-10, 7.3.1.2.2-10A/10B of [5, TS. 38.212] contain potential co-scheduled downlink DM-RS and are not used for data transmission, where "1", "2" and "3" for the number of DM-RS CDM group(s) in Tables 7.3.1.2.2-1, 7.3.1.2.2-1A, 7.3.1.2.2-7, 7.3.1.2.2-7A/7B, 7.3.1.2.2-2, 7.3.1.2.2-2A/2B, 7.3.1.2.2-8, 7.3.1.2.2-8A/8B, 7.3.1.2.2-3, 7.3.1.2.2-3A/3B, 7.3.1.2.2-9, 7.3.1.2-9A/9B, 7.3.1.2.2-4, 7.3.1.2.2-4A/4B, 7.3.1.2.2-10, 7.3.1.2.2-10A/10B of [5, TS. 38.212] correspond to CDM group 0, {0,1}, {0,1,2}, respectively.  When receiving PDSCH scheduled by DCI format 1\_0, 4\_0, or 4\_1, the UE shall assume the number of DM-RS CDM groups without data is 1 which corresponds to CDM group 0 for the case of PDSCH with allocation duration of 2 symbols, and the UE shall assume that the number of DM-RS CDM groups without data is 2 which corresponds to CDM group {0,1} for all other cases.  The UE is not expected to receive PDSCH scheduling DCI which indicates CDM group(s) with potential DM-RS ports which overlap with any configured CSI-RS resource(s) for that UE.  < Unchanged parts are omitted >  **< End of Change Request >** |

Based on the above contribution, the following TEI proposal can be discussed in RAN1#120 meeting.

### **TEI proposal #1**

* **Introduce the enhancements to antenna port allocation tables in 3GPP TS 38.212 as captured in Annex A in R1-2501418 [1].**
* **Introduce the enhancements to co-scheduling rules for UEs in 3GPP TS 38.214 as captured in Annex B in R1-2501418 [1].**
* **Introduce an additional UE capability parameter (DMRS-PartialPortEnh-DL) in 3GPP TS 38.306 that allows the UE to indicate its ability to leverage the performance benefits provided by partial port occupancy in the CDM group when using an advanced receiver.**

This proposal is already supported by Tejas Network, Reliance Jio, WiSig Networks, CEWiT, Indian Institute of Science, Bangalore, IIT Madras, IIT Kanpur & IIT Hyderabad.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Tejas Networks |  | Updated new revision R1-2501418  Co-sourcing : Reliance Jio, WiSig Networks, CEWiT, Indian Institute of Science, Bangalore, IIT Madras, IIT Kanpur & IIT Hyderabad |
| Moderator |  | Tdoc number in the proposal was updated.  Also, the co-sourcing companies were added in the supporting companies. |
| Spreadtrum | N | We don’t prefer to define multiple UE capability on a single feature. Besides, UE capability 2 will bring more issue. For example, when UE is configured with multiple CSI reports, it is possible that one group of reports meets the condtion, while the other reports don’t. As a consequence, some reports follow new rule, others follow legacy rule, which will complicate UE implementation. |
| QC | N | In general, we don’t see the necessity to introduce big change to DMRS at this late stage of NR, which will have impact to both UE and gNB implementation.  On technical details, we would like to understand the intention and scope of the enhancement. Is the scope of the enhancement only includes SU MIMO or both SU and MU MIMO? Is the intention improving SU MIMO channel estimation by distributing DMRS ports to CDM groups as evenly as possible to reduce cross-port leakage? If so, many of the proposed new combinations seem to be opposite to this intention by putting many ports in a same CDM group. Can proponents please clarify the intention and use cases for this proposal. |
| CEWiT | Y | We agree with Tejas proposal that providing these port combinations will help in better channel estimation and in turn the performance of the UE |
| Tejas Networks2 |  | Response to QC   * The intention is majorly for SU-MIMO. * Even distribution of ports combinations already there in the existing DMRS tables. * We are proposing additional new even (example for a 3-layer 1 port in each CDM group) or un-even (example for a 4-layer 2 layer in 1 CDM and one layer each in rest of CDM group) combinations which results in better channel estimation for layers allocated to ports in partial occupied CDM groups. (If we bypass the de-spread step for that CDM group) We have seen improvement in performance with this approach especially with higher delay spread and higher QAM channels.   Response to Spreadtrum   * UE capability parameter indicates whether it can take advantage of the partially allocated CDM groups. We are open to other mechanisms of indication to select new rows. * We don’t see any conflict with Multiple CSI reports for the UE. Based on the UE capability Proposed new tables suffixed with ‘B’ will be used for all the associated CSI reports. Also, the table with ‘B’ will have both legacy rows and newly added rows and it is up to the scheduler implementation to choose the appropriate rows based on the channel and MCS conditions. |
| OPPO | N | We have some comments on the evaluation on MSE gain of the proposal:   1. It seems that the enhancement can only provide gain in high SNR region (e.g. >30dB in Figure 6 in [1]). In normal SNR range which is more common, legacy configuration can provide similar or better performance. 2. For MU-MIMO case: For legacy configuration which occupies less CDM groups for one UE, there is no (or less) inter-UE DMRS inference since different CDM groups would be allocated among UEs. For the proposal DMRS configuration, the DMRS ports of one UE is assigned in more CDM groups, which are also used by other UEs via CDM. Then there could be higher inter-UE inference, which may not be considered in the evaluation. That is to say, OCC among UEs is still needed if the DMRS ports of one UE are allocated in partially occupied CDM group. If we assume the same number of total DMRS ports among UEs, we cannot see there would be any MSE gain for the proposal. 3. For SU-MIMO case: The proposal needs more CDM groups for one UE, which means more CDM groups for data rate-matching needs to be configured. The additional DMRS overhead would eliminate the gain from channel estimation. |
| Samsung | N | Design principle for Rel-15/18 DMRS port indication is   1. putting DMRS ports into a same CDM group as much as possible, 2. then, if one CDM group cannot accommodate required number of DMRS ports, use the next CDM group. 3. If 2-front loaded symbols, in one CDM group, put DMRS ports into a same sub-group with a same TD-OCC code. 4. If one sub-group cannot accommodate required number of DMRS ports, use the next sub-group with a different TD-OCC code.   🡺 Then, the TEI proposal has totally opposite principle with this.  If across-CDM DMRS port mapping is firstly used and OCC de-spreading on certain CDM group(s) is not used, other UEs cannot be allocated on those CDM group(s) to guarantee the UE's performance.  If across-CDM DMRS port mapping is firstly used, (since number of CDM group without data(s) can be maximized) there are few chances on PDSCH reception in DMRS symbol (i.e., FDM between PDSCH and DMRS) and power boosting on DMRS (blanking other CDM group(s) so that there can be other co-scheduled UE(s)).  Also, it is unclear to have good performance considering feasibility and complexity of UE receiver implementation on performing de-spreading for some CDM group(s) and skipping de-spreading for the other CDM group(s). |

* 1. UE frequency hopping enhancement for positioning

Following proposal is made in the contribution.

|  |  |
| --- | --- |
| [2] | In Rel-18, for positioning enhancements for RedCap UEs, Rx frequency hopping of DL PRS and Tx frequency hopping of UL SRS for positioning are supported with the maximum hop bandwidth for a single hop being 20MHz for FR1 and 100MHz for FR2. To improve positioning accuracy, the frequency hopping feature could also be applicable for non-RedCap UEs with limited UL SRS transmitting bandwidth capability or limited DL PRS processing bandwidth capability (e.g., 50MHz). The maximum bandwidth for a single hop can be extended to be larger than 20MHz for FR1 and larger than 100MHz for FR2 to support non-RedCap UE frequency hopping.  ***Observation 1:*** *For non-Redcap UEs with limited bandwidth capability, the feature of frequency hopping cannot be used to improve the positioning accuracy.*  Moreover, in Rel-18, bandwidth/carrier aggregation is introduced for achieving an equivalent larger bandwidth than the hopping bandwidth and therefore achieving higher accuracy. The maximum aggregated bandwidth of 2 PFLs/carriers for positioning which is supported by UE can be up to 200MHz in FR1 (for 30 kHz SCS) and up to 800MHz in FR2, and the maximum aggregated bandwidth of 3 PFLs/carriers for positioning which is supported by UE can be up to 300MHz in FR1 (for 30 kHz SCS) and up to 1200MHz in FR2. However, for UEs not supporting the bandwidth aggregation feature, the frequency resources of intra-band contiguous CCs cannot be used for positioning accuracy improvement. In order to make use of the intra-band contiguous CCs and the up-to-300MHz frequency resources in FR1, the maximum SRS bandwidth across all hops can be extended such that the SRS hops can span across intra-band contiguous CCs. In such case, the frequency resources can be effectively utilized for a UE only supporting the SRS Tx hopping feature but not supporting the SRS bandwidth aggregation feature.  ***Observation 2:*** *For UEs not supporting bandwidth aggregation feature, the frequency resources of intra-band contiguous CCs cannot be used for positioning accuracy improvement.*  UL SRS Tx frequency hopping is supported for both RRC\_CONNECTED state and RRC\_INACTIVE state. A UE can be configured to perform SRS Tx hopping separate from UL BWP where the UE may be configured with SCS, CP and bandwidth that are different from the UL active BWP (i.e., UL BWP for positioning SRS hopping). Also, there is no additional impact on measurement report since one TRP measurement is associated with one SRS resource ID, wherein the total bandwidth of all hops within that SRS resource is larger than a carrier/BWP bandwidth. The maximum SRS bandwidth across all hops can be 300MHz in FR1.  For DL, DL PRS Rx hopping across multiple PFLs can be realized by bandwidth aggregation configuration. For example, if a DL PRS bandwidth aggregation across multiple PFLs is configured, a UE can achieve large bandwidth via frequency hopping by implementation, wherein the UE only receive one PFL at one time.  Based on the above analysis, we propose to at least support SRS Tx hopping across carriers in both RRC\_CONNECTED state and RRC\_INACTIVE state.  ***Proposal 1:*** *Extend Rel-18’s DL and UL frequency hopping for DL-PRS reception and UL SRS for positioning transmission to non-RedCap UEs*   * *At least support the maximum SRS or DL PRS bandwidths across up to three intra-band contiguous carriers or PFLs respectively.* |

Based on the above contribution, the following TEI proposal can be discussed in RAN1#120 meeting.

### **TEI proposal #2**

* **Extend Rel-18’s DL and UL frequency hopping for DL-PRS reception and UL SRS for positioning transmission to non-RedCap UEs**
  + **At least support the maximum SRS or DL PRS bandwidths across up to three intra-band contiguous carriers or PFLs respectively.**

This proposal is already supported by ZTE Corporation, China Unicom, Sanechips, Huawei, HiSilicon.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

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| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Spreadtrum |  | We don’t think it is a simple extension from RedCap UE to normal UE. More study is needed especially on UE RF capability. |
| Qualcomm | comment | In principle and in technical terms, this proposal could be a useful feature to be supported for non-redcap devices that do not support BW/carrier aggregation. However, we believe that some clarifications are needed;  In intraband contiguous carriers there can be a guard band between the carriers; our understanding is that the UE is not expected to transmit in the guard band, but the way this feature is specified could result in such transmissions unless there are some clarifications or modifications in the feature.  Therefore, it may be more clear what is the intention if the following is clarified: “The UE is not expected to transmit in the guard band” and that the existing feature is used “as a starting point”.  Furthermore, we believe that there needs to be some more discussion with regards to the UE capabilities for this feature that may need to be clarified. |
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* 1. Counting of active P/SP CSI-RS resources

Following proposal is made in the contribution.

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| --- | --- |
| [3] | In RAN1#119, the issue of active resource counting with a proposal to introduce an enhancement as a TEI item in Rel-19. In the second round of discussion (see TEI proposal #5’ of R1-2410891), some additional restrictions were raised. We provide some views on a few of these restrictions below:   * Restriction of NZP CSI-RS (CMR) and CSI-IM (IMR) has the same periodicity: typically, in order for the UE to compute CSI, the needs to perform both channel measurements on the CMR and interference measurements on IMR. In NR, the periodicity and the slot offset of CMR and IMR are independently configurable as part of NZP-CSI-RS IE and CSI-IM IE, respectively. However, such flexibility may not be necessary, we are open to consider introducing an assumption that both CMR and IMR have the same periodicity. * Regarding slot offset of NZP CSI-RS (CMR) and CSI-IM (IMR): in RAN1#119’, it was proposed by some companies to introduce a threshold duration which is the maximum offset between a paired CMR and IMR, where the threshold duration is subject to UE capability. In our view, we don’t see a need to define such a threshold duration and introduce additional UE capabilities for this. It should be possible to configure either the same offset or a slot offset that differs by a maximum value. Hence, we don’t support the introduction of a threshold duration on slot offset between the paired CMR and IMR. * On whether to limit the new active resource counting feature to only non-CRI based CSI reporting: in the case with CRI based reporting, the pairs of CMR and IMR corresponding to different CRI values may have different periodicities and/or slot offsets. As such, introducing active resource counting durations (as proposed in this TEI) may be come complicated as multiple active resource counting durations may need to be defined for the different pairs of CMR and IMR. Hence, our preference is to limit this feature to only non-CRI based CSI reporting. |
| [7] | T38.214 V18.4.0 subclause 5.2.1.6 CSI processing criteria defines how the abovementioned capability is counted for aperiodic, semi-persistent and periodic NZP-CSI-RS [4] (formatting changed for readability):   |  | | --- | | In any slot, the UE is not expected to have more active CSI-RS ports or active CSI-RS resources in active BWPs than reported as capability. NZP CSI-RS resource is active in a duration of time defined as follows.   * **For aperiodic CSI-RS**, starting from the end of the PDCCH containing the request and ending at the end of the scheduled PUSCH containing the report associated with this aperiodic CSI-RS. When the PDCCH candidates are associated with a search space set configured with *searchSpaceLinkingId*, for the purpose of determining the NZP CSI-RS resource active duration, the PDCCH candidate that ends later in time among the two linked PDCCH candidates is used. * **For semi-persistent CSI-RS**, starting from the end of when the activation command is applied, and ending at the end of when the deactivation command is applied. * **For periodic CSI-RS**, starting when the periodic CSI-RS is configured by higher layer signalling, and ending when the periodic CSI-RS configuration is released. |     It can be noted that for A-CSI-RS the resource is only considered active during the timeline of the one A-CSI reporting procedure, starting from the end of the triggering DCI and ending at the end of the PUSCH delivering the CSI report, while for P-CSI-RS the resource is considered active all the time even if the periodicity maybe large. Similarly for SP-CSI-RS, the CSI-RS resource is active over the whole duration when SP-CSI-RS is activated even if the periodicity maybe large.  The fact that the P-CSI-RS and SP-CSI-RS resources are counted as always active puts pressure on the UEs to support a larger number of simultaneously active NZP-CSI-RS resources while low UE capability restricts the network operation. The low cap on the aggregate number of active NZP-CSI-RS resources across all component carriers further hinders the usage of carrier aggregation.    Figure 1: Example of a staggered CSI reporting with 4 component carriers.   - If the CSI-RS are periodic, 4 NZP-CSI-RS resources are active all the time.  - If the CSI-RS are aperiodic, at most 1 NZP-CSI-RS resource is active at any given time  **Observation 1: With the same CSI-RS => CSI report timings, the periodic CSI-RS/reporting may need multiple times the number of active NZP-CSI-RS resources than aperiodic CSI-RS/reporting**  RAN1#119 discussed the TEI19 proposal for counting active CSI-RS resources [5], and at least the following concerns were raised with regard to the proposal [6]:   * **Substantial specification impact**: [5] provided a proposal for specification implementation to TS38.214, the impact is fairly minor and contained in a single subclause of the specification. Additionally a UE capability, and potentially RRC activation may be needed, which are business as usual for all TEI items. * **Substantial implementation impact:** This can be seen as dependent on the underlying UE implementation that would be implementing this TEI proposal, but the supporting companies believe that some UE implementations should be able to accommodate this counting method and be able to indicate a higher CSI-RS capability with already existing processing capability. We acknowledge that there maybe other types of UE architectures where the feature would be more troublesome to implement. These UE types can be assumed to not indicate support for the new counting. * **Averaging over multiple CSI-RS occasions:** The CSI report can indeed be based on unrestricted observation interval, and span across undefined number of CSI-RS instances. However this doesn’t necessitate maintaining the CSI-RS resource as active across the whole averaging window, that would be just one particular implementation that would continue to rely on the existing counting. It may also be that the storing of the report value for further averaging is a trivial step relative to the actual measurement, and the resource can be freed between the CSI-RS samples. * **CSI timeline is not applicable for this purpose:** This is true as per the existing specificatition. However, the point of this TEI proposal is to define a CSI timeline that would be applicable in this case. Using the CSI timeline was considered as a reasonable proposal to initiate discussions, while the proponents are willing to discuss other alternatives. However, we have addressed this aspect by updating the proposal to include the duration a resource is counted as active as a separate and independent UE capability.   Thus the following proposals are made:  **Proposal 1: For periodic and semi-persistent NZP-CSI-RS counting, consider a NZP-CSI-RS resource as “active” from the slot of the CSI-RS for a fixed number of slots determined by a new UE capability.**  **Proposal 2: Take the text proposal below as the baseline for introducing the new counting of NZP-CSI-RS resource as “active”**   |  | | --- | | In any slot, the UE is not expected to have more active CSI-RS ports or active CSI-RS resources in active BWPs than reported as capability. NZP CSI-RS resource is active in a duration of time defined as follows.  - For aperiodic CSI-RS, starting from the end of the PDCCH containing the request and ending at the end of the PUSCH containing the report associated with this aperiodic CSI-RS. When the PDCCH candidates are associated with a search space set configured with *searchSpaceLinkingId*, for the purpose of determining the NZP CSI-RS resource active duration, the PDCCH candidate that ends later in time among the two linked PDCCH candidates is used.  - For a UE not indicating support for [*active NZP-CSI-RS resource counting UE capability*] for semi-persistent CSI-RS, starting from the end of when the activation command is applied, and ending at the end of when the deactivation command is applied.  - For a UE not indicating support for [*active NZP-CSI-RS resource counting UE capability*] for periodic CSI-RS, starting when the periodic CSI-RS is configured by higher layer signalling, and ending when the periodic CSI-RS configuration is released.  - For a UE indicating support for [*active NZP-CSI-RS resource counting UE capability*] for semi-persistent and periodic CSI-RS, starting from the start of the slot containing the NZP-CSI-RS for a duration of *N* symbols rounded up to full slots, where *N* is indicated by the UE capability. | |

This TEI proposal was proposed and discussed in the last RAN1 meeting, and several concerns were raised by companies [9]. However, the proponent provided the following responses for each concern.

• **Substantial specification impact**: The impact is fairly minor and contained only in a single subclause of the specification other than RRC parameters and UE capabilities.

• **Substantial implementation impact**: The supporting companies believe that some UE implementations should be able to accommodate this counting method and be able to indicate a higher CSI-RS capability with already existing processing capability. We acknowledge that there may be other types of UE architectures where the feature would be more troublesome to implement. These UE types can be assumed to not indicate support for the new counting.

• **Averaging over multiple CSI-RS occasions**: The CSI report can indeed be based on unrestricted observation interval, and span across undefined number of CSI-RS instances. However, this does not necessitate maintaining the CSI-RS resource as active across the whole averaging window, that would be just one particular implementation that would continue to rely on the existing counting. It may also be that the storing of the report value for further averaging is a trivial step relative to the actual measurement, and the resource can be freed between the CSI-RS samples.

• **CSI timeline is not applicable for this purpose**: The point of this TEI proposal is to define a timeline that would be applicable in this case. Using the CSI timeline was considered as a reasonable proposal to initiate discussions, while the proponents are willing to discuss other alternatives. However, we have addressed this aspect by updating the proposal to include the duration a resource is counted as active as a separate and independent UE capability.

Based on the above contribution, the following TEI proposal can be discussed in RAN1#120 meeting.

### **TEI proposal #3**

* **For periodic and semi-persistent NZP-CSI-RS counting, consider a NZP-CSI-RS resource as “active” from the slot of the CSI-RS for a fixed number of slots determined by a new UE capability.**
* **Endorse the following TP for clause 5.2.1.6 in TS 38.214.**

|  |
| --- |
| In any slot, the UE is not expected to have more active CSI-RS ports or active CSI-RS resources in active BWPs than reported as capability. NZP CSI-RS resource is active in a duration of time defined as follows.  - For aperiodic CSI-RS, starting from the end of the PDCCH containing the request and ending at the end of the PUSCH containing the report associated with this aperiodic CSI-RS. When the PDCCH candidates are associated with a search space set configured with *searchSpaceLinkingId*, for the purpose of determining the NZP CSI-RS resource active duration, the PDCCH candidate that ends later in time among the two linked PDCCH candidates is used.  - For a UE not indicating support for [*active NZP-CSI-RS resource counting UE capability*] for semi-persistent CSI-RS, starting from the end of when the activation command is applied, and ending at the end of when the deactivation command is applied.  - For a UE not indicating support for [*active NZP-CSI-RS resource counting UE capability*] for periodic CSI-RS, starting when the periodic CSI-RS is configured by higher layer signalling, and ending when the periodic CSI-RS configuration is released.  - For a UE indicating support for [*active NZP-CSI-RS resource counting UE capability*] for semi-persistent and periodic CSI-RS, starting from the start of the slot containing the NZP-CSI-RS for a duration of *N* symbols rounded up to full slots, where *N* is indicated by the UE capability. |

This proposal is already supported by Nokia, Apple, Ericsson, MediaTek, NTT DOCOMO, Spreadtrum.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| DOCOMO | Y |  |
| Spreadtrum | Y |  |
| Ericsson | Y | We are supportive of the current TP. Having said that, we are also open to discuss some of the restrictions brought up in the last meeting which we discuss in [3]. |
| Samsung | N | We have not changed our view. UE needs to occupy ARC to take care of multiple P/SP CSI-RS occasions for calculating CSI report, UL buffer, a potential misaligned periodicity/offset of CSI-IM and CSI-RS, etc. Also, we are not sure how to handle CRI-based reporting (i.e., multiple CSI-RS resources) and Doppler CSI which always needs previous measurements, etc, that are already defined based on the legacy ARC counting definition. |

* 1. SRS-CS + uplink Tx switching

Following proposal is made in the contribution.

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| --- | --- |
| [4] | Uplink Tx switching between two uplink carriers was first specified in Rel-16, where the Tx chain would switch from one carrier to the other carrier when uplink switching is triggered. For the case of discussion in this subsection, let’s assume the following scenario, as shown in Fig. 1:   * UL Tx switching is configured between C1 and C2   + For example, (C1, C2) represents (carrier1, carrier2), i.e. C2 supports 2Tx where 1Tx can switch to C1 * *SRS-CarrierSwitching* is configured between C2 and C3, where C3 is DL only.   For this case, specification is not clear for the following aspects:   * Switching gap: when all Tx chains are not available at the source CC, RF tuning time depends on whether UE is supposed to switch first from C1 to source (C2) and next switch from source to target (C3); or UE is capable to directly switch from C1 to C3. For this aspect, a new UE capability for switching gap may be needed. * Prioritization rules for SRS-CS: following current specification, overlapping is determined based on required time for SRS transmission plus switching time to/from target CC. Now the question is, if UE is not capable of simultaneous transmission of SRS-CS (including RF tuning times) and uplink transmission on C1 under Tx switching scenario, whether/how to update the prioritization rules in 38.214 Sec. 6.2.1.2 to consider uplink transmission on C1. Current prioritization rules do not consider the interaction between SRS-CS configuration on target and uplink transmission on a band configured with ulTxswitch with source. For example, UE may be capable to keep simultaneous transmission between C1 and C3, if total number of used Tx chains in both bands is not more than two. In our view, specifying such complicated procedure is not desired given that in addition to specification efforts, it limits UE flexibility on which antenna to be sounded and depending on overlapping scenario, it may be even infeasible at the end. For this issue, it is more convenient for both UE and NW to clarify that the prioritization rules are applied between C1 and C3 only based on *srs-SwitchingAffectedBandsListNR-r17* and regardless of number of SRS antenna port configuration for transmission on target. * ulTxswitch state: UE and NW need to have same understanding on Tx switching state, after SRS-CS is performed. In the example shown in Fig.1, the state of Tx chain can be back to that of before SRS-CS (1T+1T), or both Tx chains are returned back to the source (0T+2T). This ambiguity needs to be discussed and resolved.   A screenshot of a computer  Description automatically generated  **Fig. 1:** **SRS-CS + ulTxswitch**  It should be noted that in theory, the required specification depends on the configuration of SRS antenna switching on target, i.e. 1TyR vs 2TyR. Given that when 2Tx changes are available 2TyR is a more practical configuration, the focus of the rest of this paper is on 2TyR.  Based on the above discussion, the following is proposed:  **Proposal: To resolve ambiguities with concurrent configuration of SRS-CS and ulTxswitch**   * **Confirm that the prioritization rules in 38.214 Sec. 6.2.1.2 are applied between target and C1, regardless of SRS-AS antenna port configuration on target CC, if UE indicates based on *srs-SwitchingAffectedBandsListNR-r17* that SRS-CS on target impacts uplink transmission on C1, where C1 is the CC which may share Tx chains with source CC. No spec change is needed.** * **If the UE is under the operation state in which all Tx chains are available at the source CC, the required switching time before the beginning of SRS-CS transmission on target CC is SRS-SwitchingTimeNR. Otherwise, the switching time before the beginning of SRS-CS transmission on target CC is the sum of *uplinkTxSwitchingPeriod* and *SRS-SwitchingTimeNR*.** * **After SRS transmissions within an SRS resource set is done, if UE is indicated to transmit on C1, the switching gap between the end of SRS-CS transmission on target CC and start of UL transmission on C1 is the sum of *uplinkTxSwitchingPeriod* and *SRS-SwitchingTimeNR*. Otherwise, all Tx chains are returned to the source CC, and the RF tuning time to switch from target to source will be *SRS-SwitchingTimeNR*.** |

Based on the above contribution, the following TEI proposal can be discussed in RAN1#120 meeting.

### **TEI proposal #4**

* **To resolve ambiguities with concurrent configuration of SRS-CS and ulTxswitch**
  + **Confirm that the prioritization rules in 38.214 Sec. 6.2.1.2 are applied between target and C1, regardless of SRS-AS antenna port configuration on target CC, if UE indicates based on srs-SwitchingAffectedBandsListNR-r17 that SRS-CS on target impacts uplink transmission on C1, where C1 is the CC which may share Tx chains with source CC. No spec change is needed.**
  + **If the UE is under the operation state in which all Tx chains are available at the source CC, the required switching time before the beginning of SRS-CS transmission on target CC is SRS-SwitchingTimeNR. Otherwise, the switching time before the beginning of SRS-CS transmission on target CC is the sum of uplinkTxSwitchingPeriod and SRS-SwitchingTimeNR.**
  + **After SRS transmissions within an SRS resource set is done, if UE is indicated to transmit on C1, the switching gap between the end of SRS-CS transmission on target CC and start of UL transmission on C1 is the sum of uplinkTxSwitchingPeriod and SRS-SwitchingTimeNR. Otherwise, all Tx chains are returned to the source CC, and the RF tuning time to switch from target to source will be SRS-SwitchingTimeNR.**

This proposal is already supported by Apple.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Qualcomm | Y | We support in general this clarification, but we have one minor additional clarification to add: the first bullet clarifies what the UE is supposed to do when the UE indicates “srs-SwitchingAffectedBandsListNR-r17”, but does not clarify what is the UE behavior in case it does not indicate the above capability. We should capture that the UE can only perform simultaneous transmission when the number of ports is less than or equal to 2. |
| OPPO | Y | In our understanding, if C1 is not indicated by srs-*SwitchingAffectedBandsListNR-r17*, the uplink transmission in C1 would not be impacted according to current spec. |
| Ericsson | Y | We support in principle the attempt to resolve these ambiguities in a single non-open ended agreement. The proposal looks good but we are open to discuss details further. |

* 1. Counting of the same active CSI-RS resources for *N* CSI reporting

Following proposal is made in the contribution.

|  |  |  |
| --- | --- | --- |
| [5] | The current specification defines rules how the number of the NZP CSI-RS resources are calculated for UE capability signaling, When the same NZP-CSI-RS resource is used in multiple CSI reporting configurations, that one resource is counted as multiple active CSI-RS resources. The different UE implementations may or may not be aligned with this assumption. The UEs may need to report conservative CSI-RS capability values per CC due high receive antenna and CSI-RS port requirement, and with CA the aggregate limit across all CCs may further limit what the UE can be configured with in a given CC. For other UE implementations, eliminating these active NZP-CSI-RS counting inefficiencies would allow for a larger number of CSI-RS configurations while maintaining the same capability value.  Therefore, at RAN1#118bis, a proposal was discussed in [1] to allow a new UE capability for a UE which may not need N times the UE processing capability for N CSI reports based on the same CSI-RS resources.  From the resulting discussion captured in [2], the main comment made by many companies was that counting simultaneous CSI resources as the same may cause a problem for some UE implementations in the case where certain reported contents are different across the N reports, which may not allow a common capability to be used. Different *codebookType* values (e,g, a mix of type I and type II) and *reportFreqConfiguration* values (e.g. some wideband some sub-band, or not all for same sub-band) were highlighted.  On the other hand, comments and support from other device vendors suggested that there are UE implementations that may not require such restriction, so it would seem reasonable to also be able to optimise for those UE implementations.  Concerns were also raised for NES R18 functionality, where different CSI reporting sub-configurations may lead to separate processing requirements in some UE implementations.  Therefore, the proponents have taken the feedback from other companies into account and developed what we hope to be an acceptable proposal below.  **Proposal 1: For simultaneous CSI-RS reception in UE features 2-33, 2-36, 2-40, 2-41 and 2-43, define 2 new UE capabilities:**   * **UE capability 1: To allow the UE to indicate that CSI-RS ports within one CSI-RS resource, as well as the CSI-RS resource, are counted as one resource,** **even if the CSI-RS resource is referred by *N* Report Settings.** * **UE capability 2: To allow the UE to indicate that CSI-RS ports within one CSI-RS resource, as well as the CSI-RS resource, are counted as one resource even if the CSI-RS resource is referred by *N* Report Settings, but ONLY if the following reporting configuration parameters are set to the same value for each of the N reports:**   + ***codebookType***   + ***reportFreqConfiguration***   **Proposal 2: For simultaneous CSI-RS reception in Network Energy saving UE features 42-1/1a/1b/1c, and 42-2/2a/2b/2c, define the following new UE capability:**   * **UE capability 3: To allow the UE to indicate that CSI-RS ports within one CSI-RS resource, as well as the CSI-RS resource, are counted as one resource even if the CSI-RS resource is referred multiple times.**   Possible specification changes according to proposals 1 and 2 are shown below.   |  | | --- | | If a CSI-RS resource is referred *N* times by one or more CSI Reporting Settings not configured with higher layer parameter *csi-ReportSubConfigToAddModList*, the CSI-RS resource and the CSI-RS ports within the CSI-RS resource are  - counted once, if the UE indicates [*active NZP-CSI-RS resource counting UE capability 1*],  - counted once, if the UE indicates [*active NZP-CSI-RS resource counting UE capability 2*] and each of the N CSI Reporting settings fulfil the conditions applicable for that UE capability, specified in [TS38.306]  - counted *N* times otherwise.  For a CSI-RS Resource Set for channel measurement configured with two Resource Groups and Resource Pairs, if a CSI-RS resource is referred times by one of the CSI-RS resources, where is defined in clause 5.2.1.4.2, and/or one or two Resource Pairs, the CSI-RS resource and the CSI-RS ports within the CSI-RS resource are counted times.  For a *CSI-ReportConfig* containing a list of *L* sub-configuration(s) provided by higher layer parameter *csi-ReportSubConfigToAddModList,* if a CSI-RS resource is referred by *M* sub-configurations among *N* triggered sub-configurations for CSI reporting for aperiodic CSI-RS resource, or *L* configured sub-configurations for CSI reporting for periodic or semi-persistent CSI-RS resource, the CSI-RS resource is  - counted once, if the UE indicates [*active NZP-CSI-RS resource counting UE capability 3*],  - counted *M* times otherwise,  and the CSI-RS ports within the CSI-RS resource are  - counted once, if the UE indicates [*active NZP-CSI-RS resource counting UE capability 3*],  - counted times otherwise, where *P* is the number of ports configured by *nrofPorts* and is the number of CSI-RS ports in *s*-th sub-configuration from *M* sub-configurations derived from the corresponding antenna port subset indicator *portSubsetIndicator* according to clause 5.2.1.4.2 if configured, otherwise . |   **Proposal 3: Consider the draft text proposal in this document as a starting point for the specification update.** |

Based on the above contribution, the following TEI proposal can be discussed in RAN1#120 meeting.

### **TEI proposal #5**

* **For simultaneous CSI-RS reception in UE features 2-33, 2-36, 2-40, 2-41 and 2-43, define 2 new UE capabilities:**
  + **UE capability 1: To allow the UE to indicate that CSI-RS ports within one CSI-RS resource, as well as the CSI-RS resource, are counted as one resource, even if the CSI-RS resource is referred by N Report Settings.**
  + **UE capability 2: To allow the UE to indicate that CSI-RS ports within one CSI-RS resource, as well as the CSI-RS resource, are counted as one resource even if the CSI-RS resource is referred by N Report Settings, but ONLY if the following reporting configuration parameters are set to the same value for each of the N reports:**
    - **codebookType**
    - **reportFreqConfiguration**
* **For simultaneous CSI-RS reception in Network Energy saving UE features 42-1/1a/1b/1c, and 42-2/2a/2b/2c, define the following new UE capability:**
  + **UE capability 3: To allow the UE to indicate that CSI-RS ports within one CSI-RS resource, as well as the CSI-RS resource, are counted as one resource even if the CSI-RS resource is referred multiple times.**
* **Endorse the following TP for clause 5.2.1.6 in TS 38.214.**

|  |
| --- |
| If a CSI-RS resource is referred *N* times by one or more CSI Reporting Settings not configured with higher layer parameter *csi-ReportSubConfigToAddModList*, the CSI-RS resource and the CSI-RS ports within the CSI-RS resource are  - counted once, if the UE indicates [*active NZP-CSI-RS resource counting UE capability 1*],  - counted once, if the UE indicates [*active NZP-CSI-RS resource counting UE capability 2*] and each of the N CSI Reporting settings fulfil the conditions applicable for that UE capability, specified in [TS38.306]  - counted *N* times otherwise.  For a CSI-RS Resource Set for channel measurement configured with two Resource Groups and Resource Pairs, if a CSI-RS resource is referred times by one of the CSI-RS resources, where is defined in clause 5.2.1.4.2, and/or one or two Resource Pairs, the CSI-RS resource and the CSI-RS ports within the CSI-RS resource are counted times.  For a *CSI-ReportConfig* containing a list of *L* sub-configuration(s) provided by higher layer parameter *csi-ReportSubConfigToAddModList,* if a CSI-RS resource is referred by *M* sub-configurations among *N* triggered sub-configurations for CSI reporting for aperiodic CSI-RS resource, or *L* configured sub-configurations for CSI reporting for periodic or semi-persistent CSI-RS resource, the CSI-RS resource is  - counted once, if the UE indicates [*active NZP-CSI-RS resource counting UE capability 3*],  - counted *M* times otherwise,  and the CSI-RS ports within the CSI-RS resource are  - counted once, if the UE indicates [*active NZP-CSI-RS resource counting UE capability 3*],  - counted times otherwise, where *P* is the number of ports configured by *nrofPorts* and is the number of CSI-RS ports in *s*-th sub-configuration from *M* sub-configurations derived from the corresponding antenna port subset indicator *portSubsetIndicator* according to clause 5.2.1.4.2 if configured, otherwise . |

This proposal is already supported by MediaTek, Nokia, Apple, NTT DOCOMO, Ericsson.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| DOCOMO | Y | Since the concerns for the previous proposal are resolved, the current proposal should be acceptable. |
| Spreadtrum | N | We don’t prefer to define multiple UE capability on a single feature. Besides, UE capability 2 will bring more issue. For example, when UE is configured with multiple CSI reports, it is possible that one group of reports meets the condtion, while the other reports don’t. As a consequence, some reports follow new rule, others follow legacy rule, which will complicate UE implementation. |
| Ericsson | Y | In the TP, we suggest to align the description for UE capability 2 with what is proposed in TEI proposal #5. |
| OPPO |  | For UE capability 2, we think more configuration parameters need to be considered other than *codebookType* and *reportFreqConfiguration*, e.g., *timeRestrictionForChannelMeasurements* and *subbandSize*. For example, if *timeRestrictionForChannelMeasurements* is configured for one report, instant channel information may be stored, while average channel information among multiple occasions could be stored for another report without this parameter configured. That may lead to different active CSI-RS for the same resource. Also, *subbandSize* could have similar impact as *reportFreqConfiguration*. |

* 1. SR triggered SSSG switching

Following proposal is made in the contribution.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [6] | To address the UL latency issue, the SR overriding (SRO) feature for PDCCH skipping should be extended to SSSG switching. This means that an SR transmission should be allowed to override SSSG switching as well as PDCCH skipping to avoid delaying the UL transmission.  To demonstrate the impact of SRO on latency, we conducted a system-level performance evaluation. We assumed three different PDCCH monitoring adaptation schemes: 1) Rel-17 PDCCH skipping, 2) Rel-17 SSSG switching, and 3) Rel-17 SSSG switching with SRO. Note that SRO is already supported for PDCCH skipping but not for SSSG switching. The PDCCH monitoring adaptation schemes were assumed to be triggered by the last scheduling DCIs before the DL buffer is flushed. For each scheme, we tried different configurations as described in Table 1 to show the trade-off between power saving gain and latency. For the traffic model, we assumed an interactive web-browsing traffic model, consisting of both DL and UL traffic.  In Figure 1, the relationship between power saving gain over the baseline and latency is shown for the three PDCCH monitoring adaptation schemes. In Figure 1(a), it is observed that at the same power saving gain, SRO significantly improves the UL latency of SSSG switching. Additionally, with SRO, SSSG switching achieves the same power saving gain vs. latency trade-off as PDCCH skipping. Interestingly, in Figure 1(b), it is observed that SRO can also improve the DL latency of SSSG switching. Since the assumed web-browsing traffic model is interactive, a UL transmission may trigger a follow-on DL transmission and vice versa. Thus, SSSG switching with SRO primes the network for subsequent DL transmissions and reduces DL latency.  Table 1: Configurations of PDCCH monitoring adaptation schemes.   |  |  |  | | --- | --- | --- | | Power saving | PDCCH skipping | SSSG switching (both with and w/o SRO) | | Baseline | PDCCH monitoring in every slot (No skipping/SSSG switching) | | | Scheme 1 | PDCCH skipping for 5 ms | Switching to SSSG with 5 ms PDCCH monitoring periodicity | | Scheme 2 | PDCCH skipping for 10 ms | Switching to SSSG with 10 ms PDCCH monitoring periodicity | | Scheme 3 | PDCCH skipping for 20 ms | Switching to SSSG with 20 ms PDCCH monitoring periodicity | | Scheme 4 | PDCCH skipping for 30 ms | Switching to SSSG with 30 ms PDCCH monitoring periodicity |   Figure 1: Power saving gain vs. latency: (a) uplink latency, (b) downlink latency.  Regarding SR-triggered SSSG switching, a few concerns were raised in RAN1 #118bis. These concerns can be easily addressed as follows:  **Misalignment between gNB and UE in case of SR misdetection or false alarm**  The issue of SSSG misalignment is not unique to this SRO scenario. During the Rel-17 UE power saving discussions, the same issue was identified in various scenarios. For instance, the gNB may send DCI indicating an SSSG switch to the UE, but the UE might miss it, resulting in a misalignment situation.  In the Rel-17 discussions, however, RAN1 decided not to pursue any complex mechanisms to handle the misalignment (except for the inactivity timer-based fallback to SSSG #0), leaving it up to gNB implementation. For example, gNB can resort to a nested SSSG configurations, i.e., the sparse SSSG is a subset of the dense SSSG. We believe the same principle should apply here. There are transparent solutions addressing the misalignment issue, and it can be left up to gNB implementation.  **Duplicated purpose between PDCCH skipping and SSSG switching**  The functional duplication between PDCCH skipping and SSSG switching was also recognized during the Rel-17 UE power saving discussions. After thorough evaluation and comparison, RAN1 observed that there is no dominant scheme in all scenarios (as captured in RAN1 #103-e agreement) and decided to specify both schemes in Rel-17 (RAN1 #104-e agreement).  For example, in a random and bursty traffic scenario, PDCCH skipping may be more beneficial than SSSG switching because it can quickly adapt to traffic arrival while maintaining dense PDCCH monitoring occasions. However, in a quasi-periodic traffic scenario, SSSG switching would be advantageous because it does not require recurring transmission of PDCCH skipping indications.  Considering that both PDCCH skipping and SSSG switching have their intended use cases, despite their functional similarities, we believe the same SR overriding feature as in PDCCH skipping should also be supported for SSSG switching to ensure both schemes are fair and equally attractive.  **Designation of a target SSSG**  In the legacy inactivity timer-based SSSG fallback operation, configuring the default SSSG (i.e., SSSG #0) as a "sparse" SSSG would be more beneficial from a UE power-saving perspective. Conversely, the target SSSG for SR-triggered SSSG switching should ideally be a "dense" SSSG, and it does not necessarily have to be the default SSSG.  Several methods can be considered for designating the target SSSG. For instance, the target SSSG may be implicitly determined based on the time-domain densities of PDCCH monitoring occasions of configured SSSGs. Since the density assessment can be conducted once when the SSSGs are configured, the impact on UE complexity should be minimal. Alternatively, an explicit parameter indicating the target SSSG may be introduced. As this involves a single new parameter (e.g., under *SearchSpaceSwitchConfig* IE), the impact on RRC is marginal.  Proposal 1: If a UE is instructed to monitor PDCCH according to search space sets with a group index other than a designated index, the UE stops PDCCH monitoring according to search space sets with the group index and start PDCCH monitoring according to search space sets with the designated group index from the first slot that is at least symbols after the last symbol of a PUCCH carrying an SR. |

This TEI proposal was proposed and discussed in Rel-19, and several concerns were raised by companies. However, the proponent provided the following responses for each concern.

• **Misalignment between gNB and UE in case of SR misdetection or false alarm**: The issue of SSSG misalignment is not unique to this SR overriding scenario. During the Rel-17 UE power saving discussions, the same issue was identified in various scenarios.

• **Duplicated purpose between PDCCH skipping and SSSG switching**: Beneficial/intended scenarios are different between PDCCH skipping and SSSG switching. For example, PDCCH skipping and SSSG switching may be more beneficial in a random/bursty traffic scenario and in a quasi-periodic traffic scenario, respectively.

Based on the above contribution, the following TEI proposal can be discussed in RAN1#120 meeting.

### **TEI proposal #6**

* **If a UE is instructed to monitor PDCCH according to search space sets with a group index other than a designated index, the UE stops PDCCH monitoring according to search space sets with the group index and start PDCCH monitoring according to search space sets with the designated group index from the first slot that is at least P\_switch symbols after the last symbol of a PUCCH carrying an SR.**

This proposal is already supported by Qualcomm.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

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| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Ericsson | N | We are open to considering this proposal if the functionality is controlled via explicit new RRC configuration. The proposal should not impact legacy UE operation. The designated index should be up to gNB configuration via a new RRC parameter. |
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* 1. SRS beamforming for FR2 positioning

Following proposal is made in the contribution.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| [8] | Tab. 1 shows the evaluation results of single-BS RTT+AoA positioning, where the RTT group delay error is assumed with Gaussian distribution with the std of 2ns. It is worth noting that 2ns is already a very stringent requirement from the perspective of BS/UE group delay calibration.  It can been that 0.2m and 0.1m accuracy can be achieved under 400MHz and 800MHz, respectively, using two selected SRS beams, while the group delay error dominates the error if only single SRS beam is used.  Tab. 1 Evaluation results for single-BS RTT+AoA positioning   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **Location evaluation InF-DH: (Central frequency=30GHz, ISD=20m)** | | | | | | | | |  | Single-BS, RTT+AOA | Bandwidth | Group delay error STD | 50% | 67% | 80% | 90% | | Horizontal accuracy | Single SRS beam (LoS) | 400MHz | 2ns | 0.326 | 0.525 | 0.695 | 0.875 | | 800MHz | 2ns | 0.317 | 0.513 | 0.682 | 0.857 | | Two SRS beams (LoS+MP) | 400MHz | 2ns | 0.029 | 0.051 | 0.085 | 0.157 | | 800MHz | 2ns | 0.016 | 0.023 | 0.036 | 0.063 |   ***Observation 1: Positioning SRS transmission using beam sweeping is desired for positioning feature.***  In the current specification, for positioning SRS not configured with spatial relation, it is up to UE to choose the SRS spatial relation as in [TS 38.214] as follows:   |  | | --- | | If the UE is not configured with the higher layer parameter *spatialRelationInfoPos* the UE may use a fixed spatial domain transmission filter for transmissions of the SRS configured by the higher layer parameter *SRS-PosResource* across multiple SRS resources or it may use a different spatial domain transmission filter across multiple SRS resources. |   Nevertheless, this UE implementation is not friendly to network to perform positioning. For example, for some UE implementations, when the spatial relation RS is not configured, UE may be prone to transmit the SRS resources using the spatial domain transmission filters based on the Rx beamformed RSRP from serving cell downlink RS, resulting in a fixed SRS Tx beam. However, the network expectation would be rather requesting UE to transmitting SRS in a way that explores the spatial diversity, e.g. based on blind beam sweeping, or path-power based beam correspondence.  In addition, a fixed spatial domain transmission filter could already be realized by configuring multiple positioning SRS resources with the same SRS resource as the spatial relation RS as exemplified in Fig. 2.  SRS resource #0  SRS resource #1  SRS resource #2  *spatialRelationInfoPos* not configured  *spatialRelationInfoPos* = SRS resource #0  *spatialRelationInfoPos* = SRS resource #0  Fig. 2: Realizing the same spatial transmission filer  ***Observation 2: There exists a configuration method to allow multiple SRS resources transmitted using the fixed beam, e.g. by configuring one SRS resource as the spatial relation RS of other SRS resources in the resource set.***  Overall, towards boosting the mmWave positioning performance, the issue would like to be addressed is the case when UE is “not configured with the spatial relation RS” but UE is expected to use different beams for SRS transmissions.  The solution is defining a new UE capability based on which network can indicate UE to transmit SRS using a different spatial domain transmission filter across multiple SRS resources.  ***Proposal 1: Introduce a new RRC parameter for a positioning SRS resource set, indicating that the UE is expected to use different spatial transmission filters for the positioning SRS resources not configured with spatialRelationInfoPos.***   * + ***A per-band UE capability is introduced.***   During RAN1#119, there were comments on the benefit of such a proposal and also the comment on potential impact on the power control. We would like to provide the following responses.   * + **Benefit:** It should be well acknowledged that beam coverage across spatial domain is important for mmWave positioning, for both single-BS positioning and multi-BS positioning. With the TEI, we aim to fix the ambiguity of the existing beam sweeping configuration. It can be jointly used with beam repetition by, e.g., configuration of a first subset of resources without spatial relation for beam sweeping and a second subset of resources with spatial relation each pointing to a SRS resource in the first set as repetition, which cannot be achieved with the existing specification, as shown in Fig. 3.   + **Power control:** In general, there is no impact on the power control, as the pathloss RS and other open loop PC parameters are still resource set level, and are based on RSRP of the DL RS. In fact, keeping the same transmission power for the SRS resources in an SRS resource set is important, so that network could benefit from the receive power difference to infer the pathloss difference.   SRS resource #0  SRS resource #1  SRS resource #2  *spatialRelationInfoPos* not configured  *spatialRelationInfoPos* = SRS resource #0  *spatialRelationInfoPos* = SRS resource #0  SRS resource #3  SRS resource #4  SRS resource #5  *spatialRelationInfoPos* not configured  *spatialRelationInfoPos* = SRS resource #3  *spatialRelationInfoPos* = SRS resource #3  **Beam 1**  **Beam 2**  Fig. 3: Configuration of SRS with beam sweeping and repetition  The TEI proposal is updated as follows:  ***Proposal 1: Introduce a new RRC parameter for a positioning SRS resource set, indicating that the UE is expected to use different spatial transmission filters for the positioning SRS resources not configured with spatialRelationInfoPos.***   * + ***A per-band UE capability is introduced.***   ***Proposal 2: Endorse the TP in Annex.*** |

This TEI proposal was proposed and discussed in the last RAN1 meeting, and several concerns were raised by companies [9]. However, the proponent provided the following responses for each concern.

• **Unclear benefit**: Beam coverage across spatial domain is important for mmWave positioning, for both single-BS positioning and multi-BS positioning. With the TEI, we aim to fix the ambiguity of the existing beam sweeping configuration. It can be jointly used with beam repetition by.

• **Power control uncertainty**: There is no impact on the power control, as the pathloss RS and other open loop PC parameters are still resource set level, and are based on RSRP of the DL RS. In fact, keeping the same transmission power for the SRS resources in an SRS resource set is important, so that network could benefit from the receive power difference to infer the pathloss difference

Based on the above contribution, the following TEI proposal can be discussed in RAN1#120 meeting.

### **TEI proposal #7**

* **Introduce a new RRC parameter for a positioning SRS resource set, indicating that the UE is expected to use different spatial transmission filters for the positioning SRS resources not configured with spatialRelationInfoPos.**
  + **A per-band UE capability is introduced.**
* **Endorse the following TP for clause 6.2.1.4 in TS 38.214.**

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| --- |
| ========================= Unchanged parts =========================  6.2.1.4 UE sounding procedure for positioning purposes  When the SRS is configured by the higher layer parameter *SRS-PosResource* and if the higher layer parameter *spatialRelationInfoPos* is configured*,* it contains the ID of the configuration fields of a reference RS according to Clause 6.3.2 of [TS 38.331]. The reference RS can be an SRS configured by the higher layer parameter *SRS-Resource* or *SRS-PosResource*, CSI-RS, SS/PBCH block, or a DL PRS configured on a serving cell or a SS/PBCH block or a DL PRS configured on a non-serving cell. If the UE is configured for transmission of *SRS-PosResource* in RRC\_INACTIVE mode, the configured *spatialRelationInfoPos* is also applicable.  The UE is not expected to transmit multiple SRS resources with different spatial relations in the same OFDM symbol.  If the UE is not configured with the higher layer parameter *spatialRelationInfoPos* the UE may use a fixed spatial domain transmission filter for transmissions of the SRS configured by the higher layer parameter *SRS-PosResource* across multiple SRS resources or it may use a different spatial domain transmission filter across multiple SRS resources.  Subject to UE capability, if the UE is configured with the high layer parameter [*DifSplFiler*] for a SRS resource set configured by *SRS-PosResourceSet*, the UE is expected to use different spatial domain transmission filters across the SRS resources that are not configured with the higher layer parameter *spatialRelationInfoPos* in the SRS resource set.  In RRC\_CONNECTED mode, the UE is only expected to transmit an SRS configured by the higher layer parameter *SRS-PosResource* within the active UL BWP of the UE.  When the configuration of SRS is done by the higher layer parameter *SRS-PosResource*, the UE can only be provided with a single RS source in *spatialRelationInfoPos* per SRS resource for positioning.  For operation on the same carrier, if an SRS configured by the higher parameter *SRS-PosResource* collides with a scheduled PUSCH, the SRS is dropped in the symbols where the collision occurs.  Unless specified otherwise, the UE does not expect to be configured with *SRS-PosResource* on a carrier of a serving cell with slot formats comprised of DL and UL symbols, not configured for PUSCH/PUCCH transmission.  ========================= Unchanged parts ========================= |

This proposal is already supported by Huawei, HiSilicon, China Unicom, ZTE, Sanechips, CATT.

Companies are encouraged to check above TEI proposal and to provide feedback if any in below.

|  |  |  |
| --- | --- | --- |
| Company | Suppport (Y/N) | Comment |
| Qualcomm | N | Our view hasn’t changed compared to last time this proposal was discussed.  The proponents argue that the proposal might be useful to some extent for UL-based positioning solutions, but it is unclear to what extent. Essentially, they believe the UE should be explicitly configured to perform 'beam switching' when not configured with specific spatial relation RS. Currently, the UE may or may not perform beam switching. However, without specification support or understanding of the extent of beam switching, the number of beams it will try, and the differences between the beams (all typically up to implementation), the value of this TEI appears very limited.  In other words, even in the current specification, the UE can perform beam switching up to implementation. Even when the UE performs beam switching, the beams may still be similar to each other, or if the UE is not doing beam switching, the beams may still change due to changes in the absolute orientation of the UE. Conversely, a UE may not always be in a position to try a different beam (due to other constraints), or it may actually try a new beam in the local coordinate system, but due to the UE’s movement, the actual beam may appear the same eventually at the receiver.  We believe that one thing that is potentially missing is whether the UE reports that it attempted multiple beams or not, and not whether the UE is configured to attempt multiple beams which is what the proponents are suggesting they want to add in the specification.  Therefore, overall, we see limited value in this TEI. |
| Huawei, HiSilicon | Y | Reply to QC:  We have discussed with some UE implementations, and the answer is that currently there is no clear UE behavior for beam determination for positioning SRS without spatial relation, because there is no clear indication from network to the UE on the intention, and UE implementation may face multiple factors as well, e.g. narrow beam/omni beam.  We would make the TEI proposal a fix to enable the “beam sweeping” operation, which is also.  The issues QC mentioned, that absolute orientation change and/or movement will impact the judgement of the same beam or different beam, poses more stringent requirement in reporting beam ID, which cannot be fixed in a single TEI proposal.  In addition, reporting beam ID is only possible after UE actually transmits SRS, which is less useful from fixing the transmission in the first place. |
|  |  |  |

1. Proposal for online session

To be updated

1. Conclusion

To be updated

1. Agreements in Rel-19 TEI

RAN1#119

Agreement

* For up to 32 HARQ process numbers for TN in FR1 and FR2-1,
  + The value ranges of the new RRC parameters are defined as follows
    - harq-ProcessNumberSizeDCI-0-1-Ext-r19 with value range of ‘INTEGER (5)’,
    - harq-ProcessNumberSizeDCI-1-1-Ext-r19 with value range of ‘INTEGER (5)’,
    - harq-ProcessNumberSizeDCI-0-2-Ext-r19 with value range of ‘INTEGER (0..5)’,
    - harq-ProcessNumberSizeDCI-1-2-Ext-r19 with value range of ‘INTEGER (0..5)’,
    - harq-ProcessNumberSizeDCI-0-3-Ext-r19 with value range of ‘INTEGER (0..5)’,
    - harq-ProcessNumberSizeDCI-1-3-Ext-r19 with value range of ‘INTEGER (0..5)’.

RAN1#118bis

Agreement

For the indication of whether a UE can simultaneously perform SRS carrier switches

* *srs-SwitchingAffectedBandsListNR-r17* is the baseline for indication.
  + *Details about UE capability will be discussed in UE feature session.*
  + *The structure of UE capability signalling is reused*
* Two SRS carrier switches are considered to be simultaneous if the SRS transmission (including RF retuning time) in both CCs overlap in time.
* A UE that indicates it is not capable of simultaneous SRS carrier switching among a set of switching pairs is not expected to be configured / scheduled with simultaneous SRS carrier switching in the set of switching pairs.
* Note: except for UE capability, the spec impact is only 38.214

Agreement

* Support a maximum of 32 HARQ process numbers for TN in FR1 and FR2-1 in Rel-19.
  + Introduce new UE capabilities, by duplicating the Rel-17 UE FGs 24-8/24-9 defined for FR2-2 to FR1 and FR2-1.
    - The reporting granularity of the UE capabilities is changed to ‘per FSPC’.
  + Introduce new RRC parameters, harq-ProcessNumberSizeDCI-0-1-Ext-r19, harq-ProcessNumberSizeDCI-1-1-Ext-r19, harq-ProcessNumberSizeDCI-0-2-Ext-r19, harq-ProcessNumberSizeDCI-1-2-Ext-r19, harq-ProcessNumberSizeDCI-0-3-Ext-r19, harq-ProcessNumberSizeDCI-1-3-Ext-r19.
  + For FR1, the above downlink related parameters can only be configured when the maximum number of layers configured for PDSCH is up to 4.
  + For FR1, the above uplink related parameters can only be configured when the maximum number of layers configured for PUSCH is up to 4.

Reference

[1] R1-2501418 Enhancement of CDM DMRS port allocation combinations for enhanced uplink and downlink performance Tejas Network Limited

[2] R1-2500579 Rel-19 TEI on UE frequency hopping for positioning ZTE Corporation, Sanechips

[3] R1-2500615 On TEI-19 Ericsson

[4] R1-2500809 Rel-19 TEI proposal on remaining ambiguities with SRS carrier switching Apple

[5] R1-2501034 Proposals for TEI19 MediaTek Inc.

[6] R1-2501180 TEI proposal on SR triggered SSSG fallback Qualcomm Incorporated

[7] R1-2501284 TEI19: Counting of active NZP-CSI-RS resources Nokia, Apple, Ericsson, MediaTek, NTT DOCOMO, Spreadtrum

[8] R1-2501323 Enhancement of SRS beamforming for FR2 positioning Huawei, HiSilicon, China Unicom, ZTE, Sanechips, CATT

[9] R1-2410891 FL Summary #3 on Rel-19 TEIs Moderator (NTT DOCOMO, INC.)

[10] RP-191602 Handling of TEI & contribution submission in RAN WGs for NR and LTE 3GPP RAN TSG and WG1/2/3/4 Chairmen

[11] RP-210826 Handling of TEI CRs ETSI MCC

Appendix: TEI guidance in [8]

**A. TEI Work Item codes shall only be used for small technical enhancements and improvements.**

This is how TEI was and is defined and it means that bigger topics should be done in an own WI.

**B. A TEI CR set shall be fully completed within one TSG cycle/quarter in all affected WGs.**

This requirement from TR 21.900 was never challenged. It also clarifies that only complete sets can be approved.

**C. TEI Work Item codes shall not be used where another appropriate Work Item code exists.**

This repeats the rule from TR 21.900 and it means that TEI cat.F CRs shall be an exception. Note: The CR author is supposed to find out which former CR introduced an error in the spec and the cat.F correction should then use the same WI code. So in theory, cat.F TEI CRs should only be needed to correct cat.B/C TEI CRs of the past.

D. Inter-TSG aspect:

**D1. Normally, for TSG SA/CT work that requires cat.B/C CRs from RAN WGs a RAN WI is required..**

This is what RAN applied in the last decade (if not longer). This also covers the strong discouragement of cross TSG TEI CRs expressed in RP-191602 slide 3.

**D2. In case the RAN work triggered via a TSG SA/CT WI\* is small and it affects only one RAN WG, then the RAN WG CR(s) shall use the WI code\* of the TSG SA/CT WI that triggered this work.   
NOTE: \*: provisional WI codes, companion WIDs/"mini-WIDs" are not meant here but already TSG approved proper WIs.**

This is what RAN applied in the last decade. Note: As TSG RAN has no agenda items for all SA/CT WIs, this sort of CRs were usually submitted under a TEI agenda item but for traceability we shall not use a TEI WI code on such a CR.  
(Note: D2. could work also in the other direction, i.e. if there is a RAN WI for which is turns out that only a small change would be needed in one SA WG or one CT WG. But you better consult TSG SA/CT before trying this approach.)

**D3. It is not possible to trigger work in RAN WGs via TEI CRs coming from TSG SA/CT or SA/CT WGs. The same applies for the reverse direction.**

Otherwise "small" (TEI) but affecting multiple TSGs would contradict each other. (Apart from this, inter-TSG TEI CRs would also not work well together for cat.B/C CRs if SA/CT use a companion WID but RAN does not.).

E. Inter-RAN WG aspects:

Section E. is addressing the problem that multiple RAN WGs work on the same feature but it is still intended to not have an own WI for this but to cover this feature under cat.B/C TEIxx (this is challenging time-wise and coordination-wise and therefore not a recommended approach but it is not forbidden). As RAN5 has introduced specific rules regarding the testing of TEI CRs, see RP-200931 [5] and since they use a different WI code (TEIxx\_Test) and testing work is usually coming at a later stage, this section E. is considering linked TEI CRs of RAN1/2/3/4.

In a similar way: RAN1/2/3/4 Core part work happens usually in the same time interval while RAN4 Perf. part work usually happens at the end of or after the RAN4 Core part work. In other words, having a TEI CR package that combines Core and Perf. part work requires a very careful timing to not violate requirement B.

RP-191602 [2] provided some guidance on Cross-WG TEI CRs in RAN WGs:

- Cross WG TEI CRs are strongly discouraged

- RAN1/2 TEI proposals with RAN4 impact to core requirements are strongly discouraged

- **RAN2 impact of RAN1/4-led TEI CRs shall be limited to RRC signalling of configuration parameters and UE capabilities (no MAC impact, no RRC procedural impact, etc.)**

Note: Ideally one RAN WG would take the decision about whether a TEI feature should be introduced or not and other RAN WGs then accept this decision and contribute their TEI CRs.

But as this guidance was not forbidding Cross-WG TEI CRs in RAN WGs some more requirements had to be defined how to guarantee traceability, consistency and visibility of this sort of CRs.

The basic requirements discussed in section E. were endorsed by TSG RAN in RP-202867 [7] but further clarification/guidance is provided here.

**E.1 It is mandatory to fill out the "other specs affected" for all CRs, i.e. either Yes or No shall be ticked and  
 if Yes is ticked at least the TS/TR shall be indicated and this for the present WG and all other WGs that have CRs linked to the present CR.  
 TEI CRs missing this information or having wrong information shall not be approved.**

These requirements were always there. But some clarification is required.

- "other specs affected" is used to link CRs that belong together which is essential for cat.F CRs and for cat.B/C TEI CRs to guarantee that a complete set of CRs is approved. Note: For cat.B CRs of other WIs, we have an extra RAN agenda item for each of them and we usually approve all stage 3 CRs together. But for closed WIs or TEI CRs we have normally just one agenda item collecting a larger number of CRs and then the relation of the CRs becomes unclear if "other specs affected" is not filled out properly.  
 NOTE: Other specs affected should also list inter-TSG related CRs if it is clear that these CRs can only be applied together. This usually involves a conditional approval at TSG level

- "Other core specifications" under "Other specs affected" on the CR cover: Going back to RAN #46 of Dec.2009 where TSG RAN decided to have separate Core part WIs and Perf. part WIs (in RP-091374) you can see from comparing with CR form v9.6 that the term "Other core specifications" is only intended to distinguish those specs from "Test specifications" and "O&M specifications" but not to exclude Perf. part related specs from "Other specs affected": This means as long as CR form is not updated "Other core specifications" should cover Core part specifications AND Perf. part specifications as defined in TSG RAN.

- "Test specifications" under "Other specs affected" on the CR cover: Testing under TSG RAN is either done in RAN4 or in RAN5. Since RAN5 has separate WIs for testing that usually are also just started after RAN4 work is completed, it would not make much sense to reference RAN5 specs on a RAN4 CR as it is clear that the RAN5 CR will just follow later (here it is more appropriate to review the corresponding RAN5 WI when it becomes available).  
 Examples where it could make sense to fill out this field: For RAN4 CRs to a WI that involve BS testing for the same WI/a linked CR. For CRs to SI TRs to which RAN4 and RAN5 contribute together with CRs. For a cat.B/C TEI CR of RAN1/2/3/4 that has a corresponding CR in RAN5 under TEIx\_Test.

- "O&M Specifications" under "Other specs affected" on the CR cover: O&M specifications are handled by SA5. SA5 has usually separate WIs for their changes and RAN CRs are not submitted to TSG SA or SA5, therefore the benefit of this field is higher within TSG SA. Nevertheless, there may be cases of tighter cooperation of RAN WGs with SA5 (like Minimization of drive tests) where it will be beneficial to indicate a related SA5 change coming to the same TSG meeting.

- What needs to be done if WGx is assuming that TS/TR ab.cde of WGy is affected but they are not sure?  
 WGx should list under "other comments" on the CR cover: "WGx thinks that also TS/TR ab.cde of WGy could be impacted by this CR." Depending on the probability WGx would tick Yes (and mention the spec) or No.  
 CR proponents shall check this with WGy (e.g. by sending an LS from WGx to WGy, submitting a Tdoc in WGy, talking to the chairman of WGy) so that at the TSG meeting where WGx submits this CR for approval it is either clear that there is no impact or that the WGy CR is available as well for approval.  
 NOTE: MCC has the possibility to correct CR covers before RAN submission (e.g. remove a potential impact comment if it turned out that there is no impact). But CR proponents need to inform MCC about this.  
 Incomplete CR sets (i.e. WGx CR there but linked WGy CR not available) can not be approved at TSG level and since cat.B/C TEI CRs have to be completed within one quarter, this is time critical.   
 Therefore very good preparation of cat.B/C TEI CRs which affect multiple WGs is essential.

**E.2 Each TEI cat.B/C CR and each TEI cat.F/A CR that corrects functionality related to an earlier TEI cat.B/C CR shall have a unique TEI identifier in square brackets [ ] at the end of the CR title on the CR cover sheet.  
 TEI cat.B/C CRs without such a unique TEI identifier cannot be approved at RAN.**

This principle was endorsed in RP-202867 [7] and further guidance for this approach is provided here:

- The TEI identifier should be short (4 to 18 characters using letters and/or digits or using \_ or - but avoiding blanks or other special characters which will complicate searches) and characterize the CR.

- The originating company takes care that related CRs in other WGs use the same TEI identifier.

- Unique identifiers are not added retroactively: Cat.F/A CRs for TEIs which did not have a unique identifier by RAN #91e will not get a unique identifier.

- Apart from plain TEI CRs, the unique TEI identifiers shall also be applied to NR\_newRAT-Core, TEIxx CRs because NR\_newRAT-Core was the huge WI for 5G.

- As the unique idendifiers are part of the CR title, they will be automatically stored in the CR database. Therefore CR authors have to make sure that the complete CR title in 3GU is in line with the title on the CR cover.

- For cases where it is not 100% clear whether a linked CR was agreed in another WG, it is the task of the CR author to double-check the situation in the week after the WG meeting and to inform MCC in case any updates of CR titles are required otherwise they risk that not properly linked CRs are rejected at RAN level.

**E.3 WG chairman reports report to TSG RAN about all agreed and technically endorsed cat.B/C TEI CRs of the last quarter. For each unique TEI identifier all related CRs of the considered WG are listed plus the corresponding CRs in the other WGs (if there are any) or the potential impacts on other WGs.**

How this is done is up to the chairman (e.g. it can be a slide with a table like the examples below, it can be an extra Excel table included in the zip file of the WG status report). The WG chairman could request inputs from MCC (Tdoc list filtered for agreed/endorsed TEI CRs) and all CR authors of the WG who had agreed/endorsed TEI CRs (to clarify whether there were related CRs in other WGs) and this could be condensed in such an overview.

Examples:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **unique TEI identifier** | **feature** | **Rel** | **CRs in own WG** | **CRs in/impacts on other WGs** |
| [HDUPLEX\_unpaired] | Modification to half duplex in unpaired spectrum | Rel-16 | R1-211234 (38.213, cat.C) | R2-2112345 (38.331 cat.C) |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **unique TEI identifier** | **feature** | **Rel** | **CRs in own WG** | **CRs in/impacts on other WGs** |
| [intRAT\_HO\_NR\_ENDC] | Introduction of inter-RAT handover NR to ENDC | Rel-16 | R2-2123456 (38.306, cat.B)  R2-2123457 (38.331, cat.B) | potential impact on 38.133 for .... ? |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **unique TEI identifier** | **feature** | **Rel** | **CRs in own WG** | **CRs in/impacts on other WGs** |
| [E2E\_delay\_meas] | E2E delay measurement for QoS monitoring for URLLC | Rel-16 | R3-211234 (38.413, cat.B)  R3-211235 (38.423, cat.B)  R3-211236 (38.463, cat.B) | none |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **unique TEI identifier** | **feature** | **Rel** | **CRs in own WG** | **CRs in/impacts on other WGs** |
| [DRX\_coord] | Introduction of DRX coordination | Rel-16 | R4-2123456 (38.133, cat.B) | R2-2112345 (38.331, cat.B) |

- what's the main goal of this activity? To have a checkpoint in each WG (RAN1/2/3/4) where after the WG meeting it is checked whether a complete CR set is available for all cat.B/C TEI features for TSG RAN; by comparing the tables of different WGs a cross-check is possible.

- should this activity be limited to cat.B/C TEI CRs only? It would be useful to also list cat.F/A TEI CRs to correct formerly as cat.B/C TEI introduced features (corresponding CRs will have [ ] at the end of the Tdoc title and CR proponents will inform the WG chairman if there were any agreed/endorsed CRs lile this)

- what about CRs for WI code combinations like "<WI code>, TEIxx"?  
 These CRs appear when <WI code> was a WI of a Rel-yy with yy<xx.  
 These CRs are usually well identified via <WI code> and would therefore not need any more tracking.  
 But one exception should be made for <WI code> = NR\_newRAT-Core as this was the generic NR WI that introduced the whole 5G and if we do not track "NR\_newRAT-Core, TEIxx" as well, it could be used as a way to bypass this tracking activity.

- How big is the expected effort: Double-checking TEI16 CRs of 2020, we had about 110 cat.B/C CRs from RAN1/2/3/4 together with ~50% TEI16, ~25% "NR\_newRAT-Core, TEIxx" and ~25% other WI code, TEI16 CRs. So this means ~20 CRs per TSG RAN meeting plus a few cat.F/A corrections to former cat.B/C TEIxx CRs.

- What is TSG RAN supposed to do with the tables of TEI CRs from the WG chairmen? The impacts on other WGs have to be carefully reviewed (the earlier the tables from the WG chairmen are available the better, ideally at latest 1 week after the WG meeting): If WGx expected a CR from WGy but WGy did not provide such a CR, then there are 2 possibilities: The CR from WGy was not needed (then this will be documented e.g. in the RAN minutes or in a revised WG chairman's report) or WGy did not manage to conclude on a CR which means we have an incomplete CR set that cannot be approved. It is then up to TSG RAN to discard the incomplete CR set or to request a company CR for the WGy spec (if it is easy to solve) or to consider the start of a new WI (if the problem is more complex).

**E.4 MCC will support this tracking activity with a list of TEI CRs for a considered release that were handled at RAN and that have the unique TEI identifier.**

- The resulting Tdoc list of each RAN meeting includes already a complete list of all CRs handled in this meeting. An additional list will be added after RAN #92e listing the TEI CRs with unique TEI identifiers in [ ].  
 After RAN #93e, a further list will be appended to the TEI CR list so that in the end a list for all TEI cat.B/C CRs (and their corresponding cat.F/A corrections) will develop that allows easy search and filtering for new TEI features.

- Such a list could be generated per release and will allow an improved visibility and tracing of new TEI features.  
 Note: Due to the unique TEI identifiers and the proper documentation as outcome of the RAN meetings, also 3GU will allow to search for TEI CR sets.