3GPP TSG RAN WG1 #101 R1-200xxxx

e-Meeting, May 20th – June 5th, 2020

Source: Moderator (OPPO)

Title: Discussion on Issue#b-11 in Email Thread 3

Agenda Item: 7.2.6.2

Document for: Discussion and Decision

1. Introduction

Rel-16 enhancement on MIMO WID includes objectives of enhancing multi-TRP/Panel transmission with ideal and non-ideal backhaul. During the work of rel-16, designs for multiple-PDCCH based and single-PDCCH based multi-TRP/Panel transmission were discussed and specified. This document provides the discussion for Issue #b-11 in multi-TRP email thread 3:

* Issue #b-11 to Capture the missing conditions for scheme 4 and scheme 2a/2b/3 in TS 38.214 and also to correctly capture condition 1 for Scheme 4 in TS 38.214.

# Issue#b-11: capturing the missing conditions for scheme 4 and scheme 2a/2b/3 in TS 38.214

**Reason for changes and background**:

In RAN1#99, we made the following agreement on conditions for those URLLC enhancement schemes of single-DCI based multi-TRP transmission:

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| **Agreement**Following TCI state and joint schemes are supported

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|  |  TCI states | CDM groups | URLLCRepNum | URLLCSchemeEnabler | UE Behavior  |
| 0 (in spec draft) | 1 | >=1 | Not applicable | Not applicable | Rel 15  |
| A (one scheme) | 1 | 1 | Condition 1 | Configured or not configured  | "Scheme 4" with repetition from the same TRPLimitations agreed for Scheme 4 apply |
| A’ (one scheme) | 1 | >=1 | Condition 2 | Not configured  | Rel 15  |
| B (in spec draft) | 2 | 1 | Condition 1 | Not configured  | Scheme 4 |
| C (in spec draft) | 2 | 2 | Condition 2 | Not configured  | 1a/NCJT |
| E (in spec draft) | 2 | 2 | Condition 4 | Not configured  | 1a/NCJT |
| F (in spec draft) | 2 | 1 | Condition 4 | Configured  | Scheme 2a/2b/3 |
| D’’ (one scheme) | 2 | 2 | Condition 4 | Configured  | 1a/NCJT |
| G’ (one scheme) | 1 | >=1 | Condition 2 | Configured  | Rel 15  |
| G (one scheme) | 1 | >=1 | Condition 4 | Configured  | Rel 15  |

Note:* Condition 1: indicates ~~at least~~ one entry in *pdsch-TimeDomainAllocationList* containing *URLLCRepNum* (>1) in *TDRA by DCI*
* Condition 2: indicates one entry in *pdsch-TimeDomainAllocationList* having no *URLLCRepNum by DCI*, but at least one entry having URLLCRepNum
* Condition 4: None of entry in TDRA contains *URLLCRepNum*
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Furthermore, in RAN1 #100bis e-Meeting, we made the following agreement in a reply LS to RAN2:

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| *From RAN1 perspective, schemes 2a/2b/3 and scheme 4 are mutually exclusive, which will be captured (with text proposal to be finalized) in TS38.214, Section 5.1.* |

Companies [1][2][4][9][14] discussed this issue in the contribution and most of them proposed TP to capture the missing conditions:

* [4] proposed to capture the missing conditions of URLLC scheme switching. [4] also propose to align the RRC parameter name in TS 38.214 with 38.331: the RRC parameter in 38.311 to configure scheme 2a/2b/3 is repetitionSchemeConfig-r16 and the RRC parameter for scheme 4 repetition number is repetitionNumber-r16. [4] also suggested that condition 1 for scheme 4 of Row A and B are not correctly captured too. Corresponding TP is provided by [4].
* [1] proposed to capture the condition 4 for scheme 2a/2b/3 and also “RepSchemeEnabler is not configured” for scheme 4. Corresponding TP is provided by [1]
* [2] also proposed TP to capture the missing condition for scheme4 and scheme 2a/2b/3 in TS 38.214
* [9] also proposed TP to capture the missing conditions for scheme 4 and scheme 2a/2b/3 in TS 38.214
* While [14] proposed to support dynamic switching between scheme 2a/2b/3 and 4.

Based on those two agreements made in RAN1#99 and RAN1#100bis e-Meeting and also the proposals by companies, FL suggests we update the TS 38.214 to capture those missing conditions for URLLC schemes.

A draft TP is proposed based on the TPs proposed in [1][2][4] and [9]:

**Proposal: adopt the following TP for TS 38.214**

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| 5.1 UE procedure for receiving the physical downlink shared channel\*\*\* Unchanged text is omitted \*\*\*When a UE is configured by higher layer parameter *RepetitionNumber-r16* set to one of '*FDMSchemeA'*, '*FDMSchemeB'*, '*TDMSchemeA'* andconfigured by the higher layer parameter *PDSCH-config* that indicates none of the entries in *pdsch-TimeDomainAllocationList* containing *repetitionNumber-r16*, if the UE is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* and DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)"*.- When two TCI states are indicated in a DCI and the UE is set to '*FDMSchemeA',* the UE shall receive a single PDSCH transmission occasion of the TB with each TCI state associated to a non-overlapping frequency domain resource allocation as described in Clause 5.1.2.3. - When two TCI states are indicated in a DCI and the UE is set to '*FDMSchemeB'*, the UE shall receive two PDSCH transmission occasions of the same TB with each TCI state associated to a PDSCH transmission occasion which has non-overlapping frequency domain resource allocation with respect to the other PDSCH transmission occasion as described in Clause 5.1.2.3. - When two TCI states are indicated in a DCI and the UE is set to '*TDMSchemeA'*, the UE shall receive two PDSCH transmission occasions of the same TB with each TCI state associated to a PDSCH transmission occasion which has non-overlapping time domain resource allocation with respect to the other PDSCH transmission occasion and both PDSCH transmission occasions shall be received within a given slot as described in Clause 5.1.2.1. When a UE is not configured with higher layer parameter *RepetitionNumber-r16* and the UE is configured by the higher layer parameter *PDSCH-config* that indicates at least one entry in *pdsch-TimeDomainAllocationList* containing *RepetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocatio*n, the UE may expect to be indicated with one or two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* together with the DCI field "*Time domain resource assignment*' indicating an entry in *pdsch-TimeDomainAllocationList* which contain *RepetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocatio*n and DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)"*. - When two TCI states are indicated in a DCI with '*Transmission Configuration Indication*' field, the UE may expect to receive multiple slot level PDSCH transmission occasions of the same TB with two TCI states used across multiple PDSCH transmission occasions as defined in Clause 5.1.2.1. - When one TCI state is indicated in a DCI with '*Transmission Configuration Indication*' field, the UE may expect to receive multiple slot level PDSCH transmission occasions of the same TB with one TCI state used across multiple PDSCH transmission occasions as defined in Clause 5.1.2.1. When a UE is not indicated with a DCI that DCI field "*Time domain resource assignment*' indicating an entry in *pdsch-TimeDomainAllocationList* which contain *RepetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocatio*n, and it is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* and DM-RS port(s) within two CDM group in the DCI field "*Antenna Port(s)"*, the UE may expect to receive a single PDSCH where the association between the DM-RS ports and the TCI states are as defined in Clause 5.1.6.2. When a UE is not indicated with a DCI that DCI field "*Time domain resource assignment*' indicating an entry in *pdsch-TimeDomainAllocationList* which contain *RepetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocatio*n, and it is indicated with one TCI states in a codepoint of the DCI field *'Transmission Configuration Indication',* the UE procedure for receiving the PDSCH upon detection of a PDCCH follows Clause 5.1. \*\*\* Unchanged text is omitted \*\*\*5.1.2.1 Resource allocation in time domain\*\*\* Unchanged text is omitted \*\*\*When a UE is configured by the higher layer parameter *repetitionSchemeConfig-r16* set to '*TDMSchemeA',* andconfigured by the higher layer parameter *PDSCH-config* that indicates none of the entries in *pdsch-TimeDomainAllocationList* containing *repetitionNumber-r16* and indicated DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)"*, the number of PDSCH transmission occasions is derived by the number of TCI states indicated by the DCI field *'Transmission Configuration Indication'* of the scheduling DCI*.* - If two TCI states are indicated by the DCI field '*Transmission Configuration Indication*', the UE is expected to receive two PDSCH transmission occasions, where the first TCI state is applied to the first PDSCH transmission occasion and resource allocation in time domain for the first PDSCH transmission occasion follows Clause 5.1.2.1. The second TCI state is applied to the second PDSCH transmission occasion, and the second PDSCH transmission occasion shall have the same number of symbols as the first PDSCH transmission occasion. If the UE is configured by the higher layers with a value$ \overbar{K}$ in *StartingSymbolOffsetK*, it shall determine that the first symbol of the second PDSCH transmission occasion starts after $\overbar{K}$ symbols from the last symbol of the first PDSCH transmission occasion. If the value$ \overbar{K}$ is not configured via the higher layer parameter *StartingSymbolOffsetK*, $\overbar{K}$ = 0 shall be assumed by the UE. The UE is not expected to receive more than two PDSCH transmission layers for each PDSCH transmission occasion. For two PDSCH transmission occasions, the redundancy version to be applied is derived according to Table 5.1.2.1-2, where $n=0, 1$ applied respectively to the first and second TCI state.- Otherwise, the UE is expected to receive a single PDSCH transmission occasion, and the resource allocation in the time domain follows Clause 5.1.2.1. When a UE configured by the higher layer parameter *PDSCH-config* that indicates at least one entry in *pdsch-TimeDomainAllocationList* contain*RepetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocatio*n, - If two TCI states are indicated by the DCI field 'Transmission Configuration Indication' together with the DCI field "Time domain resource assignment' indicating an entry in pdsch-TimeDomainAllocationList which contain *RepetitionNumber-r16* in PDSCH-TimeDomainResourceAllocation and DM-RS port(s) within one CDM group in the DCI field "Antenna Port(s)" and the UE is not configured with higher layer *repetitionSchemeConfig-r16*, the same SLIV is applied for all PDSCH transmission occasions, the first TCI state is applied to the first PDSCH transmission occasion and resource allocation in time domain for the first PDSCH transmission occasion follows Clause 5.1.2.1.  When the value indicated by *RepetitionNumber-r16* in PDSCH-TimeDomainResourceAllocation equals to two, the second TCI state is applied to the second PDSCH transmission occasion. When the value indicated by *RepetitionNumber-r16* in PDSCH-TimeDomainResourceAllocation is larger than two, the UE may be further configured to enable CycMapping or SeqMapping in RepTCIMapping.\*\*\* Unchanged text is omitted \*\*\*- If one TCI state is indicated by the DCI field 'Transmission Configuration Indication' together with the DCI field "Time domain resource assignment' indicating an entry in pdsch-TimeDomainAllocationList which contain *RepetitionNumber-r16* in PDSCH-TimeDomainResourceAllocation and DM-RS port(s) within one CDM group in the DCI field "Antenna Port(s)", the same SLIV is applied for all PDSCH transmission occasions, the first PDSCH transmission occasion follows Clause 5.1.2.1, the same TCI state is applied to all PDSCH transmission occasions. The UE may expect that each PDSCH transmission occasion is limited to two transmission layers. For all PDSCH transmission occasions, the redundancy version to be applied is derived according to Table 5.1.2.1-2, where $n$ is counted considering PDSCH transmission occasions. \*\*\* Unchanged text is omitted \*\*\*5.1.2.3 Physical resource block (PRB) bundling\*\*\* Unchanged text is omitted \*\*\*For a UE configured by the higher layer parameter *repetitionSchemeConfig-r16* set to '*FDMSchemeA' or* '*FDMSchemeB'* andconfigured by the higher layer parameter *PDSCH-config* that indicates none of the entries in *pdsch-TimeDomainAllocationList* containing *repetitionNumber-r16, and* when the UE is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication* and DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)*", - If  is determined as "wideband", the first $\left⌈\frac{n\_{PRB}}{2}\right⌉$ PRBs are assigned to the first TCI state and the remaining $\left⌊\frac{n\_{PRB}}{2}\right⌋$ PRBs are assigned to the second TCI state, where $n\_{PRB} $is the total number of allocated PRBs for the UE. - If  is determined as one of the values among {2, 4}, even PRGs within the allocated frequency domain resources are assigned to the first TCI state and odd PRGs within the allocated frequency domain resources are assigned to the second TCI state. - The UE is not expected to receive more than two PDSCH transmission layers for each PDSCH transmission occasion.For a UE configured by the higher layer parameter *repetitionSchemeConfig-r16* set to '*FDMSchemeB'* andconfigured by the higher layer parameter *PDSCH-config* that indicates none of the entries in *pdsch-TimeDomainAllocationList* containing *repetitionNumber-r16,* andwhen the UE is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication* and DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)",* each PDSCH transmission occasion shall follow the Clause 7.3.1 of [4, TS 38.211] with themapping to resource elements determined by the assigned PRBs for corresponding TCI state of the PDSCH transmission occasion, and the UE shall only expect at most two code blocks per PDSCH transmission occasion when a single transmission layer is scheduled and a single code block per PDSCH transmission occasion when two transmission layers are scheduled. For two PDSCH transmission occasions, the redundancy version to be applied is derived according to Table 5.1.2.1-2, where $n=0, 1$ are applied to the first and second TCI state, respectively.\*\*\* Unchanged text is omitted \*\*\*5.1.3.1 Modulation order and target code rate determination\*\*\* Unchanged text is omitted \*\*\*For a UE configured with *FDMSchemeB* andconfigured by the higher layer parameter *PDSCH-config* that indicates none of the entries in *pdsch-TimeDomainAllocationList* containing *repetitionNumber-r16*, and when the UE is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication* and DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)*", the determined modulation order of PDSCH transmission occasion associated with the first TCI state is applied to the PDSCH transmission occasion associated with the second TCI state. \*\*\* Unchanged text is omitted \*\*\*5.1.3.2 Transport block size determination\*\*\* Unchanged text is omitted \*\*\*For a UE configured with *FDMSchemeB* andconfigured by the higher layer parameter *PDSCH-config* that indicates none of the entries in *pdsch-TimeDomainAllocationList* containing *repetitionNumber-r16* and indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication* and DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)*", the TBS determination follows the steps 1-4 with the following modification in step 1: a UE determines the total number of REs allocated for PDSCH ()$N\_{RE})$ by $N\_{RE}= \overbar{N}\_{RE}^{'}\* n\_{PRB}$, where *nPRB* is the total number of allocated PRBs corresponding to the first TCI state. and the determined TBS of PDSCH transmission occasion associated with the first TCI state is also applied to the PDSCH transmission occasion associated with the second TCI state.\*\*\* Unchanged text is omitted \*\*\*5.1.6.2 DM-RS reception procedure\*\*\* Unchanged text is omitted \*\*\*When a UE is not indicated with a DCI that DCI field "*Time domain resource assignment*' indicating an entry in *pdsch-TimeDomainAllocationList* which contain *RepetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocatio*n and it is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* and DM-RS port(s) within two CDM group in the DCI field "*Antenna Port(s)",* - the first TCI state corresponds to the CDM group of the first antenna port indicated by the antenna port indication table, and the second TCI state corresponds to the other CDM group.\*\*\* Unchanged text is omitted \*\*\*5.1.6.3 PT-RS reception procedure\*\*\* Unchanged text is omitted \*\*\*When a UE is not indicated with a DCI that DCI field "*Time domain resource assignment*' indicating an entry in *pdsch-TimeDomainAllocationList* which contain *RepetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocatio*n, and if the UE is configured with the higher layer parameter *maxNrofPorts* equal to *n2*, and if the UE is indicated with two TCI states by the codepoints of the DCI field *'Transmission Configuration Indication'* and DM-RS port(s) within two CDM group in the DCI field "*Antenna Port(s)"*, the UE shall receive two PT-RS ports which are associated to the lowest indexed DM-RS port among the DM-RS ports corresponding to the first/second indicated TCI state, respectivelyWhen a UE configured by the higher layer parameter *repetitionSchemeConfig-r16* set to '*FDMSchemeA'* or '*FDMSchemeB'* andconfigured by the higher layer parameter *PDSCH-config* that indicates none of the entries in *pdsch-TimeDomainAllocationList* containing *repetitionNumber-r16,* and the UE is indicated with two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication* and DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)*", the UE shall receive a single PT-RS port which is associated with the lowest indexed DM-RS antenna port among the DM-RS antenna ports assigned for the PDSCH, a PT-RS frequency density is determined by the number of PRBs associated to each TCI state, and a PT-RS resource element mapping is associated to the allocated PRBs for each TCI state.\*\*\* Unchanged text is omitted \*\*\* |

 Please input your views and comments on this TP draft:

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| --- | --- |
| Company | Views and comments |
| Apple | Support the TP |
| OPPO | Support the TP. |
| ZTE | Agree in principle. Some typos should be corrected, e.g. yellow parts should be replaced by ‘ *repetitionSchemeConfig-r16*’.In addition, this part will be changed if MTRP can also be used for DCI format 1\_2. |
| MediaTek | Agree in principle. There are a few typos. The name *RepSchemeEnabler* should be replaced by *repetitionScheme-r16*, instead of *RepetitionSchemeConfig-r16* or *repetitionNumber-r16*. Besides, the first letter of *repetitionScheme-r16* and *repetitionNumber-16* should be lower case. |
| vivo | Agree in principle.Just one comment: From the agreement on Scheme 4 and "Scheme 4" with repetition from the same TRP, the conditions are slightly different on whether *repetitionSchemeConfig-r16* is configured or not.

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|  TCI states | CDM groups | URLLCRepNum | URLLCSchemeEnabler | UE Behavior  |
| 1 | 1 | Condition 1 | Configured or not configured  | "Scheme 4" with repetition from the same TRPLimitations agreed for Scheme 4 apply |
| 2 | 1 | Condition 1 | Not configured  | Scheme 4 |

For "Scheme 4" with repetition from the same TRP, UE behavior is different to some extent:When applies the condition of “*repetitionSchemeConfig-r16*” configured or not configured, it means when *repetitionSchemeConfig-r16* is configured, the UE support DCI-based dynamic switching between "Scheme 4" with repetition from the same TRP and scheme 2a/2b/3 depending on the number of TCI states and *repetitionNumber-16* indicated in the scheduling DCI.When applies the condition of “*repetitionSchemeConfig-r16*” not configured, it means when *repetitionSchemeConfig-r16* is configured, the UE is never able to switch to "Scheme 4" with repetition from the same TRP.To exactly reflect the agreement, the TP provided by the FL can be revised as:================================When a UE ~~is not configured with higher layer parameter~~ *~~RepetitionNumber-r16~~* ~~and the UE~~ is configured by the higher layer parameter *PDSCH-config* that indicates at least one entry in *pdsch-TimeDomainAllocationList* containing *RepetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocatio*n, the UE may expect to be indicated with one or two TCI states in a codepoint of the DCI field *'Transmission Configuration Indication'* together with the DCI field "*Time domain resource assignment*' indicating an entry in *pdsch-TimeDomainAllocationList* which contain *RepetitionNumber-r16* in *PDSCH-TimeDomainResourceAllocatio*n and DM-RS port(s) within one CDM group in the DCI field "*Antenna Port(s)"*. - When two TCI states are indicated in a DCI with '*Transmission Configuration Indication*' field, and the UE is not configured with higher layer parameter *RepetitionNumber-r16*, the UE may expect to receive multiple slot level PDSCH transmission occasions of the same TB with two TCI states used across multiple PDSCH transmission occasions as defined in Clause 5.1.2.1. - When one TCI state is indicated in a DCI with '*Transmission Configuration Indication*' field, the UE may expect to receive multiple slot level PDSCH transmission occasions of the same TB with one TCI state used across multiple PDSCH transmission occasions as defined in Clause 5.1.2.1.================================= |
| QC | The TP has some typos as mentioned by other companies. Also, instead of mentioning the full set of conditions in every instant, we can simply have a statement in Section 5.1 as “A UE does not expect to be configured with *repetitionScheme-r16* if the UE is configured with higher layer parameter *repetitionNumber-16*”This should be the case even if both DCI formats 1\_1 and 1\_2 are allowed (otherwise, dynamic stitching is possible by using different DCI formats, which is not aligned with the agreement). Regarding "Scheme 4" with repetition from the same TRP, even though we agreed the condition is independent of whether *repetitionScheme-r16* is configured or not, dynamic switching between “Scheme 4” with one TCI state and schemes 2a/2b/3 is not allowed in the agreement. This is because of “condition 4” is row F (schemes 2a/2b/3 are applicable only if no TDRA entry has *repetitionNumber-16*).  |

1. Reference
2. R1-2003397 On remaining issues on M-TRP vivo
3. R1-2003469 Maintenance of multi-TRP enhancements ZTE
4. R1-2003531 Remaining issues on multi-TRP in R16 Huawei, HiSilicon
5. R1-2003627 Discussion on remaining issues of multi-TRP/panel transmission CATT
6. R1-2003660 Remaining issues on multi-TRP transmission MediaTek Inc.
7. R1-2003742 Corrections to multi-TRP Intel Corporation
8. R1-2003819 Remaining issues on multi-TRP/panel transmission Lenovo, Motorola Mobility
9. R1-2003881 On Rel.16 multi-TRP/panel transmission Samsung
10. R1-2003928 Text proposals on enhancements on multi-TRP/panel transmission LG Electronics
11. R1-2003954 Remaining issues on multi-TRP/panel transmission CMCC
12. R1-2003987 Discussion on remaining issues of multi-TRP operation Spreadtrum Communications
13. R1-2004047 Text proposals for enhancements on multi-TRP and panel Transmission OPPO
14. R1-2004229 Remaining issues for Multi-TRP enhancement Apple
15. R1-2004265 Maintenance of Rel-16 Multi-TRP operation Nokia, Nokia Shanghai Bell
16. R1-2004311 Remaining issues on multi-TRP transmission NEC
17. R1-2004395 Remaining issues on multi-TRP/panel transmission NTT DOCOMO, INC
18. R1-2004432 Remaining issues on Multi-TRP/Panel Transmission Ericsson
19. R1-2004463 Multi-TRP Enhancements Qualcomm Incorporated
20. R1-2004592 Clarification on Multi-TRP URLLC Scheme 4 Convida Wireless
21. R1-2004719 FL summary #2 for Multi-TRP/Panel Transmission Moderator(OPPO)