3GPP TSG RAN WG1 #117 DRAFT R1-2404351

Fukuoka, Japan, May 20th – 24th, 2024

Agenda item: 8.1

**Source:** Moderator (MediaTek Inc.)

**Title:** Moderator summary for maintenance of Rel-18 MIMO on unified TCI extension

**Document for:** Discussion and Decision

# Introduction and plan

In this summary, the followings are provided based on the contributions from companies [1]-[22],

* Summary of companies’ views on each of maintenance issues raised by interested companies, where the maintenance issues are categorized as follow:
	+ Issue 1 – Maintenance issue on unified TCI extension
	+ Issue 2 – Maintenance issue on UL power control for UL MTRP operation
* Observations/assessments on maintenance issue(s) based on the summary of companies’ views. An assessment as follows is provided to each maintenance issue in this summary, and it can be revised based on further companies’ input to this summary:
	+ Critical (C): this includes high-priority issue (essential, pending issues, broken spec components) or editorial change that either enhances the clarity of the specs or corrects mistakes in the specs
	+ Non-essential (N): this includes all other purposes such as spec optimization and low-priority issues
	+ Editorial (E): this includes editorial issues that will be handled as editorial CRs
* Text proposal(s) would be provided for maintenance issue(s) with critical (C) and editorial (E)

# Text proposal to be discussed online

Based on the summary of companies’ views in Table 1 and Table 2, the following text proposals are provided for those maintenance issues identified as “C” or “E”.

TBD

# Discussion on maintenance issues

Issue 1 – Maintenance issue on unified TCI extension

Table 1 Summary for Issue 1

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| # | Issue | Assessment | Companies’ view (please provide your view on the assessment of each issue) |
| 1.1 | (M-DCI) BAT issue in M-DCI based MTRP operation. One contribution points out a potential issue of BAT for joint HARQ-ACK feedback in M-DCI based MTRP operation [11]* Based on current Rel-18 specification, if multiple HARQ-ACK bits are transmitted on a PUCCH/PUSCH, the indicated TCI state associated with the latest DCI with positive HARQ-ACK value is applied.
* However, in case of joint HARQ-ACK codebook for M-DCI based MTRP operation, one PUCCH/PUSCH may contain multiple HARQ-ACK bits associated with both TRPs. Based on the TS38.214 V18.1.0, the UE applies the indicated TCI state associated with the latest DCI with positive HARQ-ACK value regardless of coresetPoolIndex value. This makes cross-TRP TCI state indication which is not aligned with the previous RAN1 agreement for Rel-18 eUTCI.

FL note: The issue has been brought up for the third meeting. | C/N? | Critical (C): Docomo [15], NEC, Samsung, ZTE (conclusion is also fine)Non-essential (N): OPPO, EricssonDocomo: In RAN1#116b, 7 companies think this issue is critical and 3 companies understand the current spec. specifies cross TRP TCI state indication (R1-2402181). For opponents, could you explain how can we read the following text as “non-cross TRP beam indication” in case of joint HARQ-ACK feedback in mDCI mTRP?--5.1.5 Antenna ports quasi co-location[…]and if the UE receives more than one indicated TCI state for a CC/BWP to be applied starting from the first slot that is at least $ beamAppTime$ symbols after the last symbol of the PUCCH or the PUSCH, the indicated TCI state carried in the latest DCI in time corresponding to positive HARQ-ACK value is applied.OPPO: From our understanding, we can hardly to interpret the excerpts above as “cross TRP beam indication”. Firstly, we are all clear that this BAT is specified for the case of M-DCI MTRP. Secondly and literally, the highlighted text involves only “the indicated TCI state”, rather than both TCI states (for 2 TRPs). In our reading, we would interpret that the indicated TCI state carried in the latest DCI by default applies on a per TRP basis, therefore no cross TRP beam indication.  ZTE: Per my understanding, the current spec should be interpreted per CORESET (otherwise, it does not make sense). Alternatively, we may have a RAN1 conclusion. Ericsson: Not needed. The specification statesWhen a UE is configured with *dl-OrJointTCI-StateList* or *TCI-UL-State* and is configured by higher layer parameter *PDCCH-Config* that contains two different values of coresetPoolIndex in *ControlResourceSet*, an indicated TCI state is specific to a coresetPoolIndex value, when it is indicated by the DCI field 'Transmission Configuration Indication' in DCI format 1\_1/1\_2 associated with the coresetPoolIndex value.So an indicated TCI state is specific to a coresetPoolIndex. The highlighted paragraph should be understood in that context. In other words, for mDCI any indicated TCI state is specific to a coresetPoolIndex . |
| 1.2 | In current TS 38.214, it is specified that when two SRS resource sets with higher layer parameter usage in SRS-ResourceSet set to 'codebook' or 'nonCodebook' are configured, the UE does not expect that the first indicated TCI-State or TCI-UL-State is applied to the second SRS resource set and that the second indicated TCI-State or TCI-UL-State is applied to the first SRS resource set. However, it should be clarified that the number of SRS resource sets should be counted within *srs-ResourceSetToAddModList* or s*rs-ResourceSetToAddModListDCI-0-2*, instead of both lists.6.2.1 UE sounding procedure-----------------------------------Unchanged parts are omitted------------------------------------ When two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'nonCodebook' ~~are configured~~, the UE does not expect that the first indicated *TCI-State* or *TCI-UL-State* is applied to the second SRS resource set and that the second indicated *TCI-State* or *TCI-UL-State* is applied to the first SRS resource set.-----------------------------------Unchanged parts are omitted-----------------------------------FL note: The issue has been brought up for the first meeting. | C | Critical (C): CATT [11], Docomo, OPPO, Panasonic, Samsung, ZTE, Ericsson, XiaomiNon-essential (N):  |
| 1.3 | (S-DCI/M-DCI) Clarify that a PDCCH reception should be prioritized if a PDSCH reception scheduled before a threshold overlaps (in at least one symbol) with the PDCCH reception having QCL assumptions different from that of the firs/second indicated TCI state, for both S-DCI and M-DCI cases [2]FL note: The issue has been brought up for the third meeting. | C/N? | Critical (C): ZTE [7][8], Samsung (open to discuss)Non-essential (N): Docomo, OPPO, EricssonZTE: Regardless of reviewing the spec for other case, e.g., R17 uTCI or R15~17 mTRP operation, we have clear rule of handling this overlapping between PDCCH/CORESET and PDSCH < a threshold. If not, but overlapping occur. What’s the UE behavior? We do believe that the clear UE behavior is needed herein. Ericsson: Current specification already covers this.  |
| 1.4 | Based on current specification, when an AP CSI-RS triggered before the threshold in the same symbols of other DL signal with an indicated TCI state, if the UE is in frequency range 1, or the UE reports its capability of [default beam per coresetPoolIndex for M-DCI based MTRP] in frequency range 2, and there are two other DL signals applying the first and the second indicated TCI states, respectively, in the same symbols as the aperiodic CSI-RS, the UE shall apply the first or the second indicated TCI state to the aperiodic CSI-RS according to the higher layer configuration(s) provided to the aperiodic CSI-RS resource or aperiodic CSI-RS resource set. But actually, UE can buffer the AP CSI-RS with two TCI states if any one of the three conditions satisfied. The combination of any two conditions is unnecessary. It means the UE shall apply the first or the second indicated TCI state to the aperiodic CSI-RS according to the higher layer configuration(s) provided to the aperiodic CSI-RS resource or aperiodic CSI-RS resource set when any one of the three conditions satisfied, i.e., 1) if the UE is in frequency range 1, 2) or if the UE reports its capability of [default beam per coresetPoolIndex for M-DCI based MTRP] in frequency range 2, 3) or if there are two other DL signals applying the first and the second indicated TCI states, respectively, in the same symbols as the aperiodic CSI-RS.FL note: The issue has been brought up for the second meeting. | C/N? | Critical (C): Xiaomi [12]Non-essential (N): Docomo, OPPO, EricssonXiaomi: There are 3 conditions. Could opponents explain which condition can’t work standalone? We think UE can buffer with two beams if any one of 3 conditions satisfied. It means that:* Condition 1: if the UE is in frequency range 1, the UE shall apply the first or the second indicated TCI state to the aperiodic CSI-RS according to the higher layer configuration(s) provided to the aperiodic CSI-RS resource or aperiodic CSI-RS resource set.
* Condition 2: if the UE reports its capability of [default beam per coresetPoolIndex for M-DCI based MTRP] in frequency range 2, the UE shall apply the first or the second indicated TCI state to the aperiodic CSI-RS according to the higher layer configuration(s) provided to the aperiodic CSI-RS resource or aperiodic CSI-RS resource set.
* Condition 3: if the UE is in frequency range 2, and there are two other DL signals applying the first and the second indicated TCI states, respectively, in the same symbols as the aperiodic CSI-RS, the UE shall apply the first or the second indicated TCI state to the aperiodic CSI-RS according to the higher layer configuration(s) provided to the aperiodic CSI-RS resource or aperiodic CSI-RS resource set.

There is no doubt on Condition 1. But for Condition 2 and Condition 3, more clarification is needed. In our opinion, either Condition 2 or Condition 3 satisfied, UE can buffer data with two beams. The UE capability of Condition 3 is ‘full/partially-overlapped PDSCHs in time for Multi-DCI based multi-TRP’ (i.e., 16-2a/2a-0/2a-1) and ‘Simultaneous reception with different Type-D’ (16-2c), it is different from the capability (i.e., 16-2a-6, default beam per coresetPoolIndex for M-DCI based MTRP) in Condition 2. Capability in Condition 2 means UE can buffer with two beams if the offset between DCI and DL signals is less than timedurationQCL. The FG 16-2a and 16-2c are the prerequisites of the FG 16-2a-6. But there is no redundant between Condition 2 and Condition 3. That means if there are two overlapped DL signals but UE doesn’t support two default beams, UE can also buffer with two beams. If “and” between Condition 2 and Condition 3 is used, for the case of Condition 2 is satisfied but there is only one other DL signal or no other DL signal, the UE can only buffer data with one beam according to the current text, that is not correct. |
| 1.5 | 1. For cjtSchemeB, the second indicated TCI state is not needed to be restricted as only “joint TCI state”. Updating the second indicated TCI state for cjtSchemeB to remove the unnecessary restriction of joint TCI state.

FL note: To my understanding, PDSCH-CJT must be supported in joint DL/UL TCI mode, as agreed in RAN1#110bis. However, to align the terminology in TS 38.214 and TS 38.331, we can still use “TCI-state” to represent a joint TCI state.1. In current TS 38.214, there are some places with wording “joint/DL TCI state” or with italic “*TCI-state*” to represent joint or downlink TCI state, while there are some places only mentioning not italic “TCI-state”, leading to non-uniform expression. Update with unified form of italic “*TCI-state*” to represent joint or downlink TCI state.
2. It was agreed that for multi-TRP scenario, one TCI codepoint can update a subset of joint/DL TCI states, and/or a subset of UL TCI states, while the condition “When a UE is configured with dl-OrJointTCI-StateList and is having two indicated TCI-states” only mentions case of two joint/DL TCI states, two indicated TCI-UL-States should also be included to make it complete. Adding “and/or two indicated TCI-UL-States” to make condition complete.

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| When a UE is configured with *dl-OrJointTCI-StateList* and is having two indicated *TCI-states* and/or two indicated *TCI-UL-States*, if the UE receives a TCI codepoint mapped with a sub-set of first and second *TCI-State(s)* and/or a sub-set offirst and second *TCI-UL-State(s)*, the UE shall update the first/second *TCI-State(s)* and/or first/second *TCI-UL-State(s)* mapped to the TCI codepoint, when applicable, and keep the previously indicated first/second *TCI-State(s)* and/or first/second *TCI-UL-State(s)* that is/are not updated by the TCI codepoint. |

 | E | Editorial (E): NEC [13], Docomo, OPPO, Samsung, ZTENEC: There is one more update place for subset of updating TCI states, where UL TCI states (*TCI-UL-States*) should also be included in the condition:

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| When a UE is configured with *dl-OrJointTCI-StateList* and is having two indicated *TCI-states* and/or two indicated *TCI-UL-States*, if the UE receives a TCI codepoint mapped with a sub-set of first and second *TCI-State(s)* and/or a sub-set offirst and second *TCI-UL-State(s)*, the UE shall update the first/second *TCI-State(s)* and/or first/second *TCI-UL-State(s)* mapped to the TCI codepoint, when applicable, and keep the previously indicated first/second *TCI-State(s)* and/or first/second *TCI-UL-State(s)* that is/are not updated by the TCI codepoint. |

And regarding “joint TCI state” for CJT, thanks FL for the assessment, we are fine to keep all the mentioned TCI state for CJT to be “joint TCI state” or remove the word “joint”, at least we think the description should be aligned in the same paragraph, rather than “TCI-states” in some places and “joint TCI state” for the second indicated one, so the purple highlight should be aligned with same form as the green highlight.

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| When a UE is configured by higher layer parameter *cjtSchemePDSCH* and *dl-OrJointTCI-StateList* and is indicated with two *TCI-States* applied for PDSCH reception and reports [support for two joint TCI states for PDSCH-CJT]:- if the UE is configured with *cjtSchemeA*, the UE assumes that PDSCH DM-RS port(s) are QCLed with the DL RSs of both indicated *TCI-States* with respect to QCL-TypeA. - if the UE is configured with *cjtSchemeB*, the UE assumes that PDSCH DM-RS port(s) are QCLed with the DL RSs of both indicated *TCI-States* with respect to QCL-TypeA except for QCL parameters {Doppler shift, Doppler spread} of the second indicated *TCI-state*. |

Non-essential (N): OPPO: If we are going to add UL TCI state in this case, should we also mention that the UL TCI states are configured too as the change below?

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| When a UE is configured with *dl-OrJointTCI-StateList* and is having two indicated *TCI-states* and/or is configured with *ul-TCI-StateList* and is having two indicated *TCI-UL-States*, if the UE receives a TCI codepoint mapped with a sub-set of first and second *TCI-State(s)* and/or a sub-set offirst and second *TCI-UL-State(s)*, the UE shall update the first/second *TCI-State(s)* and/or first/second *TCI-UL-State(s)* mapped to the TCI codepoint, when applicable, and keep the previously indicated first/second *TCI-State(s)* and/or first/second *TCI-UL-State(s)* that is/are not updated by the TCI codepoint. |

ZTE: In my views, it should be possible that there is a single DL TCI state but two UL TCI states for UL mTRP operation in Rel18 eUTCI. Ericsson: Sometimes, it is better to use the looser term TCI state (without italics) when there is no risk for misunderstanding, and I think this is the case here. The proposed change: When a UE is configured with *dl-OrJointTCI-StateList* and is having two indicated *TCI-states* and/or two indicated *TCI-UL-States*seems unnecessary, since the UE must have two indicated DL TCI states if it has two UL TCI states. The conditions are thus equivalent. |
| 1.6 | The following higher layer parameters in TS38.214 are not align with those in TS38.331/TS38.306/TS38.212:* applyIndicatedTCIState
* tciSelection-PresentInDCI
* two default beams for S-DCI based MTRP
* support for two joint TCI states for PDSCH-CJT
* [[followUnifiedTCI-StateSRS]]
* cjtSchemePDSCH

Update above parameters in TS 38.214 to:* applyIndicatedTCI-State-r18
* applyIndicatedTCI-StateDCI-1-0
* tci-SelectionPresentInDCI-r18
* defaultQCL-TwoTCI-r16
* twoTCI-StatePDSCH-CJT-TxScheme-r18
* ~~[[~~followUnifiedTCI-StateSRS~~]]~~
* cjt-Scheme-PDSCH-r18
 | E | Editorial (E): CATT [11], NEC, Docomo, OPPO, Panasonic, Samsung, ZTE, EricssonNon-essential (N):Ericsson: note that in RAN1 specs, we omit the extension “-r18” when there is no risk for misunderstanding.  |

Issue 2 – Maintenance issue on UL power control and beam failure recovery

Table 2 Summary for Issue 2

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| # | Issue | Assessment | Companies’ view (please provide your view on the assessment of each issue) |
| 2.1 | Enhancements to single PHR mode (i.e., if a UE is not provided *twoPHRMode*). UE behaviors of single PHR mode in current specification for may not be clear for STx2P in some cases, and corresponding enhancements proposed by companies including:1. For single-DCI based STx2P, if an actual PUSCH transmission associated with both first and second indicated TCI states, the UE provides a PHR for the actual PUSCH transmission based on the first indicated TCI state
2. For multi-DCI based STx2P, if two PUSCH transmissions associated with two different *coresetPoolIndex* values overlapped to each other in time domain, the UE provides a PHR for the actual PUSCH transmission associated with *coresetPoolIndex* value 0

FL note: It would be good if the UE behaviors of single PHR mode for STx2P can be clarified. | C/N? | Critical (C): Samsung [4], vivo [5], Nokia [14], Docomo [16], ZTE, EricssonNon-essential (N):OPPO: Open to have a discussion on solutions Xiaomi: generally ok with the proposal, fine to discuss further. |
| 2.2 | For cell-specific BFR, specify how the UE would implicitly determine the BFD-RS set according to the RS index(es) in the two indicated TCI statesFL note: The issue has been brought up for the third meeting. To my understanding, the UE would implicitly determine the BFD-RS set from the TCI state used for CORESETs based on current spec, regardless of the TCI state provided by Rel-15 MAC-CE or Rel-17 unified TCI state.  | N | Critical (C): Samsung [2]Non-essential (N): Docomo, OPPO, EricssonDocomo: We think the issue can be solved by gNB implementation (e.g. gNB configures 2 CORESETs and indicates 1st and 2nd indicated TCI to each CORSET).Samsung: for one indicated TCI state case, we would be fine with the FL’s assessment if the group has the same understanding, even though the text(s) highlighted here was originally provided for the TCI state indicated by Rel-15 MAC CE. But for Rel-18, we have two indicated TCI states, and we need to clarify that the UE should implicitly determine the BFD-RS set according to the two indicated TCI states for the cell-specific BFR. Regarding Docomo’s comment, we do not think that it can be solved by gNB implementation: when two TCI states are indicated, for cell-specific BFR, the UE needs to determine the BFD-RS set from both indicated TCI states – otherwise, it is unclear whether the UE can determine the BFD-RS set from one of the two indicated TCI states.Ericsson: Agree with FL. Even if the UE is indicated with two TCI states, it is only the TCI state(s) that are associated with PDCCH receptions that matter.  |
| 2.3 | For cell-specific BFR, capture that the two indicated TCI states are specific to the first and second *coresetPoolIndex* values, respectivelyFL note: The issue has been brought up for the third meeting. To my understanding, current spec already includes both S-DCI and M-DCI cases for cell-specific BFR. | N | Critical (C): Samsung [3]Non-essential (N): Docomo, OPPO, ZTE, Ericsson, Docomo: We think the issue can be solved by gNB implementation (e.g. gNB configures 2 CORESETs and indicates 1st and 2nd indicated TCI to each CORSET).Samsung: Our intention is only to clarify that the cell-specific BFR is applicable for MDCI as well (when two values of *coresetPoolIndex* are provided in *PDCCH-Config*). Same practices of clarifying that the two indicated TCI states (or the first and second indicated TCI states) are respectively associated to values 0 and 1 of *coresetPoolIndex* have been carried out throughout 213 (e.g., for indicating ‘first’/‘second’/‘both’ TCI state(s) for PUCCH transmission) and 214 (e.g., for indicating ‘first’/‘second’ TCI state for AP CSI-RS reception, ‘first’/‘second’ TCI state for PUSCH transmission and ‘first’/‘second’ for SRS transmission). The corresponding excerpts from 213 and 214 are provided below:In 38.213:

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| “*If the UE**- is not provided coresetPoolIndex or is provided coresetPoolIndex with a value of 0 for first CORESETs on an active DL BWP of a serving cell, and**- is provided coresetPoolIndex with a value of 1 for second CORESETs on the active DL BWP of the serving cells,**the first and second TCI-State or TCI-UL-State are specific to the first and second CORESETs, respectively.*”  |

In 38.214:

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| “*If the UE is configured by higher layer parameter PDCCH-Config that contains two different values of CORESETPoolIndex in different ControlResourceSets, the first and the second indicated TCI-States correspond to the indicated TCI-States specific to coresetPoolIndex value 0 and value 1, respectively.*”  |

We believe that same clarifications are needed here.Ericsson: Agree with FL. The behaviour is the same for sDCI and mDCI: the RSs of all TCI states associated with any CORESET must fail, so there is no need to describe mDCI separately. |
| 2.4 | For TRP-specific BFR, support implicit BFD-RS determination in S-DCI based MTRP operation FL note: This issue has been discussed over several meetings without reaching a consensus, and it will not be treated if the situation is not changed in this meeting. | N | Critical (C): ZTE [9]Non-essential (N): Docomo, OPPO, EricssonDocomo: We think the issue can be solved by gNB implementation (e.g. gNB configures 2 CORESETs and indicates 1st and 2nd indicated TCI to each CORSET).Ericsson: This is a good idea, but we are in the maintenance phase. |

# References

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| # | Source | Title | Tdoc |
| 1 | Samsung | Discussions on cell-specific BFR under the Rel-18 unified TCI framework (eUTCI) | R1-2404092 |
| 2 | Samsung | Draft CR on BFD RS set determination for cell-specific BFR under the Rel-18 unified TCI framework | R1-2404093 |
| 3 | Samsung | Draft CR on BFD RS set determination for cell-specific BFR under the Rel-18 unified TCI framework | R1-2404094 |
| 4 | Samsung | Discussion on twoPHRmode for single-DCI based STx2P | R1-2404097 |
| 5 | vivo | Discussion on M-DCI based PUSCH+PUSCH STxMP | R1-2404158 |
| 6 | vivo | Draft CR on M-DCI based PUSCH+PUSCH STxMP | R1-2404159 |
| 7 | ZTE | Draft CR on beam collision between PDSCH with offset less than a threshold and PDCCH in S-DCI based MTRP | R1-2404252 |
| 8 | ZTE | Draft CR on beam collision between PDSCH with offset less than a threshold and PDCCH in M-DCI based MTRP | R1-2404253 |
| 9 | ZTE | Draft CR on implicit BFD-RS determination for S-DCI based MTRP | R1-2404254 |
| 10 | CATT | Correction on RRC parameters for NR Rel-18 MIMO in TS38.214 | R1-2404368 |
| 11 | CATT | Draft CR on configuration of TCI states for SRS | R1-2404370 |
| 12 | Xiaomi | Draft CR on default beam for AP CSI-RS in M-DCI based MTRP scenario with Rel-18 unified TCI state framework | R1-2404600 |
| 13 | NEC | Draft CR on indicated TCI state in TS38.214 | R1-2404673 |
| 14 | Nokia | Maintenance on NR MIMO Evolution for Downlink and Uplink | R1-2404917 |
| 15 | Docomo | Draft CR on beam application timing for mDCI mTRP for Rel-18 TCI framework | R1-2405021 |
| 16 | Docomo | Remaining issues on power control for M-TRP operation in NR MIMO Evolution for Downlink and Uplink | R1-2405022 |