**3GPP TSG RAN WG1 #112bis-e DRAFT R1-2303807**

**e-Meeting, April 17th – April 26th, 2023**

**Agenda item:** 9.1.1.1

**Source:** Moderator (MediaTek)

**Title:** Moderator summary on extension of unified TCI framework (Round 0)

**Document for:** Discussion and Decision

# Introduction

In RAN#94e, the Rel-18 WID of MIMO evolution for downlink and uplink is approved. In the approved WID, extension of unified TCI framework is a part of the RAN1 objectives, and the detailed scope of this agenda item (AI 9.1.1.1) includes the following highlighted objectives:

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| **RAN1:**   1. Specify extension of Rel-17 Unified TCI framework for indication of multiple DL and UL TCI states focusing on multi-TRP use case, using Rel-17 unified TCI framework. 2. Study, and if needed, specify the following items to facilitate simultaneous multi-panel UL transmission for higher UL throughput/reliability, focusing on FR2 and multi-TRP, assuming up to 2 TRPs and up to 2 panels, targeting CPE/FWA/vehicle/industrial devices (if applicable)    * UL precoding indication for PUSCH, where no new codebook is introduced for multi-panel simultaneous transmission      + The total number of layers is up to four across all panels and total number of codewords is up to two across all panels, considering single DCI and multi-DCI based multi-TRP operation.    * UL beam indication for PUCCH/PUSCH, where unified TCI framework extension in objective 2 is assumed, considering single DCI and multi-DCI based multi-TRP operation      + For the case of multi-DCI based multi-TRP operation, only PUSCH+PUSCH, or PUCCH+PUCCH is transmitted across two panels in a same CC. 3. Study, and if justified, specify the following    * Two TAs for UL multi-DCI for multi-TRP operation    * Power control for UL single DCI for multi-TRP operation where unified TCI framework extension in objective 2 is assumed.   For the case of simultaneous UL transmission from multiple panels, the operation will only be limited to the objective 6 scenarios. |

# Plan

Based on the contributions from companies [1]-[32], the followings are provided in this document:

* Summary of companies’ views on each of open issues raised by interested companies, where the open issues are categorized as follow:
  + Issue 1 – General issue for unified TCI extension
  + Issue 2 – TCI state update and activation
  + Issue 3 – How to inform UE which indicated TCI state(s) that UE shall apply to target channel/signal
  + Issue 4 – UL power control for UL MTRP operation
  + Issue 5 – PDSCH-CJT Tx scheme
  + Issue 6 – Beam failure recovery and beam reporting
* Observations and recommended proposals based on the summary of companies’ views

# Contact Person

For potential offline discussion, companies/delegates are encouraged to enter the contact information in the table below:

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|  |  |  |
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# Proposals to be discussed in the online session

# Discussion

# Issue 1 – General issue for unified TCI extension

Table 1-1 Summary for Issue 1

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 1.1 | Support of inter-cell (M-DCI based) MTRP operation | **FL note: Based on Tdoc contributions to RAN1#112b [3]-[34], some companies prefer an explicit agreement to support the association between activated joint/DL/UL TCI state(s) and PCI(s) for inter-cell MTRP since current specification may be applicable only for legacy TCI framework. Thus, Proposal 2.5 is recommended as follows:**  **Proposal 1.1:** On unified TCI framework extension for M-DCI based MTRP, when the UE is configured with *SSB-MTC-AdditionalPCI*, the activated joint/DL/UL TCI state(s) specific to one *coresetPoolIndex* value can be associated with the serving cell PCI and the activated joint/DL/UL TCI state(s) specific to another *coresetPoolIndex* value can be associated with a PCI other than the serving cell PCI.  **TS 38.214**  If the UE is configured with *SSB-MTC-AddtionalPCI* and with PDCCH-Config that contains two different values of *coresetPoolIndex* in *ControlResourceSet*, the UE receives an activation command for CORESET associated with each *coresetPoolIndex*, as described in clause 6.1.3.14 of [10, TS 38.321], used to map up to 8 TCI states to the codepoints of the DCI field 'Transmission Configuration Indication' in one CC/DL BWP. When a set of TCI state IDs are activated for a *coresetPoolIndex*, the activated TCI states corresponding to one *coresetPoolIndex* can be associated with one physical cell ID and activated TCI states corresponding to another *coresetPoolIndex* can be associated with another physical cell ID. |
| 1.2 | Support of inter-cell S-DCI based MTRP operation | Question 1: In Rel-18 unified TCI framework extension, whether to support inter-cell S-DCI based MTRP?   * Yes: Samsung * No: vivo, QC |

Table 1-2 Company input for Issue 1

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| **Company** | **Input** |
| Mod V00 | * Please input your comment to Proposal 1.1, if any. * Please also update your preference on the question in Issue 1.2. |
| OPPO | **On Proposal 1.1**: In our reading of the current related spec as referred by FL, it seems the terminology, i.e. TCI state, can be understood as legacy and unified TCI states. It is also commonly and widely used for other parts in RAN1 spec (e.g. TS 38.214). Moreover, in higher layer spec (e.g. TS 38.331), both legacy and unified TCI state are configured as the same IE.  From this sense, the captured spec seems sufficient and valid for the case of inter-cell M-DCI MTRP. Therefore, we believe no more progress needed.  **On Issue 1.2**: No extension to the inter-cell S-DCI based MTRP.  In our view, the inter-cell S-DCI based MTRP is a totally new feature which hasn’t been supported and specified in Rel.17 yet. Technically, the S-DCI implies the cross-cell DL scheduling that could bring some uncertainty when compared with M-DCI based MTRP. |
| vivo | Proposal 1.1: Support.  @OPPO: Current TS38.214 only considers the MAC CE in clause 6.1.3.14 of [10, TS 38.321], which doesn’t cover unified TCI states.  Issue 1.2: We think supporting inter-cell S-DCI based MTRP is out of scope. Besides, we have an agreement in RAN1#109-e.  **Agreement**  On unified TCI framework extension, consider all the intra and inter-cell MTRP schemes specified in Rel-16 and Rel-17   * Consider, if STxMP is supported, Rel-18 MTRP scheme(s) with STxMP |
| QC | For Proposal 1.1, fine  For 1.2, prefer not to support to maintain legacy behavior on this |
| Xiaomi | Proposal 1.1: support  Proposal 1.2: not support since it is not supported in Rel-16/Rel-17. |
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# Issue 2 – TCI state update and activation

Table 2-1 Summary for Issue 2

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 2.1 | (S-DCI) Switching between STRP and MTRP based on the existing TCI field | Question 1: If the UE receives a TCI codepoint mapped with one single joint TCI state in a serving cell configured with joint DL/UL TCI mode, or receives a TCI codepoint mapped with one single DL and/or UL TCI state in a serving cell configured with separate DL/UL TCI mode, whether the UE shall switch to single-TRP operation in the serving cell?   * Yes: vivo, Xiaomi, QC, Fujitsu * No: ZTE, Huawei/HiSilicon, Docomo, CMCC, Apple, Sharp, NEC, LG, IDC, FGI, Futurewei, OPPO, Samsung, MediaTek   **FL note: Based on the feedback to Q1 in pre-RAN1#112b offline discussion [1] and Tdoc contributions to RAN1#112b [3]-[34], the following conclusion is recommended. Note that this issue has been discussed offline in several meetings and it seems the situation is still not changed in this meeting.**  **Conclusion 2.1**: On unified TCI framework extension for S-DCI based MTRP operation, there is no consensus to support dynamic switching between single-TRP operation and multi-TRP operation for channels/signals based on the existing TCI field in DCI format 1\_1/1\_2 |
| 2.2 | (S-DCI) Combinations of joint/DL/UL TCI states that can be mapped to a TCI codepoint of the existing TCI field, and corresponding UE behaviors | **FL note: Based on the previous RAN1 agreement, it should be able to use the existing TCI field to indicate joint/DL/UL TCI state(s) for one of the two TRPs or both TRPs. Thus, Proposal 2.2 is recommended accordingly. Regarding the FFS in this proposal, since there are different proposals (e.g., based on RRC, MAC-CE, or DCI) for indicating/determining that each activated joint/DL/UL TCI state(s) is the 1st or 2nd joint/DL/UL TCI state(s), I suggest to leave the sub-issue for further discussion/study (please check Issue 2.3).**  **Proposal 2.2:** On unified TCI framework extension for S-DCI based MTRP operation, support the followings:   * For a serving cell configured with joint DL/UL TCI mode, a full-set or any sub-set of {first joint TCI state, second joint TCI state} can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 by TCI state activation command (MAC-CE) * For a serving cell configured with separate DL/UL TCI mode, a full-set or any sub-set of {first DL TCI state, first UL TCI state, second DL TCI state, second UL TCI state} can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 by TCI state activation command (MAC-CE) * The first/second indicated joint/DL/UL TCI state(s) is updated according to the first/second joint/DL/UL TCI state(s) mapped to the TCI codepoint received by the UE   + If the UE receives a TCI codepoint mapped with a sub-set of {first joint TCI state, second joint TCI state} or {first DL TCI state, first UL TCI state, second DL TCI state, second UL TCI state}, the UE shall keep the current indicated first/second joint/DL/UL TCI state(s) not updated by the sub-set * FFS: How to indicate/determine each activated joint/DL/UL TCI state in TCI state activation command (MAC-CE) corresponds to the first or second joint/DL/UL TCI state |
| 2.3 | (S-DCI) How to indicate/determine each activated joint/DL/UL TCI state in TCI state activation command (MAC-CE) corresponds to the first or second joint/DL/UL TCI state | Alt1: Using RRC-level TCI state grouping (i.e., separate the configured joint/DL/UL TCI states into two groups by RRC configuration), so that the UE can determine that each activated joint/DL/UL TCI state in TCI state activation command (MAC-CE) corresponds to the first or second joint/DL/UL TCI state based on RRC-level TCI state grouping   * Support: Samsung, ZTE   Alt2: TCI state activation command (MAC-CE) should indicate that each activated joint/DL/UL TCI state in TCI state activation command (MAC-CE) corresponds to the first or second joint/DL/UL TCI state (detail on how to indicate above is up to RAN2 design)   * Support: Huawei/HiSilicon, CATT, Futurewei, IDC, Intel, OPPO, Spreadtrum, TransHold, QC   Alt3: Beam indication DCI should also indicate the activated joint/DL/UL TCI state(s) mapped to the indicated TCI codepoint is the first or second joint/DL/UL TCI state(s)   * Support: Apple, CMCC |
| 2.4 | Timeline to update the indicated joint/DL/UL TCI state(s) | Question 1: In Rel-18 unified TCI framework extension for MTRP operation, whether the Rel-17 timeline for updating the indicated joint/DL/UL TCI state(s) is retained, i.e., the indicated joint/DL/UL TCI state(s) applied to the DL reception or UL transmission is updated based on the Rel-17 beam application time?   * Yes: Xiaomi, Google, Docomo, OPPO, IDC, QC, Apple, ZTE, Panasonic, Sharp, CEWiT, Huawei/HiSilicon, Fujitsu, NEC, LG, FGI, Futurewei, MediaTek * No:   **FL note: Based on pre-RAN1#112b offline discussion [1] and Tdoc contributions to RAN1#112b [3]-[34], the following proposal is recommended:**  **Proposal 2.4**: On unified TCI framework extension, the Rel-17 timeline for updating the indicated joint/DL/UL TCI state(s) is retained, i.e., the indicated joint/DL/UL TCI state(s) applied to the DL reception or UL transmission in each slot is updated based on the Rel-17 beam application time |
| 2.5 | Common TCI state ID activation/update for a CC list comprised of a mix of STRP CC(s) and MTRP CC(s) | Question 1: Whether a CC list can be comprised of a mix of STRP CC(s) and MTRP CC(s)?   * Yes: OPPO, Spreadtrum, IDC, Huawei/HiSilicon, Hyundai, Google, MediaTek, Docomo, vivo, CATT, LG, Fujitsu * No: Xiaomi, QC, NEC, CMCC, ZTE, FGI   Question 2: Whether a CC list can be comprised of a mix of S-DCI based MTRP CC(s) and M-DCI based MTRP CC(s)?   * Yes: OPPO, IDC, Huawei/HiSilicon, Hyundai, Google, Docomo, CATT * No: Xiaomi, Spreadtrum, QC, NEC, CMCC, ZTE, vivo, FGI, MediaTek   **FL note: Based on feedback to above two questions, more companies are supportive to a CC list including the mix of STRP CC(s) and MTRP CC(s), however, views on support a CC list including the mix of S-DCI based MTRP CC(s) and M-DCI based MTRP CC(s) are quite diverse. Based on above observations, the following proposal is recommended:**  **Proposal 2.5:** On unified TCI framework extension, support the followings for CA operation:   * A CC list (*simultaneousTCI-UpdateListX*) for common TCI state ID activation/update can include CC(s) operating in STRP and CC(s) operating in S-DCI based MTRP * A CC list (*simultaneousTCI-UpdateListX*) for common TCI state ID activation/update can include CC(s) operating in STRP and CC(s) operating in M-DCI based MTRP * FFS: How to support common TCI state ID activation/update for above two cases   FFS: Whether/how to support a CC list (*simultaneousTCI-UpdateListX*) for common TCI state ID activation/update can include CC(s) operating in S-DCI based MTRP and CC(s) operating in M-DCI based MTRP |

Table 2-2 Company input for Issue 2

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| **Company** | **Input** |
| Mod V00 | * Please input your comment to the recommended conclusion and proposals in Issue 2, if any. * Please also update your preference on those alternatives or questions in Issue 2.1~2.5, if needed. |
| OPPO | **Conclusion 2.1**: We are in general fine with it.  **Proposal 2.2**: Supportive.  If conclusion 2.1 is acceptable, it says no dynamic switch between STRP and MTRP operation for channels/signals. As a consequence, the UE behavior on indicated all set or sub-set of joint/DL/UL TCI state(s) should follow the rules as listed in Proposal 2.2. UE updates the indicated joint/DL/UL TCI state(s) and maintains the parts not in the indicated set for channel/signals under STRP or MTRP operation.  **Issue 2.3**:  On Alt.1, it seems the RRC based TCI state grouping conflicts the conclusion RAN1 made in RAN1#110bis-e, assuming the 1st and 2nd joint/DL/UL TCI states refers to 1st and 2nd TRP respectively.  **Conclusion**  On unified TCI framework extension in Rel-18, there is no consensus to support separate RRC-configured TCI state list(s) for each of TRPs.  On Alt.2, the MAC CE based approach aligns with legacy design of TCI state activation in Rel.16. And there seems no issue to reuse it for unified TCI states.  On Alt.3, this approach requires large TCI field extension. For example, assuming one separate DL/UL TCI state indicated, it needs at least 2 additional bits to be associated with it. These 2 bits should express the indicated TCI state is 1st DL TCI state, 1st UL TCI state, 2nd UL TCI state or 2nd UL TCI state.  **Proposal 2.4**: Support.  **Proposal 2.5**: Supportive.  For instance, the PDSCH on a CC can be dynamically switched back to S-TRP by using the newly added [TCI selection field]. For flexibility and signalling overhead reduction, this CC should be allowed to be configured in the CC list, e.g. *simultaneousTCI-UpdateListX* with another CC operating under MTRP for PDSCH. If Proposal 2.5 is not agreeable, then the above case is unfortunately not allowed in our understanding. |
| vivo | Conclusion 2.1: We think dynamic switching the entire system to legacy Rel-17 STRP operation is critical. Other-wise, a lot of RRC reconfiguration signaling per channel/RS may be needed. Considering companies’ preference, can we have the following compromised proposal based on Proposal 2.2?  **Updated Proposal 2.2:** On unified TCI framework extension for S-DCI based MTRP operation, support the followings:   * For a serving cell configured with joint DL/UL TCI mode, a full-set or any sub-set of {first joint TCI state, second joint TCI state} can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 by TCI state activation command (MAC-CE) * For a serving cell configured with separate DL/UL TCI mode, a full-set or any sub-set of {first DL TCI state, first UL TCI state, second DL TCI state, second UL TCI state} can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 by TCI state activation command (MAC-CE) * If the UE receives a TCI codepoint mapped with one single joint TCI state in a serving cell configured with joint DL/UL TCI mode, or receives a TCI codepoint mapped with one single DL and/or UL TCI state in a serving cell configured with separate DL/UL TCI mode, the UE can keep or release the current indicated first/second joint/DL/UL TCI state(s) not updated by the sub-set   + If the current indicated first/second joint/DL/UL TCI state(s) not updated by the sub-set is/are kept by UE, the first/second indicated joint/DL/UL TCI state(s) is updated according to the first/second joint/DL/UL TCI state(s) mapped to the TCI codepoint received by the UE   + ~~If the UE receives a TCI codepoint mapped with a sub-set of {first joint TCI state, second joint TCI state} or {first DL TCI state, first UL TCI state, second DL TCI state, second UL TCI state}, the UE shall keep the current indicated first/second joint/DL/UL TCI state(s) not updated by the sub-set~~ * FFS: How to indicate/determine whether to keep or release other indicated joint/DL/UL TCI state(s) not updated by the codepoint, and each activated joint/DL/UL TCI state in TCI state activation command (MAC-CE) corresponds to the first or second joint/DL/UL TCI state if other indicated joint/DL/UL TCI state(s) not updated by the codepoint is to be kept   Proposal 2.3: We think Alt2, i.e., MAC CE, is more appropriate for the indication including whether to switch to STRP operation or not. Alt1, the RRC-level TCI state grouping for S-DCI based is not necessary. How to utilize beam indication DCI in Alt3 is not clear to us.  Proposal 2.4: Support.  Proposal 2.5: Support. |
| QC | For Proposal 2.2, if it is supported, a natural way without RRC reconfig interruption is to use MAC-CE to switch sTRP/mTRP sticky mode? If so, we can accept Proposal 2.2 with MAC-CE switch as part of the proposal  For Conclusion 2.1, not support due to RRC reconfig interruption  For Proposal 2.3, support Alt2  For Proposal 2.4, support  For Proposal 2.5, not support, unless the FFS rule is clear and simple. In our view, it is sufficient for the reference CC to always be a mTRP CC, and 1st indicated TCI is applied to sTRP CCs. However, we are fine to add a note to say “Mixed sTRP and mTRP CCs are not allowed in the same CC list if no consensus on above FFSs” |
| Xiaomi | Conclusion 2.1 and Proposal 2.2:  In Rel-16/Rel-17, dynamic switching between Single-TRP operation and Multi-TRP operation is supported for each channel. Thus we slightly prefer to support it in Rel-18. And we suggest to comprise it by the updated text as below:  “……the UE shall keep or release the current indicated first/second joint/DL/UL TCI state(s) not updated by the sub-set according to the UE capability”  Issue 2.3: It can be discussed after conclusion 2.1 and proposal 2.2. For down-selection, we prefer Alt 2.  Proposal 2.4: we are general fine with it. But we would like to clarify the motivation on the word “in each slot”. In my opinion, it can be removed.  Proposal 2.5:  We can support the second sub-bullet on STRP CC and M-DCI based MTRP. But for the first sub-bullet on the STRP CC and S-DCI based MTRP, we have a question that, if TCI state of only one TRP is activated for a codepoint of existing TCI field for S-DCI based MTRP CC, does it mean for some S-TRP CC, no TCI state is activated for that codepoint? E.g.,   * for S-DCI based MTRP CC, {000}=>{TCI#0, TCI#1} , {001}=>{TCI#3, --}, {011}=>{--,TCI#4}…… * so for STRP CC1, {000}=>{TCI#0} , {001}=>{TCI#3}, {011}=>{--}…… * and for STRP CC2, {000}=>{ TCI#1} , {001}=>{--}, {011}=>{TCI#4}……   It means with mixed STRP and S-DCI based MTRP CC grouping, either case 1 or case 2 will occur.   * Case 1 is that, S-DCI MTRP CC can support some codepoint map to TCI state of only one TRP, but for some sTRP CCs, less than 8 TCI states will be activated. * Case 2 is that, 8 TCI states for all sTRP CCs can be activated, but for S-DCI MTRP CCs, each codepoint must map to TCI states of two TRPs.   If without mixed STRP and S-DCI based MTRP CC grouping, in addition to case 1 and case 2, case 3 can be supported. But case 3 can’t be supported with mixed CC grouping.   * Case 3 is that, 8 TCI states for all sTRP CCs can be activated. And for S-DCI MTRP CCs, some codepoint can map to TCI state of only one TRP. |
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# Issue 3 – How to inform UE which indicated TCI state(s) that UE shall apply to target channel/signal

A plan for discussion in this meeting on the TCI selection scheme for each target channel/signal and remaining issues is provided in the following table, including both S-DCI and M-DCI based MTRP operation:

Table 3-0 Summary of TCI selection scheme for each target channel/signal in S-DCI/M-DCI based MTRP operation

|  |  |  |
| --- | --- | --- |
| **S-DCI based MTRP operation** | | |
| **Channel/signal** | **Conclusion** | **TCI selection scheme** |
| PDCCH | Yes | RRC configuration per CORESET (FFS: whether to reuse Rel-17 rule/parameter, discussed in Issue 3.1) |
| PDSCH scheduled/activated by DCI format 1\_1/1\_2 if the [TCI selection field] is present in DCI format 1\_1/1\_2 | Yes | [TCI selection field] in DCI format 1\_1/1\_2 (FFS: details including whether/how to use the codepoint “11”, RRC-configured per CORESET/BWP/cell, and the applying/mapping order if applies both, discussed in Issue 3.9) |
| PDSCH scheduled/activated by DCI format 1\_1/1\_2 if the [TCI selection field] is not present in DCI format 1\_1/1\_2 | No | Discussed in Issue 3.2 |
| PDSCH scheduled/activated by DCI format 1\_0 (including DG and SPS) | No | Discussed in Issue 3.3 |
| PDSCH scheduled/activated by DCI format 1\_1/1\_2 before threshold for the UE doesn’t support the capability of two default beams for S-DCI based MTRP in FR2 | No |  |
| PUSCH scheduled/activated by DCI format 0\_1/0\_2 (including DG and Type2 CG) | Yes | The existing SRS resource set indicator in DCI format 0\_1/0\_2 (FFS: behaviors for SDM and SFN based PUSCH Tx schemes for the codepoint "10" and/or “11”) |
| PUSCH scheduled/activated by DCI format 0\_0 (including DG and Type2 CG) | No | Discussed in Issue 3.4 |
| Type1 CG-PUSCH | No | Discussed in Issue 3.5 |
| PUCCH | Yes | RRC configuration per PUCCH resource/resource group (FFS: the applying/mapping order if applies both) |
| AP CSI-RS for CSI/BM | No | Discussed in Issue 3.7 |
| SRS for CB/NCB/AS and AP SRS for BM | No | Discussed in Issue 3.8 |
| **M-DCI based MTRP operation** | | |
| **Channel/signal** | **Conclusion** | **TCI selection scheme** |
| PDCCH | Yes | According to *coresetPoolIndex* value |
| PDSCH scheduled/activated by DCI format 1\_0/1\_1/1\_2 | Yes | According to *coresetPoolIndex* value corresponding to scheduling PDCCH |
| PUSCH scheduled/activated by DCI format 0\_0/0\_1/0\_2 (including DG and Type2 CG) | Yes | According to *coresetPoolIndex* value corresponding to scheduling PDCCH |
| PUCCH | No | Discussed in Issue 3.6 |
| Type1 CG-PUSCH | No | To be discussed after RAN1 has decision on the adoption of Opt1 or Opt2 for PUCCH transmission (note: either Opt1 or Opt2 must be supported) |
| AP CSI-RS for CSI/BM | No |
| SRS for CB/NCB/AS and AP SRS for BM | No |

Table 3-2 Summary for Issue 3

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 3.1 | (S-DCI) PDCCH, whether Rel-17 rule/parameter is reused when provide the RRC configuration for TCI selection | Question 1: Whether Rel-17 rule/parameter is reused when provide the RRC configuration to inform the TCI selection for PDCCH reception?   * Yes: Huawei/HiSilicon, Xiaomi, Google, IDC, CMCC, ZTE, vivo, CATT, LG, Fujitsu, FGI, Fraunhofer. Spreadtrum, Samsung, Panasonic * No: Docomo (not reuse *followUnifiedTCIstate*), QC (not reuse *followUnifiedTCIstate*)   **Proposal 3.1:** On unified TCI framework extension for S-DCI based MTRP:   * If a CORESET other than a CORESET with index 0 is associated only with USS sets and/or Type3-PDCCH CSS sets, the CORESET is configured by RRC to apply the first indicated joint/DL TCI state, the second indicated joint/DL TCI state, or both first and second indicated joint/DL TCI states to PDCCH reception on the CORESET * If a CORESET other than a CORESET with index 0 is associated at least with CSS sets other than Type3-PDCCH CSS sets and *followUnifiedTCIstate* = 'enabled' is configured for the CORESET, the CORESET is configured by RRC to apply the first indicated joint/DL TCI state, the second indicated joint/DL TCI state, or both first and second indicated joint/DL TCI states to PDCCH reception on the CORESET * If a CORESET with index 0 is configured with *followUnifiedTCIstate* = 'enabled':   + If the CORESET is associated with SS#0 for Type 0/0A/2 CSS sets, the CORESET is configured by RRC to apply the first indicated joint/DL TCI state or the second indicated joint/DL TCI state to PDCCH reception on the CORESET   + Otherwise, the CORESET is configured by RRC to apply the first indicated joint/DL TCI state, the second indicated joint/DL TCI state, or both first and second indicated joint/DL TCI states to PDCCH reception on the CORESET   **FL note: PLEASE note that this issue has been discussed in several meetings. If no consensus can be reached, we may conclude the status in this meeting.** |
| 3.2 | (S-DCI) PDSCH scheduled/activated by DCI format 1\_1/1\_2 if the [TCI selection field] is not present in DCI format 1\_1/1\_2 | Alt1: Using RRC configuration to inform that the UE shall apply the first one, the second one, or both of two indicated joint/DL TCI states to the scheduled/activated PDSCH reception   * Support: Apple, CEWiT, Docomo, MediaTek, FGI, Huawei, HiSilicon, ITRI, NEC, OPPO, Panasonic, Sharp, Samsung, TransHold   Alt2: The UE shall apply the first indicated joint/DL TCI state to the scheduled/activated PDSCH reception   * Support: CATT, OPPO, Spreadtrum, vivo   Alt3: The UE shall apply both indicated joint/DL TCI states to the scheduled/activated PDSCH reception   * Support: Docomo, Google, Huawei, HiSilicon, Intel, NEC, Nokia, OPPO, Samsung, TCL, MediaTek, ZTE   Alt3A: The UE shall apply the same joint/DL TCI state(s) that is applied to the PDCCH reception with the scheduling/activation DCI to the scheduled/activated PDSCH reception   * Support: CMCC, Fraunhofer   Alt4: Which indicated joint/DL TCI state(s) is/are applied to the scheduled/activated PDSCH reception is determined according to the existing TCI field of the most recently applied beam indication DCI   * Support: CEWiT, LG, Qualcomm   **FL note: Given that Alt1 is the majority view and some proponents of Alt3 also support Alt1, Proposal 3.2 is recommended.**  **Proposal 3.2:** On unified TCI framework extension for S-DCI based MTRP, for PDSCH reception scheduled/activated by DCI format 1\_1/1\_2 configured w/o the [TCI selection field], using RRC configuration to inform that the UE shall apply the first, the second, or both indicated joint/DL TCI states to the scheduled/activated PDSCH reception |
| 3.3 | (S-DCI) PDSCH scheduled/activated by DCI format 1\_0 (including DG and SPS) | Alt1: If the UE is configured with PDSCH-SFN/PDSCH-CJT, the UE shall apply both indicated joint/DL TCI states to PDSCH reception scheduled/activated by DCI format 1\_0. Otherwise, the UE shall apply the first indicated joint/DL TCI state to PDSCH reception scheduled/activated by DCI format 1\_0.   * Support: CMCC, Docomo, Panasonic   Alt2: The UE shall apply the first indicated joint/DL TCI state to PDSCH reception scheduled/activated by DCI format 1\_0.   * Support: Huawei/HiSilicon, Fujitsu, Nokia, Qualcomm, vivo, OPPO   Alt3: Using RRC configuration to inform that the TCI selection for PDSCH reception scheduled/activated by DCI format 1\_0   * Support: Ericsson, Docomo, OPPO   Alt4: The UE shall apply the same joint/DL TCI state(s) that is applied to the PDCCH reception with the scheduling/activation DCI to the scheduled/activated PDSCH reception   * Support: Samsung, ZTE   **FL note: It seems more discussions are needed for issue, please input your preference and view on this issue. Some companies prefer to have the same TCI selection scheme for Issue 3.2 and Issue 3.3.** |
| 3.4 | (S-DCI) PUSCH scheduled/activated by DCI format 0\_0 (including DG and Type2 CG) | Alt1: The UE shall apply the first indicated joint/UL TCI state to PUSCH transmission scheduled/activated by DCI format 0\_0.   * Support: Ericsson, Fujitsu, Huawei/HiSilicon, MediaTek, Panasonic, Qualcomm, vivo   Alt2: UE shall apply the joint/UL TCI state that is applied to the PUCCH resource with lowest ID to PUSCH transmission scheduled/activated by DCI format 0\_0.   * Support: ZTE   **FL note: Given that Alt1 is the majority view, the following proposal is recommended:**  **Proposal 3.4:** On unified TCI framework extension for S-DCI based MTRP, the UE shall apply the first indicated joint/UL TCI state to PUSCH transmission(s) scheduled/activated by DCI format 0\_0 (including DG and Type2 CG) |
| 3.5 | (S-DCI) Type1 CG-PUSCH | Alt1: An RRC configuration is provided to a Type1 CG configuration to inform that the UE shall apply the first, the second, or both indicated joint/UL TCI states to the corresponding CG-PUSCH transmission   * Support: Apple, CATT, Ericsson, Huawei/HiSilicon, MediaTek, Nokia, Panasonic, Xiaomi, OPPO   Alt2: If two SRIs/TPMIs are provided to Type1 CG configuration, the UE shall apply both indicated joint/UL TCI states to the corresponding CG-PUSCH transmission. Otherwise, the UE shall apply the first indicated joint/UL TCI state to the corresponding CG-PUSCH transmission.   * Support: Qualcomm   Alt3: No enhancement is needed for Type1 CG-PUSCH   * Support: ZTE   **FL note: Given that Alt1 is the majority view, the following proposal is recommended:**  **Proposal 3.5:** On unified TCI framework extension for S-DCI based MTRP, an RRC configuration is provided to a Type1 CG configuration to inform that the UE shall apply the first, the second, or both indicated joint/UL TCI states to the corresponding CG-PUSCH transmission   * If the first or the second indicated joint/UL TCI state is applied, the UE shall apply the first or the second indicated joint/UL TCI state to all PUSCH antenna port(s) of corresponding PUSCH transmission occasions(s) * If both indicated joint/UL TCI states are applied, the UE shall apply the first indicated joint/UL TCI state to the PUSCH transmission occasions(s) associated with the first SRS resource set for CB/NCB or to the PUSCH antenna port(s) corresponding to the SRS port(s) of the indicated SRS resource in the first SRS resource set for CB/NCB, and the second indicated joint/UL TCI state to the PUSCH transmission occasions(s) associated with the second SRS resource set for CB/NCB or to the PUSCH antenna port(s) corresponding to the SRS port(s) of the indicated SRS resource in the second SRS resource set for CB/NCB |
| 3.6 | (M-DCI) PUCCH | Opt1: A *coresetPoolIndex* value can be provided per PUCCH resource/resource group, and the UE shall apply the indicated joint/UL TCI state specific to the *coresetPoolIndex* value to the corresponding PUCCH transmission   * Support: CATT, CMCC, Docomo, Fraunhofer, Fujitsu, Futurewei, Intel, Lenovo, TCL, Xiaomi, ZTE, OPPO   Opt2: An RRC configuration can be provided per PUCCH resource/resource group to inform that the UE shall apply the first or the second indicated joint/UL TCI state to the corresponding PUCCH transmission, where the first and the second indicated joint/DL TCI states correspond to the indicated joint/UL TCI states specific to *coresetPoolIndex* value 0 and value 1, respectively.   * Support: Ericsson, Nokia, MediaTek, Panasonic, QC, Samsung, Spreadtrum, TransHold   Opt3: For a PUCCH transmission triggered by PDCCH on a CORESET when the UCI in the PUCCH transmission carries HARQ-ACK information only, the UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to the PUCCH transmission, where the *coresetPoolIndex* value is determined from the one associated with the CORESET. Otherwise, either Opt1 or Opt2 is adopted.   * Support: Apple (with Opt1), Futurewei (with Opt1), Huawei/HiSilicon (with Opt2), OPPO (with Opt1), Sharp, vivo   Opt4: For a PUCCH transmission with an LRR trigged for either the first BFD-RS set () or the second BFD-RS set () when the UE is provided only one or two *schedulingRequestID-BFR* configuration, the UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to the PUCCH transmission, where the *coresetPoolIndex* value is 1 when the LRR is trigged for the first BFD-RS set () and the *coresetPoolIndex* value is 0 when the LRR is trigged for the second BFD-RS set (). Otherwise, either Opt1 or Opt2 is adopted.   * Support: Futurewei (with Opt1), Huawei/HiSilicon (with Opt2), vivo   **FL note: Proponents of Opt1 are slightly more than proponents of Opt2. Since these two alternatives achieve the same purpose, I would suggest to adopt at least Opt1 based on the current status. Also, the outcome (selection between Opt1 and Opt2) may impact the design for Type1 CG, AP CSI-RS, and SRS. Therefore, Proposal 3.6 is recommended. Note that Opt3 and Opt4 are not precluded by this proposal.**  **Proposal 3.6:** On unified TCI framework extension for M-DCI based MTRP, support at least Opt1 for PUCCH transmission, and Opt2 is not supported   * Note: Opt3 and Opt4 are not precluded |
| 3.7 | (S-DCI) AP CSI-RS for CSI/BM | Alt1: For all CSI/BM cases, using RRC configuration to inform the TCI selection for an AP CSI-RS resource set   * Support: ZTE, vivo (also for two Resource Groups for NCJT CSI), QC, Fujitsu, Sharp, Docomo, IDC, OPPO, Samsung, Intel, CATT, Ericsson, Nokia   Alt2: For special case(s), e.g., NCJT CSI and/or enhanced group-based beam report, using a fixed rule to determine the TCI selection for an AP CSI-RS resource set. For other CSI/BM cases, using RRC configuration to inform the TCI selection for an AP CSI-RS resource set.   * Support: Huawei/HiSilicon, CMCC, Apple, LG, FGI, Futurewei   **FL note: Considering only there are 3 meetings remained, I would suggest to make down-selection from above two alternatives in this meeting instead of just listing/agreeing on the alternatives. Based on pre-RAN1#112b offline discussion [1] and Tdoc contributions to RAN1#112b [3]-[34], # of proponents to above two alternatives are quite closed.**   * **According to comments from proponents of Alt2, one major concern on Alt1 is it may not be able to properly support two beams applying to an AP CSI-RS resource set configured for NCJT CSI with two Resource Groups, which are associated with different TRPs, respectively.** * **According to comments from proponents of Alt1, the issue from NCJT CSI can be resolved by providing qcl-info to AP CSI-RS resource set, i.e., each CSI-RS resource in the AP CSI-RS resource set is RRC-configured with a joint/DL TCI state instead of following the indicted joint/DL TCI state. However, additional signaling and inflexibility can be seen in order to align the beams used for PDSCH and NCJT CSI.** * **According to comments from proponents of Alt1, there is no issue from enhanced group-based reporting since NW can properly assign different indicated joint/DL TCI states to the two CMR sets by Alt1.**   **Based on above observations, one potential compromise proposal between Alt1 and Alt2 is recommended as follows:**  **Proposal 3.7:** On unified TCI framework extension for S-DCI based MTRP, if an aperiodic CSI-RS resource set for CSI/BM is configured to follow unified TCI state, an RRC configuration can be provided in *CSI-AssociatedReportConfigInfo* of *CSI-AperiodicTrigger State* for the aperiodic CSI-RS resource set to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the aperiodic CSI-RS resource set   * For an aperiodic CSI-RS resource set configured with two Resource Groups for NCJT CSI and configured to follow unified TCI state, if above RRC configuration is not provided to the aperiodic CSI-RS resource set, the UE shall apply the first indicated joint/DL TCI state to the CSI-RS resource(s) in Group 1 and the second indicated joint/DL TCI state to the CSI-RS resource(s) in Group 2. |
| 3.8 | (S-DCI) SRS for CB/NCB/AS and AP SRS for BM | Opt1: For a P/SP/AP SRS resource set for CB/NCB/AS or an AP SRS resource set for BM, if the SRS resource set is configured to follow unified TCI state, using RRC configuration to inform the TCI selection for the SRS resource set  Opt2: If two SRS resource sets for CB/NCB are configured, and if the two SRS resource sets for CB/NCB are configured to follow unified TCI state, the UE shall apply the first indicated joint/UL TCI state to the first SRS resource set for CB/NCB (the one with lower resource set ID) and the second indicated joint/UL TCI state to second SRS resource set for CB/NCB. Otherwise, Opt1 is adopted.  Support Opt1 only: Apple, CMCC, Ericsson, Qualcomm, vivo  Support Opt1+Opt2: Huawei/HiSilicon, OPPO, Panasonic, Xiaomi  **FL note: More discussions are needed for issue, please input your preference and view on this issue.** |
| 3.9 | (S-DCI) PDSCH scheduled/activated by DCI format 1\_1/1\_2, details of the [TCI selection field] in DCI format 1\_1/1\_2 | Question 1: Whether to use the codepoint “11” of the [TCI selection field]?   * Yes: CMCC, FGI, LGE, Spreadtrum, vivo, ZTE * No (reserved): ITRI, Samsung, OPPO, QC   **FL note: The outcome of Q1 may impact the design of applying/mapping order of two indicated joint/DL TCI states if both are applied, e.g., Rel-16 rules is reused, or the order can be changed according to the codepoints “10” and “11”**  Question 2: Presence of the [TCI selection field] is RRC-configured per CORESET, per BWP, per serving cell, or others?   * Per CORESET: * Per BWP: vivo (per DCI format 1\_1/1\_2) * Per CC: * Others: |
| 3.10 | How to handle the case that the spatial Tx filter(s) determined from the indicated joint/UL TCI state(s) applied to a PUSCH transmission is different from the spatial Tx filter(s) used for the SRS transmission corresponding to the SRS resource(s) indicated to the PUSCH transmission | Alt1: The UE uses the spatial Tx filter(s) determined from the indicated joint/UL TCI state(s) applied to the PUSCH transmission in this case   * Support: ZTE, vivo (meaning no special handing in spec)   Alt2: The UE uses the spatial Tx filter(s) used for the SRS transmission corresponding to the SRS resource(s) indicated to the PUSCH transmission in this case, i.e., the indicated joint/UL TCI state(s) for the PUSCH transmission is ignored   * Support: ZTE   Alt3: The case can be avoided by NW implementation, i.e., no special handing in specification to this case is needed   * Support: Docomo, Huawei/HiSilicon, OPPO, Spreadtrum, QC   **FL note: More discussions are needed for issue, please input your preference on above alternatives.** |

Table 3-3 Company input for Issue 3

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| **Company** | **Input** |
| Mod V00 | * Please update your preference and share your view on those issues in Issue 3, especially Issue 3.3, 3.8, 3.9 and 3.10, which require more discussions and input. Recommended proposals for Issue 3.3, 3.8, 3.9, and 3.10 will be provided according to more input from companies later. * Please input your comment to the recommended proposals in Issue 3, if any. |
| OPPO | **Question 1**: We see no problem to reuse the Rel.17 RRC parameter *followUnifiedTCIstate* as a flag based on which additional RRC configuration can signal to follow 1st, 2nd or both for a CORESET.  Of course, it could be up to RAN2 to have a more compact RRC parameter, which controls UE behavior on applying 1st, 2nd, both or none of indicated DL/joint TCI state(s).  We are fine either way.  **Proposal 3.2**: Supportive.  Since the DCI format 1\_1/1\_2 configured w/o the [TCI selection field], it implies NW doesn’t want to conduct dynamic TRP switch. As in Alt4, UE has to follow the most recently applied TCI state(s). It may force UE to switch between TRPs or between S-TRP and M-TRP. Hence, we prefer more static fashion as in Alt.1, Alt.2 or Alt.3.  **Issue 3.3**: Our multiple preferences added.  **Proposal 3.4**: Fine.  **Proposal 3.5**: Slightly prefer Alt.1 and thus fine with this proposal.  **Proposal 3.6**: Supportive.  If we are not going to pick up one from Opt.3 and Opt.4, we are also fine with Opt.1.  **Proposal 3.7**: It seems a fair enough compromise in the middle ground.  **Q1 of Issue 3.9**: No, the codepoint “11” can be reserved. At least for PDSCH fully or partially overlapped in time domain (e.g. PDSCH SFN, PDSCH SDM), the order of PDSCH seems invalid. |
| vivo | Proposal 3.1: Support.  Proposal 3.2: The RRC configuration makes it complicated. What if the RRC configuration informing the applied joint/DL TCI state(s) to the scheduled/activated PDSCH reception is absent either? In our view, redundant configuration is not a good way to go. We still prefer Alt2.  Proposal 3.3: Support Al2 for non-SFN PDSCH. While PDSCH-SFN should be separately discussed, which may dependent on whether dynamic switching between SFN and STRP for PDSCH is supported or not.  Proposal 3.4: Support.  Proposal 3.5: Support in principle. An FFS should be added as a sub-bullet:   * FFS: indicated joint/UL TCI states application for SDM/SFN schemes for STxMP.   Proposal 3.6: Support. Agree with FL’s assessment on Opt1. We think Opt3 and Opt4 should also be supported.  Proposal 3.7: For AP CSI-RS configured with two Resource Groups for NCJT CSI and configured to follow unified TCI state, a flexible configuration with different TCI state application orders for two Resource Groups is desired.  **Updated Proposal 3.7:** On unified TCI framework extension for S-DCI based MTRP, if an aperiodic CSI-RS resource set for CSI/BM is configured to follow unified TCI state, an RRC configuration can be provided in *CSI-AssociatedReportConfigInfo* of *CSI-AperiodicTrigger State* for the aperiodic CSI-RS resource set or Resource Group to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the aperiodic CSI-RS resource set or Resource Group   * ~~For an aperiodic CSI-RS resource set configured with two Resource Groups for NCJT CSI and configured to follow unified TCI state, if above RRC configuration is not provided to the aperiodic CSI-RS resource set, the UE shall apply the first indicated joint/DL TCI state to the CSI-RS resource(s) in Group 1 and the second indicated joint/DL TCI state to the CSI-RS resource(s) in Group 2.~~   Proposal 3.8: We think one SRS resource set shared between among TRPs can save the configuration of SRS resource sets for each individual TRP. Therefore, if the RRC configuration is not provided, the AP SRS can apply the indicated joint/UL TCI state corresponding to the indicated joint/DL TCI state applied to the CORESET carrying the triggering DCI at least for the case of only one SRS resource set for CB/NCB configured, which is the typical case for S-DCI based MTRP in Rel-16. Thus, Opt1 can be updated to:  Opt1: For a P/SP/AP SRS resource set for CB/NCB/AS or an AP SRS resource set for BM, if the SRS resource set is configured to follow unified TCI state, using RRC configuration to inform the TCI selection for the SRS resource set. If the RRC configuration is not provided for AP SRS, the AP SRS shall apply the indicated joint/UL TCI state corresponding to the CORESET carrying the triggering DCI.  Issue 3.9: Our preference on Q2 has been added.  Issue 3.10: Alt1 should be the UE behavior and no special handling is spec is needed. We think the joint/UL TCI states for PUSCH and for latest SRS resource are unnecessarily to be same. |
| QC | For Proposal 3.1, fine  For Proposal 3.2, not support. Not clear why we need RRC to inform which TCI to use by default. Why not simply switch to sTRP mode if RRC wants to use 1 TCI? In our view, Alt4 is default as in current spec for application time if no consensus  For Proposal 3.4, support  For Proposal 3.5, support  For Proposal 3.6, support  For Proposal 3.7, support  For 3.9, Q1: prefer no use like legacy. Q2: prefer per BWP  For 3.10, prefer to leave to NW implementation |
| Xiaomi | Proposal 3.1: support  Proposal 3.2: we prefer Alt 3 and we think RRC configuration is not needed.  Proposal 3.3: Prefer Alt 1. Alt 2 can’t be used for UE configured with PDSCH-SFN and not support dynamic SFN. In addition, RRC in Alt 3 is not needed for default TCI state and for Alt 4 is not preferred since it is possible the scheduling PDCCH not follow unified TCI state.  Proposal 3.4: support  Proposal 3.5: support and fine with the FFS proposed by vivo  Proposal 3.6: support the proposal  Proposal 3.7: support  Proposal 3.8: at lease support Opt 1 and Opt 2 can be supported if no RRC configuration.  Proposal 3.9: ‘no’ for Q1 and prefer ‘per BWP’ for Q2  Proposal 3.10: prefer Alt 3 |
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# Issue 4 – UL power control for UL MTRP operation

Table 4-1 Summary for Issue 4

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 4.1 | UL PC for S-DCI based STxMP (including SDM/SFN based PUSCH Tx and SFN based PUCCH Tx) | **FL note: In the last meeting, per-indicated-TCI PC parameter setting and PL-RS were agreed to be used for determining UL Tx power for MTRP operation. However, how to assume the UE-configured maximum output power for STxMP was left as FFS. According to the RAN4 LS reply on UE power limitation for STxMP [2], both per-UE and per-panel power limitation are feasible and should be applied to a same UE for STxMP. To meet/enable the per-panel power limitation, one question is raised as follows:**  Question 1: At least for S-DCI based STxMP, whether to introduce per-panel/indicated-TCI UE-configured maximum output power, i.e., the UE shall determine UL Tx power per panel or per indicated joint/UL TCI state based on per-pane/indicated-TCI UE-configured maximum output power?   * Yes: CATT, Docomo, Lenovo, LG, Panasonic, MediaTek, vivo, OPPO, QC * No:   **FL note: For M-DCI based STxMP, per-panel power limitation can be enabled by the per-Tx-occasion UE-configured maximum output power in current spec.** |
| 4.2 | Power allocation for STxMP (including both S-DCI and M-DCI based STxMP) | **FL note: According to the RAN4 LS reply on UE power limitation for STxMP [2], both per-UE and per-panel power limitation are feasible and should be applied to a same UE for STxMP. To meet/enable the per-UE power limitation, one question is raised as follows:**  Question 1: Whether prioritization for Tx power allocation/reduction is needed for STxMP so that the total UE Tx power for transmissions on serving cells in the frequency range wouldn’t exceed a total power limitation, e.g., used in TS 38.213 (clause 7.5) and defined in TS 38.101?   * Yes: Nokia, MediaTek, Panasonic, ZTE, OPPO, QC * No: vivo |

Table 4-2 Company input for Issue 4

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| **Company** | **Input** |
| Mod V00 | Please update your preference on the two questions in Issue 4.1 and Issue 4.2, respectively. |
| OPPO | **Q1 of Issue 4.1**: Yes.  **Q1 of Issue 4.2**: Yes. |
| vivo | Issue 4.1: Yes.  Issue 4.2: No. We don’t think total UE Tx power across multiple panels for simultaneous transmission on serving cells in the frequency range has a fixed relation with the total power limitation Pc,max. RAN4 focuses on per-UE measured peak EIRP Pumax rather than Pc,max, where Pumax is relevant to beam direction. We can’t assign Tx power, which doesn’t reflect any beam direction information, in per-panel level. If Tx power is allocated by restricting the total UE Tx power for transmissions less than the total power limitation, the actual measured peak EIRP may be less than Pumax. |
| QC | For 4.1 Q1: Yes. To FL, could you provide the spec section # on the per-Tx-occasion UE configured max power?  For 4.2 Q1: Yes |
| Xiaomi | Issue 4.1: Yes  We want to clarify that RAN4 only agreed that at least the current per UE power limitation which is defined based on regulation compliance should be considered for STxMP. In addition, a total power limitation over all panels, which is difference from the current per UE power limitation and power limitation per panel are feasible. But whether a total power limitation over all panels and per panel power limitation should be introduced is up to RAN1.  Hence, both whether to introduce per-panel maximum output power and whether to introduce a total power limitation over all panels should be discussed in RAN1.  Issue 4.2: Yes  But for SDCI based STxMP, the data transmitted from these panels simultaneously belongs to the same PUSCH, then how to define the prioritization might be difficult. |
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# Issue 5 – PDSCH-CJT Tx scheme

Table 5-1 Summary for Issue 5

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 5.1 | Switching between PDSCH-CJT Tx scheme and other S-DCI based PDSCH Tx scheme(s) | **FL note: Based on pre-RAN1#112b offline discussion [1] and Tdoc contributions to RAN1#112b [3]-[34], Proposal 5.1 is recommended. Note that since this is not an essential issue in this AI, it is unlikely to treat it in the GTW discussion. I hope we can converge through the offline discussion.**  **Proposal 5.1:** On unified TCI framework extension for S-DCI based MTRP, PDSCH-CJT Tx scheme is RRC-configured, and dynamic switching between PDSCH-CJT and other S-DCI based PDSCH Tx schemes is not supported   * Support: Xiaomi, Huawei, HiSilicon, QC, Docomo, CMCC, Apple, Sharp, LG, IDC, FGI, Intel, Futurewei, OPPO * Not support: ZTE |
| 5.2 | QCL type(s)/assumption(s) if two indicated joint TCI states are applied to PDSCH-CJT | Alt1: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA   * Support: Huawei, Spreadtrum, OPPO, Ericsson, Xiaomi, CATT, Qualcomm, Nokia, Docomo, CMCC, Lenovo, NEC, LG, Intel, Samsung * Concern: ZTE   Alt2: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA except for QCL parameters {Doppler shift, Doppler spread} of the second indicated joint TCI state   * Support: Huawei, ZTE, Ericsson, Xiaomi, Qualcomm, Docomo, CMCC, Samsung * Concern:   Alt3: PDSCH DMRS port(s) is QCLed with the DL RS of the first indicated joint TCI state with respect to QCL-TypeA and QCLed with the DL RS of the second indicated joint TCI state with respect to QCL-TypeB   * Support: ZTE, Ericsson * Concern: Huawei, QC, Samsung   **FL note: Based on feedback from companies, all the alternatives have their use cases. Thus, Proposal 5.2 is recommended. Note that since this is not an essential issue in this AI, it is unlikely to treat it in the GTW discussion. I hope we can converge through the offline discussion.**  **Proposal 5.2:** On unified TCI framework extension for S-DCI based MTRP, the following three alternatives are supported for PDSCH-CJT applying both indicated joint TCI states (if the UE supports two indicated joint/DL states for PDSCH-CJT):   * Alt1: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA * Alt2: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA except for QCL parameters {Doppler shift, Doppler spread} of the second indicated joint TCI state * Alt3: PDSCH DMRS port(s) is QCLed with the DL RS of the first indicated joint TCI state with respect to QCL-TypeA and QCLed with the DL RS of the second indicated joint TCI state with respect to QCL-TypeB   Introduce a UE capability on support each of above alternatives, and either one of above alternatives can be configured by RRC according to the UE capability |

Table 5-2 Company input for Issue 5

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| **Company** | **Input** |
| Mod V00 | * Please input your comment to Proposal 5.1 and Proposal 5.2, if any. * Please also update your preference on those alternatives in Issue 5.2, if needed. |
| OPPO | **Proposal 5.1**: Fine.  **Proposal 5.2**: Not supportive.  For PDSCH-CJT at FR1, we think the TRP-specific time/freq. domain compensation lacks of validity, thus UE behavior on dropping certain QCL parameter is not necessary. QCL-TypeA would be enough to serve. We don’t need to specify different UE capability on this issue. |
| QC | Proposal 5.1, support  Proposal 5.2, not support. Alt3 has no evaluation. |
| Xiaomi | Proposal 5.1: support |
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# Issue 6 – Beam failure recovery and beam reporting

Table 6-1 Summary for Issue 6

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 6.1 | Implicit BFD-RS determination for S-DCI based MTRP | **Proposal 6.1:** On unified TCI framework extension for S-DCI based MTRP, if the UE is provided the first candidate beam RS list () and the second candidate beam RS set () but not explicitly provided the first BFD-RS set () and the second BFD-RS set () for TRP-specific BFR and if both first and second indicated joint/DL TCI states are configured by RRC to be applied to CORESETs for PDCCH reception, the UE determines the BFD-RS for the first and second BFD-RS sets from the first and second indicated joint/DL TCI states, respectively.   * FFS: The case if any CORESET is configured to apply both first and second indicated joint/DL TCI states for PDCCH-SFN * FFS: Whether and how to handle the case if one or both of the first and second indicated joint/DL TCI states is/are NOT configured by RRC to be applied to CORESET(s) for PDCCH reception   **Current TS 38.213 for link recovery procedures**  If the UE is not provided and for a BWP of the serving cell, the UE determines the set and to include periodic CSI-RS resource configuration indexes with same values as the RS indexes in the RS sets indicated by TCI-State for first and second CORESETs that the UE uses for monitoring PDCCH, respectively, where the UE is provided twocoresetPoolIndex values 0 and 1 for the first and second CORESETs, or is not provided coresetPoolIndex value for the first CORESETs and is provided coresetPoolIndex value of 1 for the second CORESETs, respectively*.*  **FL note: This proposal was provided in the last meeting but no chance to discuss it online/offline, please input your comment to this proposal, if any. Note that since this is not an essential issue in this AI, it is unlikely to treat it in the GTW discussion. I hope we can converge through the offline discussion.** |
| 6.2 | Enhancement to beam update after NW response to TRP-specific BFR request | For M-DCI based MTPR, after NW response to TRP-specific BFR request to a BFD-RS set associated with a *coresetPoolIndex* value, QCL assumption/spatial Tx filter/PL-RS for channel(s)/signal(s) that applies the indicated joint/DL/UL TCI state specific to the *coresetPoolIndex* value is updated according to the new beam (qnew) corresponding to the BFD-RS set.   * Support: Docomo, CATT, Qualcomm, Xiaomi, OPPO * Concern: Ericsson   **FL note: S-DCI based MTRP case can be discussed after there is a conclusion on Issue 6.1. Note that since this is not an essential issue in this AI, it is unlikely to treat it in the GTW discussion. I hope we can converge through the offline discussion.** |

Table 6-2 Company input for Issue 6

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| **Company** | **Input** |
| Mod V00 | * Please input your comment to Proposal 6.1, if any. * Please also update your preference on Issue 6.2, if needed. |
| OPPO | **Proposal 6.1**: Supportive.  **Issue 6.2**: Support.  This is to reset/update the new beam in the similar way as that in Rel.17 for S-TRP using unified TCI state. |
| QC | Proposal 6.1, support |
| Xiaomi | Proposal 6.1: support  Issue 6.2: support for M-DCI based MTRP at least. |
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# Other issue

If there is any important issue not captured in the discussion of previous meetings, company can input to Table 7-1.

Table 7-1 Company inputs for other issue

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| **Company** | **Input** |
| ZTE | As agreed in RAN1#112, the maximum Tx power when the UE determines UL Tx power for the PUSCH/PUCCH transmission occasion(s) or antenna port(s) is to be discussed after receiving RAN4 reply on UE power limitation. Since RAN4 has provided their answers in R4-2303494, we prefer to prioritize the discussion about the following UL PC related issues for STxMP.   |  | | --- | | **Agreement:**  On unified TCI framework extension, if an indicated joint/UL TCI state(s) applies to a PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s), the UE shall determine UL Tx power for the PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s) based on the UL PC parameter setting for PUSCH/PUCCH/SRS, if any, and the PL-RS included in the indicated joint/UL TCI state   * FFS: For STxMP, the maximum Tx power when the UE determines UL Tx power for the PUSCH/PUCCH transmission occasion(s) or antenna port(s) (discussed after receiving RAN4 reply on UE power limitation for STxMP in FR2) * FFS: Default UL PC parameter setting(s) if one or both of indicated joint/UL TCI states applied to PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s) does/do not include the UL PC parameter setting(s) for PUCCH/PUSCH/SRS |   Additionally, according to RAN4 reply, both the per-panel power limitation and per-UE power limitation are feasible and shall be applied to a same UE. With both assumptions being applied, we need to further consider the cases of exceeding the power limitation for STxMP UL transmission, such as the sum of calculated transmission power for both two panels exceeds the per-UE power limitation, or the calculated transmission power of at least one panel exceeds the per-panel power limitation. Therefore, we suggest to add the following sub-bullet for further study.   * FFS: power scaling/allocating mechanism in case of exceeding the power limitation for STxMP UL transmission |
| Huawei, HiSilicon | CC group-based TCI indication is a key issue of unified TCI framework since R17. This has been discussed in previous meetings without much progress. No matter mixed or separate CC grouping is supported in Rel-18 or not, CC group-based TCI indication should be discussed and supported in mTRP-based uTCI framework in Rel-18. Since there are only three remaining meetings, we suggest to prioritize it in this meeting. |
| Docomo | Although, it is captured in the following agreement to study, we’d like to emphasize BFR is important in FR2 operation. After NW response of TRP specific BFR request, joint/DL/UL TCI state(s) and TPC assumptions should be updated for both Single-DCI based and Multi-DCI based M-TRP. If not, after BFR completion, UE cannot receive PDCCH with new beam, and it gNB cannot update indicated TCI state by MAC CE/DCI.  **Agreement**  On unified TCI framework extension, study the following enhancements for TRP-specific BFR:   * Implicit BFD-RS determination based on the indicated joint/DL TCI states for S-DCI based MTRP * Enhancement to beam update after NW response to TRP-specific BFR request |
| FGI | Agree with HW that the discussion for CC group-based TCI indication has been pending for few meetings, so we could prioritize the discussion this meeting. |
| Intel | We need to have some agreements in place for switching between sDCI mTRP schemes since now, we use the new DCI indicator field for TCI state update. The legacy method of using the #TCI states and the #DMRS CDM groups will not work depending on how sTRP switching is handled. Good to prioritize and conclude on this issue along with Proposal 2.1  [Mod] To my understanding to current agreements, the new DCI indicator field is used for TCI selection instead of TCI state update, and the new DCI indicator field can enable the dynamic switching between sTRP and mTRP.  We are also open to discuss BFR issue highlighted by Docomo. |
| Samsung | TCI signaling enhancements for SDCI MTRP are needed. As we may end up of having fullset and numerous subset TCI states combinations, we see the need of increasing the maximum number of MAC CE activated TCI codepoint. Otherwise, the beam indication flexibility would be highly restricted. Then, method to support indicating more TCI codepoints in DCI without increasing the TCI field size and DCI payload can be specified. |

# Appendix: Agreements/conclusions before/in RAN1#112b-e

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| **RAN1#112b-e** |
| Hope we will have 10+ agreements here |
| **RAN1#112** |
| **Agreement**  On unified TCI framework extension for S-DCI based MTRP, a 2-bit [TCI selection field] can be configured by RRC to be present in a DCI format 1\_1/1\_2 that schedules/activates PDSCH reception (including dynamic PDSCH and SPS PDSCH) according to the followings:   * If the DCI format 1\_1/1\_2 indicates codepoint "00" for the [TCI selection field], the UE shall apply the first one of two indicated joint/DL TCI states to all PDSCH DMRS port(s) of corresponding PDSCH transmission occasions(s) scheduled/activated by the DCI format 1\_1/1\_2 * If the DCI format 1\_1/1\_2 indicates codepoint "01" for the [TCI selection field], the UE shall apply the second one of two indicated joint/DL TCI states to all PDSCH DMRS port(s) of corresponding PDSCH transmission occasions(s) scheduled/activated by the DCI format 1\_1/1\_2 * If the DCI format 1\_1/1\_2 indicates codepoint "10" for the [TCI selection field], the UE shall apply both indicated joint/DL TCI states to the PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2 * FFS: Whether and how to use the codepoint "11" of the [TCI selection field]   If the UE is in FR1, or the UE supports the capability of two default beams for S-DCI based MTRP in FR2 regardless of threshold, above apply to PDSCH reception(s) scheduled/activated by the DCI format 1\_1/1\_2.   * Note: If the UE supports the capability of two default beams for S-DCI based MTRP in FR2, UE uses both indicated joint/DL TCI states to buffer the received signal before a threshold.   If the UE doesn’t support the capability of two default beams for S-DCI based MTRP in FR2, above apply to the scheduled/activated PDSCH reception when the offset between the reception of the scheduling DCI format 1\_1/1\_2 and the scheduled/activated PDSCH reception is equal to or larger than a threshold   * FFS: How to apply the indicated joint/DL TCI state(s) to the scheduled/activated PDSCH reception if the offset between the reception of the scheduling DCI format 1\_1/1\_2 and the scheduled/activated PDSCH reception is less than a threshold in FR2   FFS: Detail of the capability of two default beams for S-DCI based MTRP  FFS: The threshold value  **Agreement**  On unified TCI framework extension for S-DCI based MTRP, when two SRS resource sets for CB/NCB are configured, support the followings for PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2 (including DG and Type2 CG):   * If the DCI format 0\_1/0\_2 indicates codepoint "00" for the existing SRS resource set indicator, the UE shall apply the first indicated joint/UL TCI state to all PUSCH antenna port(s) of corresponding PUSCH transmission occasions(s) * If the DCI format 0\_1/0\_2 indicates codepoint "01" for the existing SRS resource set indicator, the UE shall apply the second indicated joint/UL TCI state to all PUSCH antenna port(s) of corresponding PUSCH transmission occasions(s) * If the DCI format 0\_1/0\_2 indicates codepoint "10" or “11” for the existing SRS resource set indicator:   + For TDM based PUSCH Tx scheme, the UE shall apply the first indicated joint/UL TCI state to the PUSCH transmission occasions(s) associated with the first SRS resource set for CB/NCB, and the second indicated joint/UL TCI state to the PUSCH transmission occasions(s) associated with the second SRS resource set for CB/NCB (note: the association between an SRS resource set for CB/NCB and PUSCH transmission occasions(s) is defined according to TS 38.214)   + FFS: SDM and SFN based PUSCH Tx schemes   FFS: The case that the spatial Tx filter(s) determined from the indicated joint/UL TCI state(s) applied to a PUSCH transmission is different from the spatial Tx filter(s) used for the SRS transmission corresponding to the SRS resource(s) indicated to the PUSCH transmission  **Agreement**  On unified TCI framework extension, if an indicated joint/UL TCI state(s) applies to a PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s), the UE shall determine UL Tx power for the PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s) based on the UL PC parameter setting for PUSCH/PUCCH/SRS, if any, and the PL-RS included in the indicated joint/UL TCI state   * FFS: For STxMP, the maximum Tx power when the UE determines UL Tx power for the PUSCH/PUCCH transmission occasion(s) or antenna port(s) (discussed after receiving RAN4 reply on UE power limitation for STxMP in FR2) * FFS: Default UL PC parameter setting(s) if one or both of indicated joint/UL TCI states applied to PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s) does/do not include the UL PC parameter setting(s) for PUCCH/PUSCH/SRS   **Agreement**  On unified TCI framework extension for M-DCI based MTRP, down-select from the following options for PUCCH transmission:   * Opt1: A *coresetPoolIndex* value can be provided per PUCCH resource/resource group, and the UE shall apply the indicated joint/UL TCI state specific to the *coresetPoolIndex* value to the corresponding PUCCH transmission * Opt2: An RRC configuration can be provided per PUCCH resource/resource group to inform that the UE shall apply the first or the second indicated joint/UL TCI state to the corresponding PUCCH transmission, where the first and the second indicated joint/DL TCI states correspond to the indicated joint/UL TCI states specific to *coresetPoolIndex* value 0 and value 1, respectively. * Opt3: For a PUCCH transmission triggered by PDCCH on a CORESET when the UCI in the PUCCH transmission carries HARQ-ACK information only, the UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to the PUCCH transmission, where the *coresetPoolIndex* value is determined from the one associated with the CORESET. Otherwise, either Opt1 or Opt2 is adopted.   + FFS: Whether Opt3 applies only when the UE is not provided with *ackNackFeedbackMode* = *joint* * Opt4: For a PUCCH transmission with an LRR trigged for either the first BFD-RS set () or the second BFD-RS set () when the UE is provided only one or two *schedulingRequestID-BFR* configuration, the UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to the PUCCH transmission, where the *coresetPoolIndex* value is 1 when the LRR is trigged for the first BFD-RS set () and the *coresetPoolIndex* value is 0 when the LRR is trigged for the second BFD-RS set (). Otherwise, either Opt1 or Opt2 is adopted.   Note: Either Opt1 or Opt2 must be supported  **Agreement**  On unified TCI framework extension for S-DCI based MTRP, down-select at least one of the followings for PDSCH reception scheduled/activated by DCI format 1\_1/1\_2 configured w/o the [TCI selection field]:   * Alt1: Using RRC configuration to inform that the UE shall apply the first one, the second one, or both of two indicated joint/DL TCI states to the scheduled/activated PDSCH reception * Alt2: The UE shall apply the first one of two indicated joint/DL TCI state(s) to the scheduled/activated PDSCH reception * Alt3: The UE shall apply both of two indicated joint/DL TCI states to the scheduled/activated PDSCH reception * Alt3A: The UE shall apply the same joint/DL TCI state(s) that is applied to the PDCCH reception with the scheduling/activation DCI to the scheduled/activated PDSCH reception * Alt4: Which indicated joint/DL TCI state(s) is/are applied to the scheduled/activated PDSCH reception is determined according to the existing TCI field of the most recently applied beam indication DCI   Above applies at least if the offset between the reception of the scheduling DCI format 1\_1/1\_2 and the scheduled/activated PDSCH reception is equal to or larger than a threshold (if the threshold is needed) |
| **RAN1#111** |
| **Agreement**  On unified TCI framework extension for S-DCI based MTRP, in one beam indication instance, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate joint/DL/UL TCI state(s) for one or both of the two TRPs in a CC/BWP or a set of CCs/BWPs in a CC list   * FFS: Increase on the size of the TCI field * Note: The term TRP is used only for discussion purpose in RAN1 and whether/how to capture this is FFS   **Agreement**  On unified TCI framework extension for S-DCI based MTRP, a DCI field in DCI format 1\_1/1\_2 that schedules/activates PDSCH reception is used to determine which one or both of the indicated joint/DL TCI states shall be applied to the scheduled/activated PDSCH reception   * The presence of the DCI field is configurable by RRC; when the DCI field is not present in DCI format 1\_1/1\_2, the UE shall apply the default indicated joint/DL TCI state(s) to PDSCH reception   + FFS: Details on the default indicated joint/DL TCI state(s) to PDSCH reception * FFS: The DCI field is a new indicator field or an existing field (e.g., the existing TCI field) * FFS: Regardless the DCI field is present or not present, how to apply the indicated joint/DL TCI state(s) to PDSCH reception if the offset between the reception of the DCI format 1\_1/1\_2 and the corresponding PDSCH reception is less than a threshold   FFS: How to apply the indicated joint/DL TCI state(s) to PDSCH reception scheduled/activated by DCI format 1\_0.  Above applies for the case where PDSCHs scheduled by the same DCI.  **Agreement**  On unified TCI framework extension for S-DCI based MTRP, use RRC configuration to inform that the UE shall apply the first one, the second one, or both of the indicated joint/UL TCI states to a PUCCH resource/group   * Note: Detail of the RRC configuration is left to RAN2 design   **Agreement**  On unified TCI framework extension, PDSCH-CJT is supported as a S-DCI based MTRP scheme  Note: Above does not preclude discussions specific to PDSCH-CJT design in the unified TCI framework  **Agreement**  On unified TCI framework extension for S-DCI based MTRP, use an indicator field (could be reusing an existing DCI field or introducing a new DCI field) in the DCI format 0\_1/0\_2 to inform which joint/UL TCI state(s) indicated by MAC-CE/DCI the UE shall apply to PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2  **Agreement**  On unified TCI framework extension, down-select at least one of the following alternatives for PDSCH-CJT applying both indicated joint TCI states (if the UE supports two indicated joint/DL states for PDSCH-CJT):   * Alt1: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA * Alt2: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA except for QCL parameters {Doppler shift, Doppler spread} of the second indicated joint TCI state * Alt3: PDSCH DMRS port(s) is QCLed with the DL RS of the first indicated joint TCI state with respect to QCL-TypeA and QCLed with the DL RS of the second indicated joint TCI state with respect to QCL-TypeB   **Agreement**  On unified TCI framework extension for M-DCI based MTRP, the same configuration/rule used in Rel-17 unified TCI framework (for determining whether the UE shall apply the indicated joint/DL TCI state to PDCCH on a CORESET and respective PDSCH) is reused to determine whether the UE shall apply the indicated joint/DL TCI state specific to a *coresetPoolIndex* value to PDCCH on a CORESET associated with the same *coresetPoolIndex* value and PDSCH scheduled/activated by the PDCCH.  **Agreement**  On unified TCI framework extension for M-DCI based MTRP, the UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to PUSCH transmission scheduled/activated by PDCCH (including DG-PUSCH and Type2 CG-PUSCH) on a CORESET that is associated with the same *coresetPoolIndex* value  **Agreement**  On unified TCI framework extension for S-DCI based MTRP, a new indicator field is supported as the DCI field in DCI format 1\_1/1\_2 that schedules/activates PDSCH reception to determine which one or both of the indicated joint/DL TCI states shall be applied to the scheduled/activated PDSCH reception   * FFS: Detail design of the new indicator field |
| **RAN1#110b-e** |
| **Conclusion**  On unified TCI framework extension in Rel-18, there is no consensus to support simultaneous configuration of both joint and separate DL/UL TCI modes in a serving cell  **Conclusion**  On unified TCI framework extension in Rel-18, there is no consensus to support separate RRC-configured TCI state list(s) for each of TRPs  **Agreement**  On unified TCI framework extension for M-DCI based MTRP:   * The existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) associated with one *coresetPoolIndex* value can indicate the joint/DL/UL TCI state(s) specific to the same *coresetPoolIndex* value   + FFS: The UE shall apply the indicated joint/DL/UL TCI state(s) specific to a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the same *coresetPoolIndex* value * A *coresetPoolIndex* value field is included in TCI state activation command (MAC-CE) to indicate that the mapping between the activated TCI state(s) and the TCI codepoint(s) is specific to which *coresetPoolIndex* value   **Agreement**  On unified TCI framework extension for S-DCI based MTRP, to inform the association with the joint/DL TCI state(s) indicated by DCI/MAC-CE for PDCCH repetition, PDCCH-SFN, and PDCCH w/o repetition/SFN, support the following:   * Use RRC configuration to inform that the UE shall apply the first one, the second one, both, or none of the joint/DL TCI states indicated by DCI/MAC-CE to a CORESET or a group of CORESETs (if CORESET group configuration is supported)   **Agreement**  On unified TCI framework extension for M-DCI based MTRP:   * For a serving cell configured with joint DL/UL TCI mode, one joint TCI state can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) * For a serving cell configured with separate DL/UL TCI mode, a DL TCI state, an UL TCI state, or a pair of DL and UL TCI states can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment)   **Agreement**  On unified TCI framework extension for S-DCI based MTRP, down-select one alternative from the followings in RAN1#111 for PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2:   * Alt1: Use an indicator field (could be reusing an existing DCI field or introducing a new DCI field) in the DCI format 0\_1/0\_2 to inform which joint/UL TCI state(s) indicated by MAC-CE/DCI the UE shall apply to PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2 * Alt2: PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2 follows the spatial domain transmission filter(s) used for the SRS resource(s) indicated by the DCI format 0\_1/0\_2   + - FFS: PL-RS(s), and UL PC parameter setting(s) (including P0, alpha, and closed loop index) for the PUSCH   **Agreement**  On unified TCI framework extension for S-DCI based MTRP, down-select one alternative from the followings in RAN1#111 for PUCCH transmission:   * Alt1: Use RRC configuration to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/ group * Alt2: Use RRC configuration to inform the association between a CORESET group and a PUCCH resource/group, and the indicated joint/UL TCI state(s) associated with the CORESET group applies to the PUCCH resource/group associated with the same CORESET group * Alt3: Use MAC-CE to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/group * Note: the association indicates whether the UE shall apply the first one, the second one, or both of the joint/UL TCI states indicated by DCI/MAC-CE to a PUCCH resource/group   **Agreement**  On unified TCI framework extension, up to 2 joint TCI states can be indicated by MAC-CE/DCI and applied to CJT-based PDSCH reception (PDSCH-CJT) in a BWP/CC configured with joint DL/UL TCI mode   * Support of 1 or 2 indicated joint TCI states for PDSCH-CJT is up to UE capability * FFS: QCL type(s)/assumption(s) of the indicated joint TCI state(s) applied to PDSCH-CJT * Note: On how to inform UE to apply which indicated joint TCI state(s) to target channel(s)/signal(s) in the BWP/CC, it is discussed individually in AI 9.1.1.1   **Agreement**  On unified TCI framework extension for M-DCI based MTRP:   * The UE shall apply the indicated joint/DL TCI state specific to a *coresetPoolIndex* value to PDCCH on a CORESET that is associated with the same *coresetPoolIndex* value * The UE shall apply the indicated joint/DL TCI state specific to a *coresetPoolIndex* value to PDSCH scheduled/activated by PDCCH on a CORESET that is associated with the same *coresetPoolIndex* value * FFS: Other channel(s)/signal(s) that has explicit or implicit association with a *coresetPoolIndex* value * FFS: Other channel(s)/signal(s) that doesn’t have association with a *coresetPoolIndex* value   Above are applicable to the CORESET(s) that is configured/allowed to follow the indicated joint/DL TCI state  FFS: The configuration/rule to configure/allow CORESET(s) to follow the indicated joint/DL TCI state, including the option to reuse the same configuration/rule as in Rel-17 unified TCI framework  **Agreement**  On unified TCI framework extension, study the following enhancements for TRP-specific BFR:   * Implicit BFD-RS determination based on the indicated joint/DL TCI states for S-DCI based MTRP * Enhancement to beam update after NW response to TRP-specific BFR request   **Agreement**  On unified TCI framework extension for S-DCI based MTRP, down-select one alternative from the followings in RAN1#111:   * Alt1: In one beam indication instance, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate joint/DL /UL TCI state(s) for one of the two TRPs or both TRPs in a CC/BWP or a set of CCs/BWPs in a CC list * Alt2: In one beam indication instance, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate joint/DL /UL TCI state(s) only specific to one of the two TRPs in a CC/BWP or a set of CCs/BWPs in a CC list   + Note: According to the agreement in RAN1#109-e, support of one additional TCI field or a field associating the TCI field to the TRP(s) is not precluded   Note: It has been agreed to use the existing TCI field for TCI state indication for S-DCI based MTRP in RAN1#109e  Note: The term TRP is used only for discussion purpose in RAN1 and whether/how to capture this is FFS  FFS: The behavior if the UE receives a beam indication DCI that indicates joint/DL/UL TCI state(s) for one TRP |
| **RAN1#110** |
| **Agreement**  On unified TCI framework extension, for the target use cases agreed in RAN1#109-e in AI 9.1.1.1, up to 4 TCI states can be indicated in a CC/BWP or a set of CCs/BWPs in a CC list to DL receptions and/or UL transmissions, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation   * FFS: The possible combination(s) of joint/DL/UL TCI states that can be indicated to DL receptions and/or UL transmissions in a BWP/CC/TRP * Note: This agreement does not imply that there will be more than 2 DL or UL or joint TCI states indicated in a CC/BWP for the target use cases agreed in RAN1#109-e in AI 9.1.1.1 * Note: The maximum number of TCI states that can be indicated to each of the target use cases agreed in RAN1#109-e in AI 9.1.1.1 is remained the same as in Rel-16/17   Note: The maximum number of TCI states that can be indicated simultaneously to CJT-based PDSCH reception and the required type(s) of TCI states (i.e., DL /UL/joint) are independently discussed in this AI  **Agreement**  On unified TCI framework extension for S-DCI based MTRP, to inform the association with the joint/DL TCI state(s) indicated by DCI/MAC-CE for PDCCH repetition, PDCCH-SFN, and PDCCH w/o repetition/SFN, down-selection at least one alternative from the followings:   * Alt1-1: Use RRC parameter(s) in a CORESET configuration to inform the UE whether and/or which indicated joint/DL TCI state(s) shall be applied to the corresponding PDCCH receptions on the CORESET   + FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the joint/DL TCI state(s) indicated by DCI/MAC-CE * Alt1-2: Use an RRC parameter in a CORESET configuration to inform that the CORESET belongs to which CORESET group(s), and the indicated joint/DL TCI state(s) is associated with each CORESET group   + FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the CORESET group(s)   + FFS: How to associate the indicated joint/DL TCI state(s) with each CORESET group   + FFS: The UE applies the indicated joint/DL TCI state(s) to a CORESET according to the CORESET group(s) the CORESET belongs to, or the UE applies the indicated joint/DL TCI state(s) associated with the CORESET group(s) in which the beam indication DCI is received to all PDCCH receptions * Alt2: The association between a CORESET and the indicated joint/DL TCI state(s) is determined based on a fixed rule, and the UE shall apply the indicated joint/DL TCI state(s) to the corresponding PDCCH receptions on the CORESET   + FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the joint/DL TCI state(s) indicated by DCI/MAC-CE * Alt3: Use MAC-CE to inform the UE whether and/or which indicated joint/DL TCI state(s) shall be applied to the corresponding PDCCH receptions on a CORESET   + FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the joint/DL TCI state(s) indicated by DCI/MAC-CE   Switching between multi-TRP and single TRP operation is not precluded  **Agreement**  On unified TCI framework extension for S-DCI based MTRP, for PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2, down-selection one alternative from the followings:   * Alt1: Use an indicator field (could be reusing an existing DCI field or introducing a new DCI field) in a DCI format 0\_1/0\_2 to inform which joint/UL TCI state(s) indicated by MAC-CE/DCI the UE shall apply to PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2 * Alt2: PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2 follows the spatial domain transmission filter(s) used for the SRS resource(s) indicated by the DCI format 0\_1/0\_2 * Alt3: Use an RRC parameter in a CORESET configuration to inform that the CORESET belongs to which CORESET group(s), and the indicated joint/UL TCI state(s) is associated with each CORESET group. When a scheduling/activation DCI format 0\_1/0\_2 is received in a CORESET group, the indicated joint/UL TCI state(s) associated with the CORESET group is applied to PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2   + FFS: Details of CORESET group(s)   FFS: PUSCH transmission scheduled/activated by a DCI format 0\_0 and Type-1 CG-PUSCH  **Agreement**  On unified TCI framework extension for S-DCI based MTRP, to inform the association with joint/UL TCI state(s) indicated by DCI/MAC-CE for PUCCH transmission, down-selection at least one alternative from the followings:   * Alt1: Use RRC configuration to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/ group * Alt2: Use RRC configuration to inform the association between a CORESET group and a PUCCH resource/group, and the indicated joint/UL TCI state(s) associated with the CORESET group applies to the PUCCH resource/group * Alt3: Use MAC-CE to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/group * Alt4: Use DCI to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/group |
| **RAN1#109e** |
| **Agreement**  On unified TCI framework extension, consider all the intra and inter-cell MTRP schemes specified in Rel-16 and Rel-17   * Consider, if STxMP is supported, Rel-18 MTRP scheme(s) with STxMP   **Agreement**  On unified TCI framework extension at least for single-DCI based MTRP, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate multiple joint/DL/UL TCI states in a CC/BWP or a set of CCs/BWPs in a CC list   * FFS: Detail of mapping joint/DL/UL TCI state ID(s) to a TCI codepoint, e.g., possible combinations of joint, DL, and/or UL TCI state IDs that can be mapped to a TCI codepoint * FFS: Whether to increase the max number of MAC CE activated TCI codepoints, i.e., more than 8 codepoints * FFS: Whether to increase the max number of TCI field bits, i.e., more than 3 bits * Note: This doesn't imply that support of one additional TCI field or a field associating the TCI field to the TRP(s) is precluded   Note: The term TRP is used only for the purposes of discussions in RAN1 and whether/how to capture this is FFS  **Agreement**  On unified TCI framework extension for M-DCI based MTRP, consider the following alternatives for TCI state update:   * Alt1: Reuse the same TCI state update scheme for S-DCI based MTRP * Atl2: Use the existing TCI field in the DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *CORESETPoolIndex* values to indicate the joint/DL/UL TCI state(s) corresponding to the same *CORESETPoolIndex* value * Alt3: Use the existing TCI field in any DCI format 1\_1/1\_2 (with or without DL assignment) to indicate all joint/DL/UL TCI states corresponding to both *CORESETPoolIndex* values   + Study the association between the indicated joint/DL/UL TCI state(s) and a *CORESETPoolIndex* value * Alt4: Use the existing TCI field in the DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *CORESETPoolIndex* values to indicate joint/DL/UL TCI state(s) corresponding to the same or different *CORESETPoolIndex* value.   + Study whether the indicated joint/DL/UL TCI state(s) applies to the channels/signals associated with the same *CORESETPoolIndex* value or different *CORESETPoolIndex* value is indicated by DCI   **Agreement**  On unified TCI framework extension for S-DCI based MTRP, consider at least the following alternatives to map/associate a joint/DL TCI state to PDCCH reception(s)   * Atl1: Use RRC configuration to inform the mapping/association between a configured or indicated joint/DL TCI state and a CORESET or a CORESET group * Alt2: Use RRC configuration to inform the mapping/association between a configured or indicated joint/DL TCI state and a search space set * Alt3: Use MAC-CE to inform the mapping/association between an activated or indicated joint/DL TCI state and a CORESET or a CORESET group * Alt4: Use DCI to inform the mapping/association between an indicated joint/DL TCI state and a CORESET or a CORESET group * Alt5: Based on a fixed mapping/association rule, e.g., the first indicated joint/DL TCI state always applies to PDCCH receptions   Consider above alternatives for PDCCH repetition, PDCCH-SFN, PDCCH w/o repetition/SFN, and potential support of dynamic switching between S-TRP and M-TRP for PDCCH. It is not precluded to adopt one single alternative or multiple alternatives to support these cases.  **Agreement**  On unified TCI framework extension, if an indicated joint or UL TCI state applies to a PUSCH/PUCCH transmission occasion at least for S-DCI based PUSCH/PUCCH repetition with TDM and the indicated joint or UL TCI state is associated with an UL PC parameter setting for PUSCH/PUCCH (including P0, alpha for PUSCH, and closed loop index) and a PL-RS, the UE should apply the UL PC parameter setting and the PL-RS for the PUSCH /PUCCH transmission occasion.   * FFS: How to extend to other Rel-18 MTRP scheme(s) with STxMP, if supported * FFS: UL PC enhancement for CB and non-CB SRS in above case   FFS: The applied UL PC parameter setting if one or both indicated joint or UL TCI state(s) is not associated with an UL PC parameter setting (including P0, alpha for PUSCH, and closed loop index) for PUCCH/PUSCH  **Agreement**  On UE power limitation for STxMP for FR2, send LS to RAN4 to check the followings:   * Whether it is feasible to assume power limitation per panel for STxMP (Assumption 1) * Whether it is feasible to assume a total power limitation per UE over all UE panels used for STxMP (Assumption 2) * In either of Assumption1 or Assumption 2, whether the total power limitation per UE over all UE panels used for STxMP or the sum of per-panel power limitation for STxMP can be different from (greater than) the existing power limitation for a given power class? * If both Assumption 1 and Assumption 2 are feasible, whether both assumptions can be applied to a same UE, and what is the relationship between the per-panel power limitation and total power limitation if both are applied (e.g., the sum of per-panel power limitation can be larger than the total power limitation per UE, or should be always the same)?   FFS: Detail of exact LS if agreed  Note: Scenarios of above include at least single carrier scenario for FR2  Note: Above power limitation includes both total radiated power and EIRP  LS to RAN4 is endorsed in R1-2205639. |

# References

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| 1 | [R1-2303806](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303806.zip) | Discussion on unified TCI framework extension for multi-TRP operation | Moderator (MediaTek Inc.) |
| 2 | R1-2302265 | Reply LS on UE power limitation for STxMP in FR2 | RAN4 (vivo) |
| 3 | [R1-2303778](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303778.zip) | Discussion on unified TCI framework extension for multi-TRP | ITRI |
| 4 | [R1-2303805](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303805.zip) | Discussion on unified TCI framework extension for M-TRP operation | Hyundai Motor Company |
| 5 | [R1-2303697](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303697.zip) | Discussion on unified TCI framework extension for multi-TRP | NTT DOCOMO, INC. |
| 6 | [R1-2303359](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303359.zip) | Unified TCI framework extension for multi-TRP | MediaTek Inc. |
| 7 | [R1-2303372](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303372.zip) | Discussion on unified TCI framework extension for multi-TRP | Transsion Holdings |
| 8 | [R1-2303393](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303393.zip) | Discussion on unified TCI framework extension for multi-TRP operation | TCL Communication Ltd. |
| 9 | [R1-2303405](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303405.zip) | Discussion on unified TCI framework extension for multi-TRP | FGI |
| 10 | [R1-2303516](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303516.zip) | Discussion on unified TCI framework extension for multi-TRP | Google |
| 11 | [R1-2303467](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303467.zip) | Unified TCI framework extension for multi-TRP | Apple |
| 12 | [R1-2303665](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303665.zip) | Discussion on unified TCI framework extension for multi-TRP | NEC |
| 13 | [R1-2303573](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303573.zip) | Extension of unified TCI framework for mTRP | Qualcomm Incorporated |
| 14 | [R1-2303300](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303300.zip) | Discussion on Unified TCI framework extension for multi-TRP | CEWiT |
| 15 | [R1-2303216](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303216.zip) | Discussion on unified TCI framework extension for multi-TRP | CMCC |
| 16 | [R1-2303178](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303178.zip) | Unified TCI framework extension for multi-TRP | Sharp |
| 17 | [R1-2303110](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303110.zip) | Views on unified TCI extension focusing on m-TRP | Samsung |
| 18 | [R1-2303068](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303068.zip) | Unified TCI framework extension for multi-TRP/panel | LG Electronics |
| 19 | [R1-2303005](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303005.zip) | Unified TCI framework extension for multi-TRP | Nokia, Nokia Shanghai Bell |
| 20 | [R1-2302959](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302959.zip) | Unified TCI framework extension for multi-TRP | xiaomi |
| 21 | [R1-2302780](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302780.zip) | Unified TCI Framework for Multi-TRP | Intel Corporation |
| 22 | [R1-2302900](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302900.zip) | Discussion on unified TCI framework extension for multi-TRP | Fujitsu |
| 23 | [R1-2302585](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302585.zip) | Discussion on unified TCI framework extension for multi-TRP | Spreadtrum |
| 24 | [R1-2302635](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302635.zip) | Multi-TRP enhancements for the unified TCI framework | Fraunhofer IIS |
| 25 | [R1-2302723](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302723.zip) | Discussion of unified TCI framework for multi-TRP | Lenovo |
| 26 | [R1-2302680](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302680.zip) | Further discussion on unified TCI framework extension for multi-TRP operation | CATT |
| 27 | [R1-2302311](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302311.zip) | Unified TCI framework extension for multi-TRP | FUTUREWEI |
| 28 | [R1-2302299](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302299.zip) | Unified TCI Enhancements for MTRP | InterDigital, Inc. |
| 29 | [R1-2302370](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302370.zip) | Discussion on unified TCI framework extension for multi-TRP | Huawei, HiSilicon |
| 30 | [R1-2302396](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302396.zip) | Unified TCI framework extension for multi-TRP | Panasonic |
| 31 | [R1-2302416](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302416.zip) | Enhancements on unified TCI framework extension for multi-TRP | ZTE |
| 32 | [R1-2302411](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302411.zip) | Unified TCI framework extension for multi-TRP | Ericsson |
| 33 | [R1-2302532](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302532.zip) | Unified TCI framework extension for multi-TRP | OPPO |
| 34 | [R1-2302469](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302469.zip) | Further discussion on unified TCI framework extension for multi-TRP | vivo |