**3GPP TSG RAN WG1 #110bis-e R1-221nnnn**

**e-Meeting, October 10th – 19th, 2022**

**Agenda item:** 9.1.1.1

**Source:** Moderator (MediaTek)

**Title:** Moderator summary on extension of unified TCI framework (Round 1)

**Document for:** Discussion and Decision

# Introduction

In RAN#94e, the Rel-18 WID of MIMO evolution for downlink and uplink is approved [1]. 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 [2]-[33], 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 framework for unified TCI extension
  + Issue 2 – TCI state update and activation
  + Issue 3 – How to associate the indicated TCI state(s) with each target channel/signal
  + Issue 4 – UL power control for UL MTRP
  + Issue 5 – Beam reporting and beam failure recovery
* Observations and recommended proposals based on the summary of companies’ views

This FL summary (Round 1) is prepared for our 2nd GTW discussion (Thursday 10/13 @12:00 UTC) and the 1st check point for email endorsement (Friday 10/14). Please upload your inputs to the corresponding draft folder, if any, **by Thursday 10/13 @10:00 UTC.**

# Contact Person

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

Table 0 Contact Information

|  |  |  |
| --- | --- | --- |
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# Discussion

# Issue 1 – General framework for unified TCI extension

Table 1-1 Summary for Issue 1

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| **#** | **Issue** | **Companies’ views** |
| 1.3 | RRC-configured TCI state lists | Alt1: Reuse Rel-17 design (i.e., one list for joint/DL TCI states and another list for UL TCI states)   * Support: Apple (S-DCI), Ericsson, CATT (S-DCI), Fujitsu, Panasonic, MediaTek, Qualcomm, OPPO, Huawei/HiSilicon, IDC, Futurewei, LG, vivo, TransHold, Nokia, Intel, CMCC, Samsung, Xiaomi   Alt2: Introduce TRP-specific TCI state list(s)   * Support: Apple (M-DCI), CATT (M-DCI), ZTE, Spreadtrum, TCL, Google, Docomo (M-DCI), NEC |

**Proposal 1.A**: On unified TCI framework extension, support simultaneous configuration of both joint and separate DL/UL TCI modes in a serving cell

* FFS: Signaling for the configuration

**Conclusion 1.A:** 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

**Proposal 1.B**: On unified TCI framework extension, up to 4 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

* FFS: QCL type(s)/assumption(s) of the indicated joint TCI state(s) applied to PDSCH-CJT
* Note: As in Rel-17, the indicated joint TCI state(s) can be applied to UL transmission only when applicable
* Note: On how to associate the indicated joint TCI state(s) with target channel(s)/signal(s) in the BWP/CC, it is discussed individually in AI 9.1.1.1

**Conclusion 1.C:** On unified TCI framework extension in Rel-18, there is no consensus to support separate TCI state list(s) for each of TRPs

Table 1-2 Company inputs for Issue 1

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| **Company** | **Input** |
| Mod | * **Please share your view on Proposal 1.A and Conclusion 1.A. Note that we will not have any GTW discussion for this issue, and we need to conclude in this meeting, as mentioned by Mr. Chairman. If companies still have concern on Proposal 1.A, Conclusion 1.A will be the outcome in the end of this meeting.** * **Please share your view on Proposal 1.B. Regarding the concern on the UE-compensation of Doppler shift or other QCL parameters, from FL’s perspective, it can be addressed when further define the QCL type(s)/assumption(s) of the indicated joint TCI state(s) applied to PDSCH-CJT (e.g., Doppler shift can be removed from the QCL assumption).** * **For the concern on joint TCI state in Proposal 1.B, there is no reason to configure separate DL/UL TCI mode in FR1 (which is Rel-18 CJT targets to), thus we can focus on joint DL/UL TCI mode, where TCI states can be indicated to both DL Rx and UL Tx. However, joint TCI state can be applied to UL Tx only when applicable, which is already defined in Rel-17 spec. A note is added for clarification.** * **For Proposal 1.B, regarding how to associate the indicated joint TCI states with channels/signals other than PDSCH, this can be discussed as a part of Issue 3 in this AI (including PDSCH). A note is added for clarification.** * **Given the majority view on Issue 1.3, Conclusion 1.C is recommended for this issue** |
| QC | For Proposal 1.A, support. We believe per-TRP MPE issue can happen frequently, i.e. a single TRP may be locked by human most of time, not both  For Proposal 1.B, not support. How the 4 TCIs are used is unclear. Without any solid study on the performance, we prefer only 1 TCI for R18 CJT, i.e. TRPs should be at similar locations.  **Proposal 1.B**: On unified TCI framework extension for S-DCI based MTRP,   * up to 2 joint TCI states can be indicated by MAC-CE/DCI in a CC configured with joint DL/UL TCI mode if UE is not configured with CSI report for R18 mTRP CJT * up to 1 joint TCI state can be indicated by MAC-CE/DCI in a CC configured with joint DL/UL TCI mode if UE is configured with CSI report for R18 mTRP CJT   To HW, agree that R17 SFN also has similar issue, which can be mitigated by delay/frequency diversity to our understanding. However, those diversity methods may not be applicable to CJT especially when multiple streams are precoded and the selling point of CJT is the phase combining gain. The PDSCH CJT performance is never carefully evaluated so far, and we do believe it shall not be pushed too aggressively in R18. Fine to consider 4 TCI in R19 after more careful evaluation.  For Conclusion 1.C, fine for it. |
| vivo | **Proposal 1.A** or **Conclusion 1.A,** we are fine to go with either one. Perhaps a compromise could be to support simultaneous configuration of both joint and separate DL/UL TCI modes for M-DCI based MTRP in a serving cell.  **Proposal 1.B**: we are generally fine. With regards to companies’ concern, we can make it a working assumption for companies to provide more evaluation results. From the system point of view, if only one TCI state is indicated, probably UE-specific TRS would cause large amount of TRS overhead because different UEs may be served by different TRPs and CJT is targeting more UEs to be served simultaneously.  **Conclusion 1.C**: support. |
| Xiaomi | **Proposal 1.A and Conclusion 1.A**  We prefer proposal 1.A, and suggest to update ‘configuration’ into ‘indication’. Since we are not intended to propose separate TCI state list for M-TRP. We intend to propose indication of joint TCI state for one TRP and separate DL/UL TCI state for the other TRP by MAC CE/DCI. As for TCI list configured by RRC, two TCI list will be needed. One list for joint/DL TCI state, and the other one list for UL TCI state. But dynamically change between joint TCI mode and separate DL/UL TCI mode can be realized by MAC CE or DCI. Some companies propose to use separate TCI state in both TRP in this case, but the MAC CE overhead will be higher. Thus the following updated proposal 1.A can support the per-TRP MPE with low MAC CE overhead for TCI state indication.  **Proposal 1.A**: On unified TCI framework extension, support simultaneous ~~configuration~~ indication of both joint and separate DL/UL TCI modes in a serving cell   * FFS: Signaling for the ~~configuration~~ indication   **Proposal 1.B**  We slightly prefer to support up to 2 TCI states for all M-TRP schemes to reduce the spec impact. If up to 4 TCI states is supported for PDSCH-CJT, the association of TCI state for PDCCH/PUCCH/PUSCH should be further enhanced.  **Conclusion 1.C**  Support |
| ZTE | **Proposal 1.A and Conclusion 1.A**  As mentioned during online, we have concerns on proposal 1.A. Technically speaking, the proponent’s companies’ views are much relevant to gNB configuration/indication flexibility and TRP-specific MPE. Then, to be honest, we can NOT be convinced according to the above reasons.   * + Separate TCI state configuration can be assumed as a superset of joint TCI, which means that if having separate TCI state configuration, any target(s) of simultaneous joint and separate TCI indication can be achieved well.   + After that, MPE is much relevant to relative location between UE and phone. It is very confusing why, for long-term duration (due to RRC configuration), one TRP is good but another is bad in terms of MPE. If not, that means we can not save any RRC configuration signaling even if having this proposal 1.A.   Therefore, we suggest to go with Conclusion 1.A (simple and efficient, good for backward compatibility).  **Proposal 1.B**  For moving forward this issue (in Rel-18 rather than Rel-19 ^ ^), we have the following suggestions:   * + #1 Instead of having 4 joint TCI states, just support up to 2 joint TCI state. That means that we do not need do much efforts from signaling perspective;   + #2 In technical, we share the same views with QC that some pre-compensation is needed, e.g., Doppler shift and average delay. But it is relevant to scenarios, and for motionless UE or intra-site case, some pre-compensation may not be needed. So, we may have the following subbullet     - QCL type(s)/assumption(s) of the indicated joint TCI state(s) applied to PDSCH-CJT can be configurable (by explicit or implicit manner, e.g., SFT-Scheme-2)     - Support >1 joint TCI for CJT is an optional UE feature.   **Proposal 1.C**  Definitely not our preference, but even if going like this way, we may make some modification for clarification.  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 |
| OPPO | **Proposal 1.A:** not support.  In our understanding, the target use case for the mixed mode is to address the MPE issue. When configuring UTCI states, NW cannot predict in advance which TRP will be involved with MPE and the other TRP will not. Simple solution for this unawareness is to configure separate UL/DL TCI states for both TRPs.  Moreover, if the first sub-bullet is removed in updated Proposal 1.A, one TRP can be configured with both joint and separate TCI states. This is beyond the consensus of Rel.17 UTCI design for STRP. Conclusion pasted below for reference. And besides flexibility, we fail to see other strong motivation to change the UTCI framework even for STRP.  **Conclusion**  On Rel-17 unified TCI framework, for a UE configured with both joint TCI and separate DL/UL TCI, configuration of joint TCI or separate DL/UL TCI is based on RRC signaling   * There is no consensus in RAN1 on how to support dynamic switching (either MAC-CE or codepoint based)     **Conclusion 1.A:** okay.  **Proposal 1.B**: not support.  Thanks to FL for the explanation on using the joint TCI states in the proposal. In Proposal 2.B, it seems one codepoint of TCI field in DCI could contain a DL TCI state only. Anyway, that’s not quite essential.  Regarding the main bullet, we used to think even single TCI state (containing one TRS) would serve the UE for all involved MTRP, therefore no need to increasing the maximum number to 4. When compared to up to 2 for all other MTRP schemes, it would complicate the signalling design and overhead.  Moreover, by checking the discussion related to Doppler shift and/or average delay of PDSCH-CJT, we are not sure whether pre-compensation in freq./time domain should be enhanced (like compensation for PDSCH SFN Scheme B in frequency domain) in AI 9.1.1.1. It seems our purpose is just to extend UTCI framework for at least stable MTRP schemes. We are reluctant to introduce new MTRP scheme (e.g. PDSCH-CJT with specified time/freq. compensation analogous to PDSCH SFN Scheme B) here. If that’s the case, we still hold the thought that 1 TCI state would be workable, and up to 2 can be acceptable to be aligned with other MTRP schemes.  **Conclusion 1.C:** okay. |
| Panasonic | We support **Proposal 1.A**. Moreover, **conclusion 1.A** should not include m-DCI. |
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# Issue 2 – TCI state update and activation

Table 2-1 Summary for Issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2.3 | For S-DCI based MTRP, whether to introduce/re-interpret DCI field(s) other than the existing TCI field for TCI state update | Alt1: Use only the existing TCI field for TCI state update   * Support: Apple, CATT, CEWiT, Fraunhofer, Futurewei, Intel, Lenovo, Nokia, OPPO, Qualcomm, Sharp, Spreadtrum, vivo, InterDigital, Xiaomi   ,   * Concern: Huawei/HiSilicon   Alt2: Use the existing TCI field and one additional DCI field (could be reusing an existing DCI field or introducing a new DCI field) for TCI state update   * Support: Huawei/HiSilicon, Ericsson, FGI, Google, Samsung * Concern: |

**Proposal 2.A:** 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

**Proposal 2.B:** 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)
* FFS: For a serving cell configured with both joint and separate DL/UL TCI modes, if supported, a joint TCI state, 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)

**Conclusion 2.C:** On unified TCI framework extension Rel-18, there is no consensus to support a DCI field other than the existing TCI field (could be reusing an existing DCI field or introducing a new DCI field) for TCI state indication for S-DCI based MTRP

* Note: It has been agreed to use the existing TCI field for TCI state indication for S-DCI based MTRP in RAN1#109e

Table 2-2 Company inputs for Issue 2

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| **Company** | **Input** |
| Mod | * **Please update your view on those sub-issues in Table 2-1 (especially Issue 2.3)** * **Please also share your view on Proposal 2.A – 2.B** |
| QC | For Proposal 2.A, support. We believe same-TRP TCI indication is sufficient for mDCI mTRP, whose main use case is for self-scheduling. This also saves the DCI overhead.  For Proposal 2.B, support |
| MediaTek | For P2.A, support. Cross-TRP TCI state update still can be done by MAC-CE based TCI state update.  For P2.B, support. |
| Futurewei | **Proposal 2.A:** Support in principle. In Rel. 17, the CORESET(s), AP-SRS, and AP-CSI-RS can be configured to follow or not follow the indicated unified TCI state(s). We believe the same rule should also be used in Rel. 18, Therefore we would like to modify the proposal as follows:  **Proposal 2.A:** 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   + The UE shall apply the indicated joint/DL/UL TCI state(s) to PDCCH on the CORESET(s) which are associated with the same *coresetPoolIndex* value and configured to follow the indicated joint/DL/UL TCI state(s).   + The UE shall apply the indicated joint/DL/UL TCI state(s) to PDSCH, PUSCH, AP-SRS, and AP-CSI-RS scheduled/activated/triggered by PDCCH on the CORESET(s) associated with the same *coresetPoolIndex* value, where the AP-SRS and AP-CSI-RS are configured to follow the indicated joint/DL/UL TCI state(s).   + FFS: The indicated joint/DL/UL TCI state(s) applied to other channels/signals * 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   **[Mod] Captured with adding one possible case that CORESET(s) may always follow the unified TCI even w/o configuration (e.g., CORESET other than CORESET#0 and associate only with USS/Type3 CSS)**  **Proposal 2.B:** Support. |
| vivo | **Proposal 2.A:** We share similar view as Futurewei and provide another version.  **Proposal 2.A:** 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   + The UE shall apply the indicated joint/DL/UL TCI state(s) to PDCCH on the CORESET(s) associated with the same *coresetPoolIndex* value and the respective PDSCH, if the CORESET(s) is configured to follow the indicated joint/DL/UL TCI state   + The UE shall apply the indicated joint/DL/UL TCI state(s) to ~~PDSCH,~~ PUSCH, PUCCH ~~AP-SRS, and AP-CSI-RS~~ scheduled~~/activated/triggered~~ by PDCCH on the CORESET(s) associated with the same *coresetPoolIndex* value   + The UE shall apply the indicated joint/DL/UL TCI state(s) to AP-SRS, or AP-CSI-RS triggered by PDCCH on the CORESET(s) associated with the same *coresetPoolIndex* value, if the AP-SRS, or AP-CSI-RS is configured to follow the indicated joint/DL/UL TCI state   + FFS: The indicated joint/DL/UL TCI state(s) applied to other channels/signals * 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   **[Mod] Captured with adding one possible case that CORESET(s) may always follow the unified TCI even w/o configuration (e.g., CORESET other than CORESET#0 and associate only with USS/Type3 CSS)**  **Proposal 2.B:** Does any combination of {DL TCI state, UL TCI state} mean one of the following combinations?   * DL TCI state * UL TCI state * DL TCI state and UL TCI state   If it means all above combinations, we support the proposal. |
| Google | **Proposal 2.A**: We still prefer supporting TCI field to indicate cross-TRP TCI state indication, which provides more flexibility.  **[Mod] I think current proposal is the common ground we can reach, considering the opponents of cross-TRP TCI state indication are more than the proponents.**  **Proposal 2.B**: We are fine with it |
| Panasonic | In **proposals 2.A and 2.B**, can we include that we are targeting multi DCI multi TRP PDSCH transmission if that’s indeed the case?  **Proposal 2.A**: We support but would also echo Futurewei’s remark.  Moreover, for this bullet:   * + *The UE shall apply the indicated joint/DL/UL TCI state(s) to PDSCH, PUSCH, AP-SRS, and AP-CSI-RS scheduled/activated/triggered by PDCCH on the CORESET(s) associated with the same coresetPoolIndex value*   If the scheme is for scheduling PDSCH transmissions, perhaps we should restrict the scope to channels/RS involved in the PDSCH transmission. Otherwise, use TCI state for the first TRP.  **Proposal 2.B:** Support |
| InterDigital | **Proposal 2.A**: We still think it’s better to have a flexibility in the network side on whether a codepoint(s) being mapped, via MAC-CE, to the same or different *coresetPoolIndex* value. If the network wants to strictly map all the codepoints to the same *coresetPoolIndex* value, the network still can do so, meaning the current proposal is just unnecessarily restrictive to force to use MDCI-based MTRP only with non-ideal backhaul assumption. As Rel-16 MDCI-based MTRP also supports a coordination-based operation, e.g., the joint HARQ-ACK functionality, Rel-18 UTCI extension is better to allow the “cross-TRP TCI update” flexibility just depending on what the MAC-CE selects to follow, per TCI-codepoint, the same or different *coresetPoolIndex* value.  **[Mod] I think current proposal is the common ground we can reach, considering the opponents of cross-TRP TCI state indication are more than the proponents.** |
| Nokia | Support Proposal 2.A  Support Proposal 2.B |
| Lenovo | **Proposal 2.A:** Support. It is sufficient to reuse the CORESETPoolIndex specific TCI states indication from M-DCI TCI framework in R17.  **Proposal 2.B**: We are OK with the proposal. |
| ZTE | **Proposal 2.A:** Although the direction is not our preference, we can live with that but with the following modification. Since we have a dozen of DCI field in the DCI without DL assignment (which is also decoupled with any PDSCH scheduling), we may further review this case a little bit later.  **[Mod] Thanks a lot for your flexibility.**  **Proposal 2.A:** 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   …  **[Mod] Beam indication based on DCI 1\_1/1\_2 w/o DLA has been already supported in Rel-17 unified TCI framework, and the same wording is captured in current spec as swell. Could you clarify more what’s your concern?**  **Proposal 2.B:** Support. |
| Apple | **Proposal 2.A:** Althoughthis is not our preference, we can accept it for progress such that the same flexibility of cross-TRP TCI activation as in Rel-16 mTRP can be achieved.  **[Mod] Thanks a lot for your flexibility.**  **Proposal 2.B:** Support. |
| OPPO | **Proposal 2.A:** support in principle.  As mentioned, the cross-TRP TCI indication can be done via MAC CE, hence for M-DCI MTRP we don’t think it’s necessary to enhance DCI to directly convey the TCI state for another TRP.    **Proposal 2.B:** support. |
| Fujitsu | **Proposal 2.A:** Support and agree with FUTUREWEI’s explanation.  **Proposal 2.B:** Support. |
| Samsung | **Proposal 2.A:** if companies have concerns about indicating the pool index in the beam indication DCI, the following alternative (which was also provided by the FL before) would resolve this issue:  A TCI codepoint can indicate both TCIs for the same and different pool indexes (analogous to SDCI). When MDCI is configured via signaling the two pool indexes, the UE can interpret the indicated TCI(s) accordingly and associate it to the corresponding pool index(es). We would like to check if the group can accept “same AND different” rather than “same OR different”.  **[Mod] I think current proposal is the common ground we can reach for this issue**  **Proposal 2.B**: for the FFS, we are not sure why associating both joint and separate (i.e., mixed) to a TCI codepoint is applicable to MDCI? Maybe we are missing something here.  **[Mod] Revised to avoid confusion.** |
| Xiaomi | **Proposal 2.A**  We slightly prefer to support cross-TRP TCI update based on DCI, but we can live with the proposal 2.A. And we think the Futurewei’s revision is much better.  **[Mod] Thanks a lot for your flexibility.**  **Proposal 2.B**  Support the first two sub-bullets with the following update. While for the FFS, we share same confusion as Samsung that what is the meaning of ‘Combinations of joint/DL/UL TCI states that can be mapped to a TCI codepoint’ for M-DCI?  **Updated Proposal 2.B:** 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, any combination of {DL TCI state, UL 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) * FFS: Combinations of joint/DL/UL TCI states that can be mapped to a TCI codepoint for a serving cell configured with both joint and separate DL/UL TCI modes, if supported   **[Mod] Revised to avoid confusion.**  **Issue 2.3**  Prefer Alt 1. |
| Spreadtrum | **For proposal 2.A**, we are ok with the proposal.  **For proposal 2.B**, support. |
| Mod | * **Please update your view on those sub-issues in Table 2-1 (especially Issue 2.3)** * **Proposal 2.A – 2.B are revised according to above comments, please check** |
| FGI | **Proposal 2.A** ok with the proposal but it seems that PUCCH is not included in the proposal (or perhaps is it one of the channels that FFS mentioned?)  **Proposal 2.B** support |
| Huawei, HiSilicon | **Issue 2.3:**  We do not agree with the FL note that “If no consensus can be reached in this issue, then Alt1 will be the natural outcome”. Although Alt1 uses the existing TCI field for TCI state update, it results in a substantial change in the MAC-CE design. We think that Alt1 would have been a “natural outcome” only if it did not have a specification impact. Therefore, we believe that the choice between Alt1 and Alt2 needs to be further discussed and agreed.  **Proposal 2.B:** We are not sure we understand the intention of the FFS. The purpose of supporting both joint and separate DL/UL TCI modes per CC is to support the case that one TRP is configured with the joint TCI state and the other TRP is configured with separate UL and DL TCI states. In M-DCI MTRP case, each DCI is on a CORESET configured with a *coresetPoolIndex* and, hence, TRP specific. So, even if both joint and separate DL/UL TCI modes per CC are supported only one of the joint TCI mode or the separate DL/UL TCI mode is applicable to the DCI.  We suggest the following modification to the proposal:  **Proposal 2.B (modified):** 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 state ~~any combination of {DL TCI state, UL 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) * ~~FFS: Mapping of activated TCI state(s) to a TCI codepoint for a serving cell configured with both joint and separate DL/UL TCI modes, if supported~~   **[Mod] Please check the revised FFS, where the possible combinations of TCI states still need to be confirmed.** |
| NEC | **Proposal 2.A:** We can accept it.  **Proposal 2.B:** Support. |
| CMCC | **Proposal 2.A:** Support.  **Proposal 2.B:** We are confused by the last FFS. We think even configuration with both joint and separate DL/UL TCI modes is supported, there is no additional issue for mapping of activated TCI states for M-DCI MTRP.  **[Mod] Please check the revised FFS, where the possible combinations of TCI states still need to be confirmed.** |
| Huawei, HiSilicon 2 | **Proposal 2.A:** We can support the proposal but suggest to change “aperiodic CSI-RS/SRS” to “SRS/aperiodic CSI-RS” to avoid the possible misunderstanding that aperiodic applies to both CSI-RS and SRS.  **[Mod] Captured** |
| Intel | **Proposal 2.A:** Support  **Proposal 2.B:** Support. We think the last FFS is needed and do not agree to remove it. |
| NTT DOCOMO | **Proposal 2.A:** Support.  **Proposal 2.B:** Support. |
| CATT | **Proposal 2.A:** We have updated our views. We can accept the proposal, although we think it is more flexible to use DCI to indicate cross-TRP TCI state indication.  **[Mod] Thanks a lot for your flexibility.**  **Proposal 2.B:** Support. |
| LG | **Proposal 2.A:** Support the proposal and the applicability on PDSCH/PUSCH and the RSs.  **Proposal 2.B:** Support |
| Mod | **Proposal 2.A – 2.B are revised according to above comments, please check** |
| CEWiT | **Proposal 2.A:** Support.  **Proposal 2.B:** Support. |
| Panasonic | **Proposal 2.A**: Support  **Proposal 2.B**: Support. We think the modification to the FFS made it clearer |
| ZTE | **Proposal 2.A**: Support in principle. Friendly speaking, I do not identify the reason why we need to combine some many additional information as follows in such case. If possible, we just confirm the original Alt1 and FFS the details.  ‘if the CORESET(s) is associated only with USS and/or Type3 CSS (except CORESET#0) or configured with *followUnifiedTCIstate* = 'enabled'’  **[Mod] If you still have concern one those sub-bullets, we can leave them for further discussed.**  Regarding FL’s comment, our concern is relevant to that we may support cross-mTRP beam indication with minor effort, i.e., by using DCI without DL assignment. In such case, we may use reserved DCI to achieve this target. |
| Fraunhofer IIS/HHI | **Proposal 2.A:** Our preference is to use cross-TRP indication, but we are OK with this proposal given the majority opinion.  **Proposal 2.B:** Support |
| Ericsson | **Proposal 2.A:** Do not support. There are many “if-s” and “but-s” in the proposed solutions. Claiming that “MAC CE with one activated TCI state” can be used for cross-TRP TCI state indication would provide significant limitations on the solution. Also, the proposal includes far too many details: the association is not really part of this discussion.  **[Mod] If you still have concern one those sub-bullets, we can leave them for further discussed.**  **Proposal 2.B:** Support in principle. But the proposal contains too many details: what we are trying to agree on is to reuse the TCI field also for mDCI. Also note that from a signalling/configuration point of view, there is no difference between a “joint” and a “DL” TCI state: they both point to the same RRC IE: the *TCI-State*. The proposal also states that we may configure a UE with “joint” or “separate” using some sort of separate configuration. It would also seem premature to agree on mapping only an UL TCI state. We propose the following modification:  **[Mod] 2.B is intended to define the TCI state activation and mapping to the TCI codepoint, and these details are still quite important. Regarding the joint or DL TCI state, even they are configured by the same RRC IE, how to interpret it (for both DL and UL, or for DL only) if it is indicated to the UE is still different. I also notice that joint and DL TCI states are also still captured in 331 (the description field for unifiedTCI-StateType).**  **Proposal 2.B1:** On unified TCI framework extension for M-DCI based MTRP:   * One TCI state, , or one TCI state and one 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) * FFS: If a DL 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) |
| Transsion | **Proposal 2.A**: We still prefer to support cross-TRP TCI update based on DCI, but we can accept the proposal 2.A.  **Proposal 2.B**: We are fine with it. |
| Mod | * **Please check the revised Proposal 2.A. We can focus on the main bullet first, then discuss the FFS later (which may be handled in Issue 3 later).** * **Please check Proposal 2.B, which is quite stable according to feedback.** * **Given the majority view, Conclusion 2.C is recommended.** |
| QC | For Proposal 2.A, support  For Proposal 2.B, support  For Conclusion 2.C, support |
| vivo | **Proposal 2.A:** support  **Proposal 2.B:** support  **Conclusion 2.C:** support |
| Xiaomi | Support Proposal 2.A, 2.B and Conclusion 2.C |
| Sharp | Support Proposal 2.A, 2.B and Conclusion 2.C |
| ZTE | **Proposal 2.A:** support in principle. ‘without DL assignment’ can be discussed separately.  **Proposal 2.B:** support  **Conclusion 2.C:** It is unclear for us. What’s the relationship between this conclusion and proposal 3.A? If my understanding is correct, in Proposal 3.A, super majority companies want to have an indicator field for selecting one of indicated TCI state for scheduled PDSCH reception. |
| OPPO | **Proposal 2.A:** support.  **Proposal 2.B:** support.  If Conclusion 1.A (no configuration on mixed mode of joint and separate TCI states) can be made, then the codepoint of mixed mode under FSS should be removed.  **Conclusion 2.C:** okay. |
| Panasonic | We support **Proposal 2.A, Proposal 2.B**. Confused a bit about the placement of **Conclusion 2.C** in this section, but in general we support it. |

# Issue 3 – How to associate the indicated TCI state(s) with each target channel/signal

Table 3-1 Summary for Issue 3

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 3.1 | PDSCH reception for S-DCI based MTRP, how to inform the association with joint/DL TCI state(s) indicated by DCI/MAC-CE | Alt1: Use a DCI format 1\_1/1\_2 to inform which indicated joint/DL TCI state(s) that the UE shall apply to PDSCH reception   * Support: Qualcomm, ZTE, MediaTek (indicator field other than existing TCI field), Google, vivo, Xiaomi, CMCC, Spreadtrum, NEC, Huawei/HiSilicon, Docomo, OPPO, Fraunhofer, Futurewei, InterDigital, Sharp, LG, Fujitsu, CATT, FGI, Apple, Intel, Lenovo, Nokia, Transsion * Concern: MediaTek (existing TCI field), Samsung   Alt2: Use RRC parameter(s) to inform which indicated joint/DL TCI state(s) that the UE shall apply to PDSCH reception   * Support: MediaTek (per CORESET), Samsung, Ericsson * Concern: Qualcomm, ZTE, MediaTek (per *PDSCH-Config*), vivo, OPPO   **FL note: Proposal 3.A is recommended for this issue. For opponents of DCI-based scheme if a new indicator field is introduced, one concern is a new application/switching time and default behavior before the application/switching time may be needed. Proponents of DCI-based scheme could share your view on how to address this concern. For opponents of RRC-based scheme, the main concern is it may be too slow for the switching between different TRPs or between STRP and MTRP. Proponents of RRC-based scheme could share your view on how to address this concern (only one company proposes that RRC-based scheme still can enable dynamic switching if different TCI associations are provided to different CORESETs, respectively).** |
| 3.2 | PDCCH reception for S-DCI based MTRP, down-selection from the alternatives agreed in RAN1#110 | Alt1-1 (RRC)   * Support: Qualcomm, MediaTek, vivo, NEC, DOCOMO, Huawei/HiSilicon, Sharp, Fujitsu, CATT, FGI, Apple, CATT, Ericsson, Intel, Lenovo, TCL, Transsion * Concern:   Alt1-2 (RRC with CORESET group)   * Support: ZTE, vivo, CMCC, Spreadtrum, Samsung, Fraunhofer, Futurewei, LG, TCL * Concern:   Alt2 (Fixed rule)   * Support: OPPO, Futurewei, Fujitsu, CEWiT, Fujitsu, Lenovo, Nokia * Concern:   Alt3 (MAC-CE)   * Support: Google, Xiaomi, Huawei/HiSilicon, InterDigital * Concern:   **FL note: According to contributions, majority prefer to use RRC configuration to provide the TCI association (Alt1-1 and Alt1-2). However, whether to introduce CORESET group configuration is still quite controversial, even their purposes are the same (inform the UE whether and which indicated joint/DL TCI state(s) shall be applied to PDCCH). Since RAN2 will design the corresponding RRC configuration anyway, I’d like to suggest leaving these details to RAN2, and RAN1 can conclude what functionality need to be achieved by the RRC configuration. Proposal 3.B is recommended for this issue.** |
| 3.3 | PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2 for S-DCI based MTRP, down-selection from the alternatives agreed in RAN1#110 | Alt1 (DCI)   * Support: Qualcomm, MediaTek, Google, vivo, Xiaomi, CMCC, Spreadtrum, DOCOMO, OPPO, Sharp, LG, Fujitsu, CATT, FGI, Apple, Intel, ITRI, Lenovo, TCL, Transsion * Concern: Samsung   Alt2 (SRS)   * Support: ZTE, NEC, Fraunhofer, Futurewei, FGI, Ericsson, Nokia, Panasonic, Huawei/HiSilicon * Concern: MediaTek (how to support UL PC)   Alt3 (RRC with CORESET group)   * Support: * Concern:   **FL note: Proposal 3.C is recommended for this issue with precluding Alt3. For proponents of Alt2 point of view, at least the UL beam alignment between PUSCH transmission and associated SRS transmission can be always guaranteed. However, it is unclear that how to indicate UL PC based on Alt2. Note that one scheme to indicate UL PC** **at least for S-DCI based PUSCH repetition with TDM has already been agreed in RAN1#109e.** |
| 3.4 | PUCCH transmission for S-DCI based MTRP, down-selection from the alternatives agreed in RAN1#110 | Alt1 (RRC)   * Support: Qualcomm, MediaTek, vivo, OPPO, Fraunhofer, Futurewei, Sharp, LG, Fujitsu, CATT, FGI, Apple, Ericsson, Intel, Lenovo, TCL, Huawei/HiSilicon, Transsion * Concern:   Alt2 (RRC with CORESET group)   * Support: ZTE, CMCC, Spreadtrum, Samsung, Fraunhofer * Concern:   Alt3 (MAC-CE)   * Support: Google, Xiaomi, DOCOMO, Futurewei, InterDigital, ITRI, PUCCH, Huawei/HiSilicon * Concern:   Alt4 (DCI)   * Support: DOCOMO * Concern:   **FL note: Proposal 3.D is recommended for this issue with precluding Alt4** |

**Proposal 3.A:** On unified TCI framework extension for S-DCI based MTRP, down-select one alternative from the followings in RAN1#111 for PDSCH reception:

* Alt1: Use a DCI format 1\_1/1\_2 to inform which joint/DL TCI state(s) indicated by MAC-CE/DCI that the UE shall apply to PDSCH reception
  + FFS: Informed by the existing TCI field or an indicator field other than the existing TCI field (could be reusing an existing DCI field or introducing a new DCI field) in the DCI format 1\_1/1\_2
  + FFS: Applying to the PDSCH reception(s) scheduled/activated by the DCI format 1\_1/1\_2 or all PDSCH receptions after the DCI format 1\_1/1\_2
  + FFS: Application time for applying the indicated joint/DL TCI state(s) informed by the DCI format 1\_1/1\_2
  + FFS: Only DCI format 1\_1/1\_2 with DL assignment can inform the TCI association, or both DCI format 1\_1/1\_2 with and without DL assignment can inform the TCI association
* Alt2: Use RRC configuration to inform which joint/DL TCI state(s) indicated by MAC-CE/DCI that the UE shall apply to PDSCH reception
  + FFS: The RRC configuration is provided to a PDSCH-Config or a CORESET/CORESET group

**Proposal 3.B:** 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

Note: Detail of the RRC configuration and whether/how to introduce CORESET group configuration are left to RAN2 design

**Proposal 3.C:** 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

**Proposal 3.D:** 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
* 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

Table 3-2 Company inputs for Issue 3

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | * **Please update your view on those sub-issues in Table 3-1** * **Please also share your view on Proposal 3.A - 3.D** |
| QC | For Proposal 3.A, support Alt1   * For 1st FFS, using a new DCI field seems cleaner * For 2nd FFS, the indicator is only applied to scheduled/activated PDSCH * For 3rd FFS, similar application time as R17 can be reused, e.g. X symbols after the ACK for DCI * For 4th FFS, we think this indicator is only useful to DCI with DL assignment   For Proposal 3.B, fine for the progress. But it seems unclear for the benefit of additional CORESET group  For Proposal 3.C, support Alt 1. Similar concern as MTK for PUSCH PC parameters for Alt2.  For Proposal 3.D, support Alt 1, which should be sufficient. Our understanding is that Alt1 only configures PUCCH to share which order index(s) of the 2 indicated TCI states. The exact shared TCI(s) can still by dynamically updated by the TCI activation/indication MAC-CE/DCI. So at least Alt3 seems not needed to dynamically update the associated order index(s) |
| MediaTek | For P3.A, we are open to the two alternatives in the proposal.   * For 1st FFS in Alt1, we prefer to use an indicator field other than the existing TCI field. We have concern on using the existing TCI field since the switching between TRPs or between STRP/MTRP based on the existing TCI field applies to not only PDSCH reception, but also other channels/signals associated with the indicated TCI state(s). For example, NW may want to keep PDCCH repetition even PDSCH is switched to STRP. * For 2nd FFS in Alt1, we are open. * For 3rd FFS in Alt1, application time can be based on either *timeDurationforQCL* or the BAT defined in Rel-17 unified TCI framework. Regarding the default behavior before application time, we think it should be simpler than Rel-15/16 since the joint/DL TCI states that can be used for PDSCH are already indicated to the UE. The default beam can be either the 1st joint/DL TCI state, 2nd joint/DL TCI state, or both (if UE supports the capability). * For 4th FFS in Alt1, this will depend on the conclusion of Alt2. * For 1st FFS in Alt2, we prefer the association is configured per CORESET. In this way, different CORESETs can be provided with different TCI associations, e.g., association with a 1st/2nd TCI for STRP operation or association with both 1st TCI and 2nd TCI for MTRP operation. Then, according to the scheduling/activation DCI is received on which CORESET, UE shall apply the associated TCI(s) to the scheduled/activated PDSCH reception. Therefore, dynamic switching between different TRPs or between STRP and MTRP still can be achieved by transmitting scheduling/activation DCI on different CORESETs.   For P3.B, we are fine with the proposal. Regarding MAC-CE based scheme, some companies mention that this is already supported in Rel-15/16. However, the indicated joint/DL associated with each CORESET still can be updated by MAC-CE/DCI, even they are associated by RRC. There is no need to introduce one additional dynamic signaling.  For P3.C, we prefer Alt1 with reusing the existing SRS resource set indicator. Regarding Alt2, we have concern on how to determine UL PC parameters and PL-RS from the indicated SRS resource(s) for PUSCH Tx. In Rel-17, UL PC parameters and PL-RS are associated per joint/UL TCI state, we prefer to reuse the same scheme, especially we already have a related agreement in RAN1#109 for UL MTRP.  For P3.D, support. |
| Futurewei | **Proposal 3.A:** Support and we prefer Alt. 1. Given the super majority support of Alt. 1, we suggest making the down-selection in this meeting (RAN1 #110-bis-e) instead of postponing the decision to next meeting (RAN1 #111).  **[Mod] It is always nice to make down-selection as early as possible 😊. Let’s see whether we can decide in this meeting.**  **Proposal 3.B:** We are ok with the proposal.  **Proposal 3.C:** Support the proposal and we prefer Alt. 2.  **Proposal 3.D:** Support. |
| vivo | **Proposal 3.A:** Support and prefer Alt1.   * For the 1st FFS, we think a new indicator field is needed. * For the 2nd FFS, support applying to the PDSCH reception(s) scheduled/activated by the DCI format 1\_1/1\_2. We see some problems with “applying to all PDSCH receptions after the DCI format 1\_1/1\_2”: if the indicator field is used, it will be always included in DCI format 1\_1/1\_2, why don’t we use it every time? Besides, there would be the robustness problem if the UE misses the DCI as the TCI state application is a very important indicator for a period of time, otherwise the application time to wait for the ACK feedback, causes some latency. * For the 3rd FFS, the application time for applying the TCI state(s) is not needed if “applying to the PDSCH reception(s) scheduled/activated by the DCI format 1\_1/1\_2” is adopted. * For the 4th FFS, we think “Only DCI format 1\_1/1\_2 with DL assignment can inform the TCI association” is enough if “applying to the PDSCH reception(s) scheduled/activated by the DCI format 1\_1/1\_2” is adopted.   **Proposal 3.B:** Support.  **Proposal 3.C:** Support and prefer Alt1. With Alt2, PUSCH transmission also follows the TCI states of SRS if the SRS doesn’t follow unified TCI state which is not the case in Rel-17 unified TCI framework. It prevents measuring UL CSI of another beam in advance.  **Proposal 3.D:** Support and prefer Alt1. Alt2 utilizes PDCCH group as the indication of association between TCI state and PUCCH, which is unnecessary. Using MAC CE in Alt3 is not necessary as the PUCCH resource with different associations with the indicated joint/UL TCI state(s) can be dynamically signaled in DCI. |
| Google | **Proposal 3.A**: We support Alt.1 and share similar views with FW that we can decide in this meeting.   * Re. the first FFS: We prefer a new indicator field * Re. the second FFS: We are fine with applying to the PDSCH reception(s) scheduled/activated by the DCI format 1\_1/1\_2, as long as we can make sure the PDSCH is after the application time of the indicator field. * Re. the third FFS: We share similar views with MTK * Re. the fourth FFS: W support both DCIs with and without DL assignment can inform such association.   **Proposal 3.C**: Support and prefer Alt. 1. It seems we don’t need a new DCI field.  **Proposal 3.D**: We suggest adding the following note for better comparison.  **Proposal 3.D:** 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 * 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, both of the joint/UL TCI states indicated by DCI/MAC-CE to a PUCCH resource/group   **[Mod] Thanks, it is good for later discussion.** |
| Panasonic | **Proposal 3.A:** We support Alt1. For Alt2, we do not support using RRC to supply indices of the TCI states. We think that the approach behind the unified TCI framework is that the TCI state update would be separated from the individual channels, and the TCI state is signaled to the UE instead of a particular channel. In release 17, a binary parameter was used to indicated whether a channel/RS would follow the framework or not, and we think we should follow the same approach in release 18 using such a binary parameter only.  **Proposal 3.B** Do not support. Same comment for proposal 3A. A binary parameter indicating whether or not to follow the framework should be enough and we can  FFS: How to associate the indicated joint/DL TCI state(s) with each CORESET  **Proposal 3.C** We support  **Proposal 3.D** Support. Preference is Alt3. |
| Nokia | Support Proposal 3.A in principle   * Last FFS: We think only DCI format 1\_1/1\_2 with DL assignment is applicable in this case.   Regarding Proposal 3.B, we think that simple rules could be applied without RRC level (re-)configuration. For instance, in S-DCI mTRP   * For PDCCH (CORESET) wout repetition and SFN: apply first Indicated TCI state * For SFN-PDCCH: apply both first and second Indicated TCI state * For PDCCH repetition: apply first Indicated TCI state for the first PDCCH (CORESET) in time and second Indicated TCI state for the second PDCCH (CORESET) in time   Regarding Proposal 3.C we think that further clarification is needed for Alt1. that how current port indication via SRI is provided and given that SRS resource(s) are already transmitted based on the Indicated TCI state(s). In Alt2., associations between Indicated TCI state(s) and PUSCH PC parameters are needed. In other words, that for example indicated SRS resource via SRI in DCI 0\_1/0\_2 follows second *Indicated* TCI state there should be associated PUSCH PC parameters (to second *Indicated* TCI state) that the UE would apply for the PUSCH transmission.  We support Proposal 3.D in principle but we consider that in this phase, it should be between Alt1 and Alt3. Alt2 seems to be included in Alt1. |
| Lenovo | **Proposal 3.A:** We support Alt 1.   * For the 1st subbullet, we think it is sufficient to repurpose an existing field in DCI format 1\_1/1\_2 for this. * For the 2nd subbullet, the indicated TCI shall apply to all the PDSCH received after the DCI format 1\_1/1\_2 (with the timeDurationForQCL or a similar time threshold observed). * For the 3rd subbullet, the timeDurationForQCL or a similar time threshold can be used. * For the 4th subbullet, support using DCI format 1\_1/1\_2 with or without DL assignment.   **Proposal 3.B**: We do not see the need for CORESET group in S-DCI based M-TRP, otherwise we support this proposal in general.  **Proposal 3.C**: Support Alt.1. This is more consistent with the DL TCI.  **Proposal 3.D**: Support Alt.1. |
| ZTE | **Proposal 3.A:** We support Alt1 with the following clarification:   * + Regarding first FFS: we prefer to introduce a new DCI field   + Regarding second FFS: Only relevant to the PDSCH scheduled/activated by the DCI format 1\_1/1\_2   + Regarding third FFS: reusing the latency timelime for BAT   + Regarding forth FFS: only DCI format 1\_1/2 with DL assignment.   **Proposal 3.B**: Support. A configurable ID rather than a fixed one is preferred.  **Proposal 3.C**: Support Alt.2. Then, the UL power control parameter can reuse the PC associated with indicated TCI.  **Proposal 3.D**: Support Alt2. |
| Apple | **Proposal 3.A:** Support and our preference is Alt.1.   * On the first FFS: prefer to introduce a new indicator field. * On the 2nd and 3rd FFS: These two aspects maybe relevant as depending on the application time of indicator field, it may apply the scheduled PDSCH or later PDSCH. We are open to discuss this. * On the 4th FFS: In our view, it is also related to the application time of indicator field. If it is applied for subsequent PDSCH(s), it may be useful to support DCI without PDSCH assignment.   **Proposal 3.B:** Our preference is to remove ‘a group of CORESETs’ as the motivation is unclear for us assuming per-CORESET configuration would be supported. If common understanding on ‘left to RAN2’ means that this is only related to ASN.1 details and RAN1 would always assume the per-CORESET TCI selection for the L1 designs, it can be accepted for progress. If there are other design considerations associated with ‘CORESETs group’ concept in RAN1, it should be careful to leave the ‘CORESETs group’ to RAN2.  **Proposal 3.C:** Support the proposal. We slightly prefer Alt.1.  **Proposal 3.D:** Support and our preference is Alt.1. |
| OPPO | **Proposal 3.A:** support with preference on Alt.1.   * For 1st FFS, if possible, we would like to reuse the existing TCI field. For dynamic switch between STRP and MTRP, the number of indicated DL/joint TCI state(s) can be used as a reference by UE. Specifically, if 1 TCI state indicated, it implies STRP PDSCH, else if 2 TCI states indicated, then it can be inferred as MTRP PDSCH. For both using existing field or introducing new field, analogous parameter to *TimeDurationForQCL* should be re-introduced as in Rel.15 for UE to get prepared for PDSCH reception. * For 2nd FFS, regarding the feature of UTCI defined in Rel.17, we think the indicated DL/joint TCI state(s) should be applied to all PDSCH receptions after the DCI. * For 3rd FFS, assume there are always standing and applicable TCI state(s), the newly indicated TCI states should be applied after BAT (same rule as Rel.17). * For 4th FFS, since this relates to PDSCH scheduling, or let’s say dynamic switch, it seems at least DCI format 1\_1/1\_2 with DLA should inform such association.   **Proposal 3.B:** similar view as Nokia. RRC signaling can be used to configure PDCCH transmission schemes, e.g. PDCCH repetition or PDCCH SFN. Based on PDCCH transmission scheme, simple rule can be used to determine the 1st and/or 2nd indicated DL/joint TCI state(s). It seems not really necessary to introduce another RRC parameter per CORESET to associate indicated DL/joint TCI state(s) with CORESETs.  **Proposal 3.C:** support with preference on Alt.1.  For the indicator field in DCI format 0\_1/0\_2, we suggest to associate the SRS resource set indicator with UL/joint TCI state(s). In Rel.17, the SRS resource set indicator can be used to dynamically switch between STRP PUSCH and MTRP PUSCH.  **Proposal 3.D:** support with preference on Alt.1. |
| Fujitsu | **Proposal 3.A:** Support and prefer Alt 1.   * For the 1st FFS, prefer to reuse an existing field. * For the 2nd FFS, support applying to all the PDSCHs after the DCI format 1\_1/1\_2. * For the 3rd FFS, the existing application time can be reused. * For the 4th FFS, support both DCI format 1\_1/1\_2 with and without DL assignment.   **Proposal 3.B**: We are fine with the proposal.  **Proposal 3.C**: Support and prefer Alt1.  **Proposal 3.D**: Support and prefer Alt1. |
| Samsung | **Proposal 3.A:** We have serious concerns on the dynamic DCI signaling/new field indicator based method as it would negatively affect the streamlined framework of unified TCI. It is unfortunate to see that companies want to bring the Rel-15/16 default beam paradigm back to Rel-18, making all the efforts that the group spent in Rel-17 undone. As we commented before, using dynamic DCI signaling/new field indicator to associate the indicated TCIs to individual target channels departs from the common beam design principle, which would cause multiple (dynamic) timing misalignments and cumbersome UE behaviors. The RRC based association should be the baseline, on top of which further TRP(s) selection/switching can be discussed, but not the other way around – compromising the streamlined framework is unacceptable to us.  **Proposal 3.B:** Support. Detailed signaling structure can be left to RAN2, but the corresponding UE’s behaviors should be specified in RAN1.  **Proposal 3.C** & **3.D:** Fine with the down-selection. |
| Xiaomi | **Proposal 3.A**  Support Alt 1 for dynamically switching between S-TRP and M-TRP. And we prefer to support both DCI format 1\_1/1\_2 with and without DL assignment. With DCI based indication, the application time can be similar as the TCI field in Rel-16, i.e., if the offset between DCI and PDSCH is equal to or larger than the timedurationforQCL. And the switching time and default behaviour can be similar as that in Rel-17, i.e., association will be updated only when the new association is different from the current one.  **Proposal 3.B**  In Rel-17, the PDCCH-SFN is configured per cell, not per CORESET. i.e., the PDCCH-SFN scheme will be configured by high layer signaling and one or two TCI states will be activated for each CORESET. It means that gNB can dynamically change the CORESET for PDCCH-SFN. In Rel-18, if the association between CORESET and indicated TCI states are informed by RRC, it means that the CORESET for PDCCH-SFN can’t be changed dynamically, which will reduce flexibility on PDCCH transmission.  So we prefer MAC CE based association. If majority companies support RRC based association, we can live with it.  **Proposal 3.C**  Support and prefer Alt 1.  **Proposal 3.D**  Support and prefer Alt 3. |
| Spreadtrum | **For proposal 3.A**, support and prefer Alt1.  - For 1st FFS in Alt1, we prefer to use a new DCI field  - For 2nd FFS in Alt1, applying to the scheduled PDSCH is more reasonable  - For 3rd FFS in Alt1, reuse the definition of application time in Rel-17  - For 4th FFS in Alt1, use DCI format 1\_1/1\_2 with DL assignment to inform the association  **For proposal 3.B**, we are fine with the proposal.  **For proposal 3.C**, support Alt 1 and reusing an existing field (i.e., SRS resource set indicator) is preferred.  **For proposal 3.D**, support and prefer Alt2. |
| Mod | **No change to the proposals** |
| FGI | **Proposal 3.A:** Support Alt1.  Regarding FFS1: Support to introduce a new field. Besides, is this the same question as 2.3? If yes, we can discuss this issue in the same place to avoid confusion.  Regarding FFS2: applying to the PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2 seems more realistic as there might be the switching between STRP and MTRP for each different PDSCH.  **[Mod] 2.3 is for TCI state update, instead of TCI association.**  **Proposal 3.B:** Support.  **Proposal 3.C:** Prefer alt.1 but can accept both  **Proposal 3.D**: Support alt.1 |
| Huawei, HiSilicon | **Proposal 3.A:** OK with the proposal and support Alt. 1.   * 1st FFS: We support indicator field other than the existing TCI field. * 2nd FFS: We think that the new indicator field needs to always be present in DCI. So, it can be used to inform the TCI state(s) applicable only to the PDSCH reception(s) scheduled/activated by the DCI format 1\_1/1\_2. * 3rd FFS: This needs to be discussed. The situation does not seem to be exactly similar to any of the legacy releases. Unlike Rel-17, the indicator field in the current DCI only selects one or both of the ‘indicated’ TCI states previously provided in another DCI. Unlike Rel-15/16 where the TCI field indicates a new TCI state from up to 8 activated TCI states, the indicator field in the current DCI only selects one or both of the ‘indicated’ TCI states previously provided in another DCI. Therefore, for instance, if UE has been using both indicated TCI states prior to the current DCI and the current DCI selects one of the two indicated TCI states, it does not seem to be necessary to wait for *TimeDurationForQCL* after PDCCH reception to apply the indicated beam. * 4th FFS: We think it makes sense that only DCI format 1\_1/1\_2 with DL assignment can inform the TCI association   **Proposal 3.B:** In principle, we are supportive of RRC configuration to inform the UE. Note that, for PDCCH repetition, the corresponding search space sets are linked in RRC. Therefore, if the search space of a CORESET is linked with another search space, the RRC configuration should not inform the UE to apply both TCI states to the CORESET.  More important, we don’t think it is required to define CORESET groups and, further, we are not sure if CORESET group is defined in RAN2, such a definition only has an ASN.1 impact without any RAN1 impact. Therefore, the issue of whether or not to define CORESET groups to be resolved in RAN1. We propose the following modification:  **Proposal 3.B (modified):** 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~~   ~~Note: Detail of the RRC configuration and whether/how to introduce CORESET group configuration are left to RAN2 design~~  **[Mod] Leaving it to RAN2 one possible way to progress, especially this may be just an RRC signaling design which doesn’t cause impact to RAN1 behavior.**  **Proposal 3.C:** OK with the proposal and support Alt2.  To companies that have concern regarding the UL PC parameter determination if Alt 2 is used:  Under unified TCI framework, either  A) SRS resource follows the indicated TCI state if SRS-ResourceSet configured with *followUnifiedTCIstateSRS-r17* or (in which case, technically, Alt1 and Alt2 are similar);  B) SRS resource follows UL TCI state or a joint TCI state configured in *srs-TCIState*.  In either case A or B, the applied TCI state includes UL PC parameters and the same UL PC parameters can be used for PUSCH transmission. So, we don’t see why Alt 2 can cause any issue regarding UL PC parameters determination.  The advantage of using Alt2 to Alt1 is that it is possible that the spatial domain transmission filter configured in *srs-TCIState* of the SRS resource that is indicated in SRI is different from the indicated unified TCI state *DLorJointTCIState* or *UL-TCIState*, if the UE applies the UL spatial filter determined from the indicated *DLorJointTCIState* or *UL-TCIState* for the PUSCH transmission (that is, Alt 1 is used), the beams of the PUSCH and the SRS are not aligned and the CSI info obtained by SRS measurement is not suitable for the PUSCH transmission.  **Proposal 3.D**: OK with the proposal and support Alt1 or Alt3. Also OK with the added Note by Google. |
| NEC | **Proposal 3.A**: Support and prefer Alt1.  **Proposal 3.B**: Support.  **Proposal 3.C**: Support and prefer Alt2.  **Proposal 3.D**: Support and prefer Alt1. |
| CMCC | **Proposal 3.A**: Support Alt1.  **Proposal 3.B**: Support.  **Proposal 3.C**: Support the proposal. Prefer Alt1.  **Proposal 3.D**: Support the proposal. Prefer Alt2. |
| Intel | **Support 3.A-D in principle.**  For Proposal 3.C, we think support of beam indication using DCI 0\_1/0\_2 which is not supported in Rel-17 unified TCI framework should also be discussed. Just discussing association of TCI states without beam indication using UL DCI may not be the best approach. |
| NTT DOCOMO | **Proposal 3.A**: Support and support Alt1.  **Proposal 3.B**: Support. If FL’s intention is to leave discussion of “a group of CORESETs” to RAN2, we’d like to add [ ] to [or a group of CORESETs].  **[Mod] I’m afraid that it may be more confusing to RAN2 if we add the brackets.**  **Proposal 3.C**: Support and prefer Alt1.  **Proposal 3.D**: Support and prefer Alt3. |
| CATT | **Proposal 3.A:** Support Alt1. For the FFS, we have similar views as QC, i.e. use a new DCI field, which is only applied to scheduled PDSCH.  **Proposal 3.B:** We don’t see the necessity of introducing CORESET group. We prefer to remove CORESET group.  **Proposal 3.C:** Support. We prefer Alt1.  **Proposal 3.D:** Support. We prefer Alt1. |
| LG | **Proposal 3.A:** Support the proposal and prefer Alt1.  **Proposal 3.B:** Fine with the current version. For SFN CORESET where the corresponding enabler is RRC configured and 2 TCI states are activated via MAC-CE, Utilizing CORESET group is more beneficial that it can be possible to include it to all the CORESET groups and each SFN CORESET TCI state is updated with the indicated TCI state associated with the group.  **Proposal 3.C:** Support and prefer Alt1  **Proposal 3.D:** Fine with the proposal and support Alt1 |
| Mod | **Add one note to Proposal 3.D** |
| CEWiT | **Proposal 3.A**: Support and prefer Alt1.  **Proposal 3.B**: Support.  **Proposal 3.C**: Support  **Proposal 3.D:** Support |
| Panasonic | Alt 2 in Proposal 3.A is very close to Proposal 3.B since they both intend to use indexing at the level of RRC configuration. Alt2 in Proposal 3.A issues a problem of dynamic switching that was discussed in the last meeting and was contentious. We concerned that supporting 3.B would favor Alt2 in Proposal 3.A without sufficient discussion. We propose to use simpler rules for the mapping for PDCCH repetition, or at least add this option similar to Proposal 3.A.  Proposal 3.A: Support because we can down select later  Proposal 3.B: Do not support. Suggest to add option:   * Use RRC parameter(s) in a CORESET configuration to inform the UE whether the indicated joint/DL TCI state(s) shall be applied to the corresponding PDCCH receptions on the CORESET.   + FFS: How to associate the indicated joint/DL TCI state(s) with each CORESET |
| Fraunhofer IIS/HHI | **Proposal 3.A, 3.B, 3.D:** OK  **Proposal 3.C:** I believe that the DCI containing the indicator field is the PUSCH-scheduling DCI. The current framing may mean a different DCI than the scheduling DCI as well. Propose the following change in Alt. 1:  Alt1: Use an indicator field (could be reusing an existing DCI field or introducing a new DCI field) in the scheduling/activating DCI ~~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  **[Mod] Revised a bit to address your concern. Note that this is just same wording as previous agreement.** |
| Ericsson | **Proposal 3.A**: We don’t necessarily see Alt1 and Alt2 as alternatives: in contrast, Alt1 is an add-on to Alt2, which can have some merits. However, some of the FFSs are not inline with that interpretation. We have strong concerns on another timeline, and we don’t see the need either. We would have strong concerns to have a “sticky” indication that would impact all future PDSCH transmissions.  **Proposal 3.B:** Support  **Proposal 3.C:** Support. Could we already select Alt2 in this meeting? **[Mod] But…Alt1 is the majority view.**  **Proposal 3.D:** Support. Could we already select Alt1 in this meeting? |
| Transsion | **Proposal 3.A**: Support and prefer Alt1.   * For 1st FFS in Alt1, we prefer to use new field. * For 2nd FFS and 3rd FFS in Alt1, we think it is based on the application time of indicator field and it may apply to all PDSCH receptions after the DCI format 1\_1/1\_2. We are open to discuss this.   **Proposal 3.B**: Support.  **Proposal 3.C**: Support and prefer Alt1.  **Proposal 3.D**: Support and prefer Alt1. |
| Mod | * **Please share your view on Proposal 3.A - 3.D, if any.** * **Regarding Proposal 3.B, could proponents of RRC-based scheme response to opponents (please check comments from Panasonic, Nokia, OPPO) why the TCI association cannot be based on a fixed rule?** * **Regarding whether to introduce CORESET group in Proposal 3.B, leaving it to RAN2 is one way to progress, especially this may be just an RRC signaling design which doesn’t cause impact to RAN1 behavior.** * **Proposal 3.A, 3.C and 3.D are quite stable, even some companies prefer to make downs-election in this meeting.** |
| QC | For Proposal 3.A, prefer Alt1  For Proposal 3.B, support. For the fixed rule, we think even without PDCCH repetition/SFN, there is still benefit to associated different TCIs with different CORESETs to improve reliability. This is the baseline as in R15, i.e. different CORESETs can have different beams.  For Proposal 3.C, support Alt 1. Similar concern as MTK for PUSCH PC parameters for Alt2.  For Proposal 3.D, support Alt 1, which should be sufficient. |
| vivo | **Proposal 3.A:** support and prefer Alt1.  **Proposal 3.B:** support.  We have concerns on fixed rule.   * For PDCCH (CORESET) without repetition or SFN, the CORESET should be able to apply either one of the two indicated TCI states, as the flexibility provided by Rel-16. * For PDCCH repetition, how to implement STRP based PDCCH repetition when two TCI states are indicated which is supported in Rel-17? * For SFN, the sfnSchemePDCCH is configured per cell. If the fixed rule is applied, then all CORESETs will be in SFN when two TCI states are indicated which is not expected.   **Proposal 3.C:** support and prefer Alt1.  **Proposal 3.D:** support and prefer Alt1. |
| Xiaomi | **Proposal 3.A:** support and prefer Alt 1  **Proposal 3.B:** fine for progress  **Proposal 3.C:** support and prefer Alt 1  **Proposal 3.D:** support and prefer Alt 3 |
| Sharp | Proposal 3.A: We prefer Alt 1  Proposal 3.B: Agree with FL’s suggestion and we support the proposal.  Proposal 3.C: We prefer Alt 1.  Proposal 3.D: We prefer Alt 1. |
| ZTE | **Proposal 3.A:** Support and prefer Alt 1  **Proposal 3.B:** Support  **Proposal 3.C:** Support and prefer Alt2. If going with Alt1, we have to discuss the following issue:   * What’s the UE behavior, when the spatial domain transmit filter provided by TCI-State configurations is mismatched with the spatial domain filter of the SRS resource indicated by SRI   **Proposal 3.D:** Support and prefer Alt2. The CORESET group can be assumed as a configurable ID/anchor for enabling this association. Then, we may have the same note for Alt2, like   * 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   + Note: Detail of the RRC configuration and how to introduce CORESET group configuration, e.g., a configurable ID, are left to RAN2 design |
| Panasonic | **We support Proposal 3.C and 3.D**  As for **Proposal 3.B**,  For the unified TCI framework, a CORESET if *followUnifiedTCIstate* is configured, uses the “indicated TCI state” else, configured TCI state of the CORESET is applied. This should allow ‘to associate different TCIs with different CORESETs to improve reliability,’ as per Qualcomm’s remark.  If *followUnifiedTCIstate* is configured for multiTRP, we think the UE follows a predefined rule to map the two indicated TCI states to the two CORESETs. This is our understanding of ‘fixed rule.’  Moreover, perhaps some clarification of Proposal 3B would be appreciated. Our understanding of Proposal 3B, is instead of ‘*followUnifiedTCIstate*’, the CORESET will be RRC configured with an index field that points to one of the 4 TCI states indicated to the UE. We would like to ask what happens when the indicated TCI states are updated, do you have to update the pointer index in the RRC config of the CORESET? This is our concern about this proposal.  **For Proposal 3.A**,   * For Alt2, we have the same concern as proposal 3.B: What happens when update the indicated TCI states are updated, do we need to update the pointer index in the RRC config? What is the implication on **dynamic switching?** * For Alt1, Samsung’s remark above makes sense to us. Here we would like to mention that one of the alternatives discussed in RAN1#110 was   + *Alt3: Reuse the existing TCI field in a DCI format 1\_1/1\_2, i.e., the UE shall apply the joint/DL TCI state(s) mapped to the TCI codepoint indicated by the DCI format 1\_1/1\_2 to PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2 if the PDSCH reception is scheduled/activated after the beam application time as defined in Rel-17*   It seems like a reasonable alternative to Alt1. Here we would like to mention that we still did not discuss how to update the indicated TCI states upon receiving a TCI codepoint, which was raised by some companies in their contributions, and can be an issue that affects the design of multiTRP PDSCH. |

# Issue 4 – UL power Control for UL MTRP

Table 4-1 Summary for Issue 4

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 4.1 | How to determine the UL PC parameter setting(s) if one or both indicated joint/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 | Alt1: Support two default UL PC parameter settings configured in *BWP-UplinkDedicated*, and the UE should apply the one or two default UL PC parameter settings configured in the corresponding UL BWP   * Support: Apple, MediaTek, CATT, DOCOMO, OPPO, TCL, Xiaomi, QC, Futurewei, vivo, Nokia, Lenovo, Xiaomi, Spreadtrum, Huawei/Hisilicon, CMCC, LG, Docomo, Transsion * Concern:   Alt2: No change from Rel-17 unified TCI framework (i.e., if the UL PC parameter setting is absent from any of the indicated joint/UL TCI states, the UE shall apply the one single default UL PC parameter setting configured in the corresponding UL BWP instead)   * Support: Ericsson, Samsung, ZTE * Concern:   Alt3: A joint/UL TCI state indicated for PUCCH/PUSCH transmission is always associated with a UL PC parameter setting for PUCCH/PUSCH   * Support: ZTE * Concern:   **FL note: Proposal 4.A is provided is recommended for this issue. If no consensus can be reached in this issue, then Alt2 will be the natural outcome.** |

**Proposal 4.A:** On unified TCI framework extension, if one or both of indicated joint/UL TCI states applying to PUSCH/PUCCH transmission occasions in an UL BWP at least for S-DCI based PUSCH/PUCCH repetition with TDM is/are not associated with UL PC parameter setting (including P0, alpha for PUSCH, and closed loop index) for PUCCH/PUSCH, down-selection one alternative from the followings:

* Alt1: Support two default UL PC parameter settings configured in *BWP-UplinkDedicated*, and the UE should apply the one or two default UL PC parameter settings configured in the corresponding UL BWP
  + FFS: 1-to-1 association between an indicated joint/UL TCI state and a default UL PC parameter setting
* Alt2: No change from Rel-17 unified TCI framework

Table 4-2 Company inputs for Issue 4

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | * **Please update your view on those sub-issues in Table 4-1** * **Please also share your view on Proposal 4.A** |
| QC | For Proposal 4.A, support to agree on Alt1 given the majority. Alt2 provides less flexibility than R17, where different TRPs can have different PC parameters. We think two default PC parameter sets are beneficial, e.g. gNB can configured different p0 to count for different interference/noise level p |
| MediaTek | For P4.A, support with Alt1. We think this is just a simple extension from Rel-17 design. |
| Futurewei | **Proposal 4.A:** Support and we prefer Alt. 1. |
| vivo | Support and prefer Alt1. |
| Nokia | Support Proposal 4.A and agree with QC that Alt1 would be more feasible for mTRP case (already in Rel-17). |
| Lenovo | Support and prefer Alt1. |
| ZTE | Support Alt3, but we can live with Alt2. Since having a flexibility as a motivation of Alt1 as mentioned by majority companies, why we directly use the association scheme accordingly. |
| Apple | Support Proposal 4.A and Alt.1 in particular.  It is our understanding that support of two default UL PC parameters for mTRP is a simple extension of Rel-17 per-TRP power control framework and does NOT cause any signaling overhead compared to single default PC. It does provide per-TRP flexibility to configure PC parameters based on e.g., interference level as commented by Qualcomm. |
| OPPO | Support with preference on Alt.1. |
| Samsung | Support proposal 4.A and we prefer Alt2. We do not see use case(s) that network does not configure any UL PC settings for both TRPs. |
| Xiaomi | Support. Prefer Alt.1  There is a parameter, *ul-powerControl-r17*, in UL BWP configuration and it is configured with Uplink-powerControl-r17 which includes power control parameters { P0, alpha, closed loop index } as shown in table 1. It will be configured only when no TCI state is associated with Uplink-powerControl-r17, in which case the power control parameter corresponding to *ul-powerControl-r17* will be applied.  However, based on Table 1, there is only one set of {P0, Alpha, closed Loop Index} for each UL Channel/signal. Then, to support single DCI based multi-TRP UL transmission, two sets of PC parameters { P0, alpha, closed loop index} need to be configured in UL BWP configuration or other RRC IE when these parameters are not associated with joint/UL TCI state.  Tab.1 UL power control parameter *Uplink-powerControl-r17* in UL BWP configuration   |  | | --- | | BWP-UplinkDedicated ::= SEQUENCE {  …  ul-powerControl-r17 Uplink-powerControlId-r17 OPTIONAL, -- Cond NoTCI-PC  …  ]]  }  Uplink-powerControl-r17 ::= SEQUENCE {  ul-powercontrolId-r17 Uplink-powerControlId-r17,  p0AlphaSetforPUSCH-r17 P0AlphaSet-r17 OPTIONAL, -- Need R  p0AlphaSetforPUCCH-r17 P0AlphaSet-r17 OPTIONAL, -- Need R  p0AlphaSetforSRS-r17 P0AlphaSet-r17 OPTIONAL -- Need R  }  P0AlphaSet-r17 ::= SEQUENCE {  p0-r17 INTEGER (-16..15) OPTIONAL, -- Need R  alpha-r17 Alpha OPTIONAL, -- Need R  closedLoopIndex-r17 ENUMERATED { i0, i1 }  }  Uplink-powerControlId-r17 ::= INTEGER(1.. maxUL-TCI-r17) | |
| Spreadtrum | Support proposal 4.A and prefer Alt1. |
| Mod | **Based on contributions and feedback in this summary, only one company prefers Alt3 but also is fine with Alt2, thus I remove Alt3 to make our discussion/down-selection easier. Hope ZTE could be fine with this.** |
| Huawei, HiSilicon | OK with the proposal and support Alt.1. Alt.1 is more flexible and is a natural and simple extension of default UL PC parameter solution supported in Rel-17 unified TCI framework to the mTRP case. |
| NEC | **Proposal 4.A:** We would like to clarify if the two default UL PC parameter settings are those with lowest Uplink-powerControlIDs. |
| CMCC | Support the proposal and prefer Alt1. |
| Intel | OK with Proposal 4.A |
| NTT Docomo | Support and prefer Alt.1 |
| CATT | Support and prefer Alt1. |
| LG | Support the proposal and prefer Alt1. |
| Mod | **No change to Proposal 4.A** |
| Huawei, HiSilicon | OK with the proposal and support Alt.1. Alt.1 is more flexible and is a natural and simple extension of default UL PC parameter solution supported in Rel-17 unified TCI framework to the mTRP case. |
| NEC | **Proposal 4.A:** We would like to clarify if the two default UL PC parameter settings are those with lowest Uplink-powerControlIDs. |
| CMCC | Support the proposal and prefer Alt1. |
| Intel | OK with Proposal 4.A |
| NTT Docomo | Support and prefer Alt.1 |
| CATT | Support and prefer Alt1. |
| LG | Support the proposal and prefer Alt1. |
| Mod | **No change to Proposal 4.A** |
| Ericsson | **Proposal 4.A:** Do not support. Alt1 is optimization of RRC signaling, and RAN1 should not be doing that.  **[Mod] No optimization is also one candidate captured in Alt2. Hope you could be fine to make down-selection in later meeting.** |
| Transsion | Support and prefer Alt1. Regarding the Alt2, if both of TCI states are not associated with UL PC parameter setting, then the UL PC parameter setting for two TRPs is the same and TRP specific power control is not supported. |
| Mod | **No change to Proposal 4.A** |
| ZTE | We are fine, but we think Alt2 is sufficient. |

# Issue 5 – Beam reporting and beam failure recovery

Table 5-1 Summary for Issue 5-1

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 5.1 | Enhancement to TRP-specific BFR under unified TCI framework | Implicit BFD-RS determination based on the indicated joint/DL TCI states for S-DCI based MTRP   * Support: CATT, InterDigital, vivo, Nokia, ZTE, Samsung, Huawei/HiSilicon * Concern:   Enhancement to beam update after NW response to the TRP-specific BFR request   * Support: Qualcomm, vivo, InterDigital, Nokia, ZTE, Samsung, CATT * Concern:   **FL note: Lower priority in this meeting** |
| 5.2 | Enhance/extend group-based reporting to support STxMP | Support: Qualcomm, Docomo, ZTE, vivo, Nokia, Samsung, Xiaomi, CATT  Concern: OPPO, Huawei/HiSilicon  **FL note: Lower priority in this meeting** |
| 5.3 | Enhance/extend Rel-17 UE capability index reporting to support STxMP | Support: Qualcomm, OPPO, Docomo, NEC, ZTE, InterDigital, LG, Nokia, CMCC, Samsung, Xiaomi, CATT  Concern: Huawei/HiSilicon  **FL note: Lower priority in this meeting** |
| 5.4 | Prefer to discuss Issue 5.2 and 5.3 in which AIs | Prefer to discuss in AI 9.1.1.1: QC, OPPO  Prefer to discuss in AI 9.1.4.1: Ericsson |

Table 5-2 Company inputs for Issue 5

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| **Company** | **Input** |
| Mod | **Please update your view on those sub-issues in Table 5-1** |
| QC | We think the above issues have been deferred since from beginning of R18. It would be good to discuss them in parallel, especially given STxMP PUSCH SDM is supported now. |
| ZTE | Add our views in the above table. |
| Samsung | We have updated our positions in the above table. |
| Xiaomi | **Issue 5.1**  As for ‘Implicit BFD-RS determination based on the indicated joint/DL TCI states for S-DCI based MTRP’, we want to clarify that is it for S-DCI or M-DCI? If it is for M-DCI, we think it is straightforward and we can support. If it is for S-DCI, we think it is better to discuss it only when the definition of CORESET group for S-DCI is agreed.  **Issue 5.2&5.3**  Add our views in the table above. And we prefer to discuss this in AI 9.1.4.1 or in parallel as QC suggested. |
| Huawei, HiSiliocn | Agree with the FL assessment regarding issues 5.1 to 5.3.  Regarding Issue 5.1, we think if UE is indicated with two joint/DL TCI states and not configured with and , UE assume and to include QCL RS of the first and second joint/DL TCI state, respectively. |
| NTT Docomo | We share similar view with QC. Since we had made some progress in STxMP, it would be good to start discussing these issues. |
| CATT | Our position on issue 5 is updated in the above table. |
| Ericsson | Would be good if FLs could agree to treat 5.2 and 5.3 under 9.1.4.1. |
| Mod | **Since it is unclear whether to handle Issue 5.2 and 5.3 in this AI or in AI 9.1.4.1, I’d loke to check companies’ view on this. Please update your preference in Table 5-1 for Issue 5.4.** |
| QC | For 5.2 and 5.3, they are beam related and might be good to be discussed in 9.1.1.1. The definition of 9.1.4.1 is mainly on “UL precoding indication for multi-panel transmission”, which does not cover any beam related enhancement |
| vivo | Agree with QC. |
| Xiaomi | For 5.2&5.3, these beam issues seem to be more related to Rel-18 STxMP, so we think it would be good to discuss in 9.1.4.1 together with other issues for STxMP. |
| ZTE | We share the same views as QC and vivo. In our views, for current 9.1.4.1, it is just a subset of STxMP and only relevant to UL precoding indication, i.e., modulation/demodulation. |
| OPPO | Similar view as QC that for STxMP, the beam-related issue should be discussed along with UTCI framework in AI 9.1.1.1. |

# Appendix: Agreements before/in RAN1#110bis-e

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| **RAN1#110bis-e** |
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| **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

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | RP-213598 | New WID: MIMO Evolution for Downlink and Uplink | Samsung |
| 2 | [R1-2209888](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209888.zip) | Discussion on unified TCI framework extension for multi-TRP | NTT DOCOMO, INC. |
| 3 | [R1-2209568](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209568.zip) | Views on unified TCI framework extension for multi-TRP | Apple |
| 4 | [R1-2209547](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209547.zip) | Multi-TRP enhancements for the unified TCI framework | Fraunhofer IIS, Fraunhofer HHI |
| 5 | [R1-2209540](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209540.zip) | Discussion on unified TCI framework extension for multi-TRP | Google |
| 6 | [R1-2209492](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209492.zip) | Unified TCI framework extension for multi-TRP | MediaTek Inc. |
| 7 | [R1-2209414](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209414.zip) | Discussion on unified TCI framework extension for multi-TRP | FGI |
| 8 | [R1-2209379](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209379.zip) | Unified TCI framework extension for multi-TRP | Sharp |
| 9 | [R1-2209256](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209256.zip) | Unified TCI framework extension for multi-TRP | xiaomi |
| 10 | [R1-2209320](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209320.zip) | Discussion on unified TCI framework extension for multi-TRP | CMCC |
| 11 | [R1-2209008](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209008.zip) | Discussion on unified TCI extension for MTRP | Fujitsu |
| 12 | [R1-2209039](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209039.zip) | Unified TCI Framework for Multi-TRP | Intel Corporation |
| 13 | [R1-2209138](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209138.zip) | Discussion on unified TCI framework extension for multi-TRP | NEC |
| 14 | [R1-2209165](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209165.zip) | Discussion on unified TCI framework extension for multi-TRP | Transsion Holdings |
| 15 | [R1-2208945](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208945.zip) | On unified TCI framework extension for multi-TRP operation | CATT |
| 16 | [R1-2208891](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208891.zip) | Unified TCI framework extension for multi-TRP/panel | LG Electronics |
| 17 | [R1-2208702](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208702.zip) | Discussion on unified TCI framework extension for multi-TRP operation | TCL Communication Ltd. |
| 18 | [R1-2208676](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208676.zip) | Unified TCI framework extension for multi-TRP | Ericsson |
| 19 | [R1-2208740](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208740.zip) | Discussion of unified TCI framework for multi-TRP | Lenovo |
| 20 | [R1-2208792](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208792.zip) | Unified TCI framework extension for multi-TRP | OPPO |
| 21 | [R1-2208626](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208626.zip) | Discussion on unified TCI framework extension for multi-TRP | vivo |
| 22 | [R1-2208539](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208539.zip) | Discussion on unified TCI framework extension for multi-TRP | Spreadtrum Communications |
| 23 | [R1-2208493](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208493.zip) | On Unified TCI Extension for MTRP | InterDigital, Inc. |
| 24 | [R1-2208502](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208502.zip) | Enhancements on unified TCI framework extension for multi-TRP | ZTE |
| 25 | [R1-2208439](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208439.zip) | Discussion on unified TCI framework extension for multi-TRP | Huawei, HiSilicon |
| 26 | [R1-2208373](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208373.zip) | Unified TCI framework extension for multi-TRP | FUTUREWEI |
| 27 | [R1-2209712](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209712.zip) | Views on unified TCI extension focusing on m-TRP | Samsung |
| 28 | [R1-2209967](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209967.zip) | Extension of unified TCI framework for mTRP | Qualcomm Incorporated |
| 29 | [R1-2210061](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210061.zip) | Unified TCI framework extension for multi-TRP | Nokia, Nokia Shanghai Bell |
| 30 | [R1-2210029](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210029.zip) | Discussion on unified TCI framework extension for multi-TRP | ITRI |
| 31 | [R1-2210018](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210018.zip) | Unified TCI framework extension for multi-TRP | PANASONIC |
| 32 | R1-2210104 | Discussion on Unified TCI framework extension for multi-TRP | CEWiT |