**3GPP TSG RAN WG1 #110bis-e R1-2210243**

**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 0)

**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 summary is prepared for our 1st GTW discussion (Monday 10/10 @12:00 UTC). Please upload your inputs to the draft folder corresponding to this AI, if any, **by Monday 10/10 @10:00 UTC.** As usual, some of relatively stable proposals will be treated during the GTW discussion, thus your early input would be much appreciated.

An official email thread will be announced on the reflector.

[110bis-e-R18-MIMO-01] Email discussion on unified TCI framework extension for multi-TRP by October 19

# Contact Person

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

Table 0 Contact Information

|  |  |  |
| --- | --- | --- |
| **Company** | **Point(s) of contact** | **Email address(es)** |
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| Panasonic | Khalid | khalid.zeineddine@eu.panasonic.com |
| FGI | Cubie | wanchen.lin@fginnov.com |
|  |  |  |

# Discussion

# 33Issue 1 – General framework for unified TCI extension

Table 1-1 Summary for Issue 1

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| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 1.1 | Whether to support joint and separate DL/UL TCI modes simultaneously in a same CC/BWP | Alt1: Reuse Rel-17 design (i.e., a serving cell can be RRC configured with either joint or separate DL/UL TCI mode)   * Support: ZTE, MediaTek, Google, Spreadtrum, Samsung, Fraunhofer, OPPO, LG, Lenovo, Nokia   Alt2: Support configuration of both joint and separate DL/UL TCI modes in a serving cell (FFS: how to configure)   * Support: Qualcomm, Xiaomi, CMCC, Huawei/HiSilicon, Docomo, InterDigital, Sharp, Fujitsu, Apple, FGI, CATT, Intel, ITRI, Panasonic, TCL   **FL note: Since several companies believe there is use case that needs both joint and separate TCI update modes in the same CC and no issue is identified if it is supported, Proposal 1.A is recommended for this issue.** |
| 1.2 | Whether and how to indicate and apply multiple joint/DL TCI states for PDSCH-CJT | Q1: What is the maximum number of TCI states (X) that can be indicated to PDSCH-CJT? (X = 1, 2, or 4)   * Support X = 1: NEC, Qualcomm, InterDigital, Apple * Support X = 2: Xiaomi, OPPO, Sharp, InterDigital * Support X = 4: Google, vivo, Huawei/HiSilicon, Docomo, Fraunhofer, Futurewei, FGI, CATT, Intel, Ericsson, Nokia   Q2: Any enhancement is needed to support PDSCH-CJT?   * For X > 1, enhancement is needed for QCL assumptions/types: ZTE, Qualcomm * For X = 4, enhancement is needed to indicate up to 4 joint/DL TCI states and associate up to 4 indicated TCI states for PDSCH-CJT and up to 2 indicated TCI states for other channels: MediaTek, vivo, Huawei/HiSilicon, Docomo, Fraunhofer, Futurewei, Fujitsu, FGI, CATT, Intel, Nokia   **FL note: Several companies share the same view that PDSCH-CJT can use the same UE reception behavior/QCL assumption as PDSCH-SFN scheme A (without Doppler pre-compensation). Thus, PDSCH-CJT with X=2 can be naturally supported by unified TCI extension if PDSCH-SFN is supported by unified TCI extension. However, for PDSCH-CJT with X=4, additional enhancement is still needed. From FL’s perspective, introduction of new MTRP scheme (including new UE reception behavior/QCL assumption) may not be within the scope of this AI, but it is still possible to support X=4 by extension of legacy MTRP scheme. However, there are still several companies have concern on extending PDSCH-SFN, and prefer a new MTRP scheme instead, where the QCL assumptions can be further discussed for this new MTRP scheme as well.** |
| 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+\*-   **FL note: A potential conclusion may be recommended in this meeting if no consensus can be reached in this issue** |

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

* Each TRP can be configured with either joint DL/UL TCI mode or separate DL/UL TCI mode (Note: The term TRP is used only for the purposes of discussions in RAN1 and whether/how to capture it in spec is FFS)
* This feature can be optionally supported by a UE
* FFS: Signaling for the configuration

**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

* For PDSCH-CJT, all PDSCH DM-RS port(s) is QCLed with the DL RS of the first indicated joint TCI state with respect to QCL-TypeA
  + FFS: QCL type(s)/assumption(s) of indicated joint TCI state(s) other than the first indicated joint TCI state
* FFS: If more than two joint TCI states are indicated by MAC-CE/DCI in a CC/BWP for PDSCH-CJT, whether MTRP scheme(s) other than PDSCH-CJT can be configured in a same BWP/CC?

Table 1-2 Company inputs for Issue 1

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| --- | --- |
| **Company** | **Input** |
| Mod | * **Please update your view on those sub-issues in Table 1-1** * **Please also share your view on Proposal 1.A – 1.B** |
| QC | For Proposal 1.A, support. To save TCI pool RRC overhead, both joint and separate TCI pools can be configured on the reference BWP/CC, or MAC-CE can dynamically indicate whether an activated TCI is joint or separate TCI  For Proposal 1.B, we support only 1 TCI for mTRP CJT at least in R18, since the performance with distributed TRPs is unclear. A simple example is shown in Figure 5, where UE moves in middle of two TRPs, which attempt to form a single-stream beam to the UE. Even at walking speed, the signals from 2 TRPs cannot be coherently combined at UE soon after the CSI report, due to the phase error caused by different Doppler shifts, as highlighted below. Therefore, it would be highly appreciated for companies to evaluate the CJT performance with distributed TRPs in typical scenarios including CSI overhead. Without solid evaluation, we suggest to limit R18 CJT with TRPs at similar locations, which can share a single TCI, i.e. distributed TRPs are not encourage without clear justification on the gain.  **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   **[Mod] Another proposal is provided with FFS of the QCL assumptions, whether to remove Doppler shifts from the QCL assumptions for the TCI state(s) other than the first one (i.e., NW needs to compensate the different Doppler shifts among these TRPs) can be further discussed.**  R1-2209967, R1-2209969    **Figure 5: Worst case of Doppler shift difference between two TRPs**  Some example phase errors () over a typical CSI periodicity of t=40msec are provided below in Table 1, while the experienced precoded channel power over this duration is illustrated in Figure 6. It can be observed that even with only v=10km/h, UE can experience 40dB deep fading within 40msec (for fc=700MHz) or within 15msec (for fc=2GHz), after a perfect phase alignment by PMI report at t=0.  **Table 1. Phase error over t=40msec, for 2-TRP with Doppler shifts**   |  |  |  |  | | --- | --- | --- | --- | | fc v | 3km/h | 10km/h | 30km/h | | 700MHz | 56° | 187° | 560° | | 2GHz | 160° | 533° | 1600° |   Diagram  Description automatically generated  **Figure 6. Precoded channel power over t=40msec, for 2-TRP with Doppler shifts** |
| MediaTek | For P1.A, we are fine with it. Although we still don’t see much benefit to support both joint and separate modes in the same CC, we are fine if this is the majority view. Regarding signaling for the configuration, we prefer to use RRC as in Rel-17.  For P1.B, we are fine with it. We have concern on introduction of a new MTRP scheme for CJT, which will cause a lot of further issues, e.g., the switching between or the co-existing with other MTRP schemes. |
| Futurewei | **Proposal 1.A:** we are ok with the proposal. Although our preference is to reuse Rel-17 design since it is unclear to us the need to support both joint and separate DL/UL TCI in a serving cell, we are ok with the proposal if majority of the companies support it.  **Proposal 1.B:** we are not sure why the third bullet (e.g., “QCL-TypeD source RS is absent in each of the indicated joint TCI states”) is needed here. Does that mean S-DCI based MTRP cannot have joint TCI states with QCL-TypeD source RS?**[Mod] The intension is to limit more than two indicated TCI states on in FR1, since the only use case is PDSCH-CJT, which targets to FR1.** |
| vivo | **Proposal 1.A:** we are generally fine with the supporting both joint and separate TCI state modes in a CC, at least for M-DCI based MTRP. The design of mixed TCI state modes can be considered if time allows after the design is stabilized for the case with same TCI state mode. But the current wording is somewhat confusing whether the two modes are configured simultaneously or not, an update version can be like:  **Proposed update of 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   **Proposal 1.B:** We are not sure whether CJT is a transmission scheme as an extension of PDSCH-SFN or a new scheme at this stage. If we agree the former one, does it mean the legacy SFN scheme is enhanced to support up to 4 TRP transmission in SFN? Some efforts are also needed.  **[Mod] The intension to extend PDSCH-SFN instead of a new MTRP scheme is to avoid specification effort.**  W+3e agree with Futurewei’s comment on this proposal. QCL-TypeD source RS should be considered at least for Rel-16/17 S-DCI based MTRP schemes. Even the Mod’s latest revision is not correct for a CJT case when only two TCI states are indicated.  Besides joint TCI state mode, there should be another proposal for separate TCI state mode which includes both use cases agreed in RAN1#109-e in AI 9.1.1.1 and CJT scheme.  **Proposed update of Proposal 1.B**: On unified TCI framework extension for S-DCI based MTRP, up to 4 joint TCI states can be indicated by MAC-CE/DCI in a CC configured with joint DL/UL TCI mode   * Up to 2 indicated joint TCI states can be associated/applied to the target use cases agreed in RAN1#109-e in AI 9.1.1.1 other than CJT scheme ~~PDSCH-SFN with 'sfnSchemeA'~~ * Up to 4 indicated joint TCI states can be associated/applied to CJT scheme ~~PDSCH-SFN with 'sfnSchemeA'~~ * ~~If more than two joint TCI states are indicated,~~ QCL-TypeD source RS is absent in each of the indicated joint TCI states for CJT scheme * FFS: whether CJT scheme is an extension of PDSCH-SFN with 'sfnSchemeA' |
| Google | **Proposal 1.A**: Not support. As mentioned, we don’t think there is use case of such configuration. Even MPE only occurs to one TRP link, it can also impact beam selection in the other TRP link. That is, separate TCI pool should configured for both TRPs even only one TRP link is faced with MPE issue. In addition, even the use case is valid, we don’t understand how network can predict there is about to have only one TRP link facing MPE issue, and configure such configuration?  Another one clarification question: If we take this proposal, does it mean Alt2 in Issue 1.3 is supported? If not, how to support the configuration in Proposal 1.A?  **[Mod] TRP-specific TCI state lists are not essential to support Proposal 1.A to my understanding. NW still can configure one joint/DL TCI state list and one UL TCI state list to support the simultaneous configuration. On how to interpret the joint/DL TCI state(s) if it is provided for a TRP (i.e., for DL only or for both DL and UL on the TRP) can be further discussed.** |
| Panasonic | **Proposal 1.A**: Support  **Regarding Issue 1.3 Alt2:** For each TRP-specific TCI state list, is the intention to further separate that into two lists similar to release 17 (one list for joint/DL TCI states and another list for UL TCI states)?  **[Mod] If my understanding correct, there will be two lists (joint/DL and UL) for a first TRP, and another two lists for a second TRP.** |
| InterDigital | **Proposal 1.A**: We are also fine with the proposal, as there is no harm to have this flexibility. Configurations are up to the n3etwork.  **Proposal 1.B**: Qualcomm’s arguments sounded reasonable. More technical discussions seem needed.  **[Mod] Another proposal is provided with FFS of the QCL assumptions, whether to remove Doppler shifts from the QCL assumptions for the TCI state(s) other than the first one (i.e., NW needs to compensate the different Doppler shifts among these TRPs) can be further discussed.** |
| Nokia | **1.1:** We prefer Alt1 to follow Rel-17 design but we are open for Proposal 1.A. It’s to be noted that in the end UE capabilities define what can be configured to the UE. In other words, Alt2 would require that the UE would need to support both joint and separate DL/UL TCI states.  **[Mod] I expect one new UE capability will be added for this.**  **Proposal 1.B:** In principle we are fine to have up to 4 TCI states, but we think that the use case should be CJT PDSCH and not extension of PDSCH SFN scheme. In other words, we think that we should focus on CJT PDSCH considered in CSI agenda item with unified TCI framework. In general, we would like to make a specific proposal regarding CJT PDSCH:  **Proposal 1.B-X**: On unified TCI framework extension for S-DCI based MTRP, up to 4 joint TCI states can be indicated by MAC-CE/DCI in a CC configured with joint DL/UL TCI mode and applied to CJT PDSCH   * QCL-TypeD source RS is absent in each of the indicated joint TCI states   **[Mod] If my understanding to your comment is correct, you prefer not to support MTRP schemes other than PDSCH-CJT when more than two joint TCI states are indicated. One FFS corresponding to your suggestion is added in the new proposal.**  **1.3**: We prefer Alt1, i.e. to reuse Rel-17 design. |
| Lenovo | **Proposal 1.A**: We are OK with the proposal. Because the TCI state pools and activated TCI states are defined per BWP/CC, it is better to make it clear by adding BWP to the proposal. We propose the following update:  **Proposal 1.A**: On unified TCI framework extension, support configuration of both joint and separate DL/UL TCI modes in a BWP/serving cell   * FFS: Signaling for the configuration   **[Mod] Since the TCI mode is configured per CC instead of per BWP in Rel-17 unified TCI framework, it is better to follow the same principle, if there is no other motivation to configured per BWP.**  **Proposal 1.B**: We are not sure if the word “sfnSchemeA” is appropriate here, since there is no agreement that R18 CJT is R17 sfnSchemeA. Same as Qualcomm, we are concerned with the implementation complexity for UE to deal with 4 DL or joint TCI states in a PDSCH. We think we should first consider the case where 1 TCI state is configured for CJT and assess its performance before jumping to 4 TCI states.  **[Mod] To my understanding, 1 TCI state for CJT can be enabled transparently to UE/spec.** |
| ZTE | **Proposal 1.A:** Not support. The motivation is unclear for us, besides for increasing complexity of RRC configuration or MAC-CE activation. Could any proponent clarify why one of TRP is separate but another should be joint? Even though, under separate configuration, a same spatial filter still can be configured for DL and UL well.  **Proposal 1.B:** As we mentioned several times, as well as QC above mentioned, CJT is quite different from typical SFN. Technically, compared with SFN, due to support a higher RANK transmission, since each DMRS port/layer is served by all TRP links in CJT, T/F-sync consistency between CSI-RS for CSI and PDSCH should be guaranteed. Therefore, pre-compensating delay and/or frequency offset may be considered.   * ‘Doppler shift’ offset across TRPs may introduce serious inter-layer interference, which can not be hardly compensated by UE-side Wiener filter; * ‘Average delay’ offset across TRPs may introduce serious frequency-selective fading (e.g., RE-level) or even inter-symbol interference.   Above implies that even having more than one TCI state(s) but under the gNB pre-compensation for T/F in-sync, UE may only use the portion of QCL assumption in other TCI state(s) except for first TCI state. Therefore, using which QCL types for other TCI state(s) rather than first TCI state should be explicitly indicated or implicitly determined.   * For instance, except for first TCI state(s), other TCI state(s) only w.r.t. QCL-TypeB: ‘Doppler shift’ and ‘Doppler spread’ for handling Doppler impacts due to UE mobility (low-speed).   So, the following proposal should be captured as a compromise.   * + If supporting X>1 TCI states in CJT, QCL type/assumption of other TCI state(s) except for first TCI state can be further indicated/determined (e.g., some of QCL types in the TCI states may be canceled).   **[Mod] Another proposal is provided with FFS of the QCL assumptions, whether to remove some of parameters from the QCL assumptions for the TCI state(s) other than the first one can be further discussed, as you suggested.** |
| Apple | **Proposal 1.A:** Support. The Rel-17 MAC-CE based signaling can be used to directly associated the TCI states combinations and TCI codepoint.  **Proposal 1.B:** We support the modified proposal from Qualcomm.  As this issue was discussed in last meeting already including pros/cons, one possible WF for progress is to introduce UE capability to indicate the number of supported TCI-states ranging from 1 to 4, which provides flexibility to implement the CJT feature. Hopefully it can address concern at both sides.  **[Mod] Another proposal is provided with FFS of the QCL assumptions, whether to remove Doppler shifts from the QCL assumptions for the TCI state(s) other than the first one (i.e., NW needs to compensate the different Doppler shifts among these TRPs) can be further discussed.** |
| OPPO | **Proposal 1.A**: Not support.  In Rel.17, configuration of both joint TCI and separate TCI states are not allowed in the same BWP/CC for STRP. And note that MTRP and STRP operation are somehow spec transparent. If such configuration of joint and separate TCI state combination were okay for MTRP, then via implementation (as the proposal reads) it may impact the configuration rule for STRP defined in Rel.17. Hence, if the majority view is fine with the configuration flexibility, we suggest at least to add restriction per each TRP.  **Proposal 1.A**: On unified TCI framework extension, support configuration of both joint and separate DL/UL TCI modes in a serving cell   * FFS: Signaling for the configuration * Each TRP can be configured with either joint TCI state or separate TCI state (same rule as in Rel.17)   **[Mod] Captured.**  **Proposal 1.B**: Not support.  For PDSCH-CJT, as discussed by both proponent and opponents in previous meetings, it seems the common understanding is that even single TCI state can deliver the QCL-TypeA for MTRP involved for CJT. From UE’s perspective, we hesitate to introduce more indicated joint/DL TCI states for PDSCH-CJT at FR1.  Consider the similarity between PDSCH-SFN ‘SchemeA’ and PDSCH-CJT, we are fine to reuse the agreed maximum number, i.e. 2, for the latter transmissions scheme. The spec impact would be minimum, otherwise there should be effort in designing signaling for more than 2 indicated DL/joint TCI states. |
| Fujitsu | **Proposal 1.A**: We are fine with the proposal.  **Proposal 1.B**: We are open to the discussion. However, even if supporting 4 TCI states, the wording “CJT” is more preferred instead of “sfnSchemeA” to avoid any ambiguity. |
| Samsung | **Proposal 1.A:** do not support. We do not see strong/valid application scenario(s) for supporting both joint and separate modes in the same CC (i.e., mixed TCI types). Per-panel MPE is not a common case; besides, the level of flexibility brought by the mixed mode cannot outweigh the complexity introduced for TCI activation/indication design. We propose to agree on the two basic combinations first – i.e., “joint+joint” and “{DL,UL}+{DL,UL}”.  We have also updated our position for issue 1.3. |
| Xiaomi | **Proposal 1.A**  Support. And agree with vivo and Lenovo that the following update should be supported. In addition, the dynamical switching between joint TCI and separate DL/UL TCI mode based on MAC CE should be supported.  **Updated Proposal 1.A**: On unified TCI framework extension, support simultaneous configuration of both joint and separate DL/UL TCI modes in a BWP/serving cell   * FFS: Signaling for the configuration   **[Mod] Since the TCI mode is configured per CC instead of per BWP in Rel-17 unified TCI framework, it is better to follow the same principle if there is no concern/issue to configured it per CC.**  **Proposal 1.B**  It is not a common understanding that PDSCH-SFN scheme A can be used for PDSCH-CJT. In addition, we have a clarification question on this proposal that it means only PDSCH-SFN scheme A can be used for CJT, or both PDSCH-SFN scheme A with up to 4 TCI states & scheme B with up to 2 TCI states can be used for CJT?  We prefer to support up to 2 TCI states for UE complexity reduction.  **Issue 1.3**  Support Alt 1. |
| Spreadtrum | **For proposal 1.A**, not support. As we mentioned in pre-discussion, the motivation for supporting mixed mode is not clear. We agree with the configuration of separate OR joint TCI mode in a serving cell. |
| Mod | **Proposal 1.A – 1.B are revised according to above comments, please check** |
| FGI | **Proposal 1.A –** support of simultaneous configuration of both joint and separate DL/UL TCI modes in a serving cell. A clarification towards the feature can be optionally supported by a UE – does it imply that a UE capability should be reported? |
| Huawei, HiSilicon | **Proposal 1.A**: Support.  For the signaling, RRC configuration can be used. For instance, in addition to the current *unifiedTCI-StateType,* there could be a second 1-bit RRC parameter “*unifiedTCI-StateType2*” in *ServingCellConfig*. A simple rule can be specified to clarify each TRP follows which of the joint or separate TCI modes. For instance, in mDCI based schemes where MAC-CE TCI activation includes *coresetpoolIndex* field, *unifiedTCI-StateType* (*unifiedTCI-StateType2*) corresponds to the *coresetpoolIndex*= 0 (1).  In sDCI based schemes, depending on the agreed structure of the MAC-CE TCI activation command, there should be an implicit or explicit signaling to associate the activated TCI states and the TRPs. Then, UE can apply *unifiedTCI-StateType* (*unifiedTCI-StateType2*) to the TCI states corresponding to the first (second) TRP.  **Proposal 1.B:** As a compromise and to consider the concern of ZTE, we can accept the first bullet and subbullet of the updated proposal 1.B and further study whether or not there should be restriction on the QCL types of the TCI states other than the first TCI state. However, we are not sure why the second FFS is needed. In our view, the answer to the second FFS is a “yes” and, to our understanding, other companies did not question the possibility of using CJT and other Tx schemes in the same CC. We suggest the following modification:  **Proposal 1.B (modified)**: 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   * For PDSCH-CJT, all PDSCH DM-RS port(s) is QCLed with the DL RS of the first indicated joint TCI state with respect to QCL-TypeA   + FFS: QCL type(s)/assumption(s) of indicated joint TCI state(s) other than the first indicated joint TCI state * ~~FFS: If more than two joint TCI states are indicated by MAC-CE/DCI in a CC/BWP for PDSCH-CJT, whether MTRP scheme(s) other than PDSCH-CJT can be configured in a same BWP/CC?~~     To Qualcomm:  We appreciate the analysis. However, to our understanding, the analysis is based on the investigation of the worst-case Doppler shift difference towards different TRPs which concludes that CJT is applicable only in the case of co-located TRPs and, hence, a single TCI state would be sufficient for CJT. We have two concerns regarding this argument: First, WID does not limit CJT to co-located TRPs but only to TRPs with ideal backhaul and synchronization. Therefore, the possible agreement that CJT should be limited to co-located TRPs needs to be decided in RANP level and not in 9.1.1.1 which is only concerned with the UTCI extension to mTRP. Second, we have different view from Qualcomm regarding the analysis of a worst-case scenario to refute 4 TCI states for CJT. If we follow Qualcomm argument based on the worst-case Doppler shift difference towards different TRPs, one could also use a similar argument to refute the need for more than one TCI state for PDSCH-SFN which, obviously, is against the current specification. |
| NEC | **Revised Proposal 1.A**: Support if the configuration is based on UE capability.  **Revised Proposal 1.B**: Not support. It looks 1 TCI state is enough according to the revision. Not sure why 4 TCI states are needed. |
| CMCC | **Revised Proposal 1.A:** Support.  **Revised Proposal 1.B:** The last FFS bullet should be removed. Since we already have the following note in the Agreement in RAN1#110.  **Agreement @RAN1#110**  On unified TCI framework extension, ~~at least~~ 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 |
| Intel | **Proposal 1.A:** Support the main bullet. We don’t think we need to keep the restriction on each TRP being configured with single TCI mode from Rel-17. This is an artificial restriction, and we don’t think the first sub-bullet is needed. As we commented during Rel-17 discussions, MPE is not the only use-case of supporting dynamic switching between joint and separate TCI states. In some network deployments which include micro nodes, the DL and UL can be from different nodes i.e., DL from macro node and UL to micro node. This is usually helpful for load balancing within a cell and for reducing inter-cell interference by enabling UEs to transmit with lower power to micro nodes. Dynamic switching can enable such deployments more flexibly than current design. The same argument holds true for mTRP deployments where one TRP may be a macro cell and another TRP may be a macro-DL/micro-UL setting. Therefore, even in the mTRP case, MPE is not the only use-case for enabling dynamic switching and/or configuration of joint and separate DL/UL TCI states.  **Proposal 1.B:** We are ok to support indication of up to 4 joint DL/UL TCI states for CJT with possibility of per-TRP TRS transmission. We still prefer that DM-RS ports should be QCL with the DL RSs of the more than one joint/DL TCI states with respect to QCL-TypeA. |
| NTT DOCOMO | **Proposal 1.A**: Support.  **Proposal 1.B**: Support up to 4 joint DL/UL TCI states for CJT. We prefer to remove the 1st bullet. The main use-case of CJT would be in FR1, and QCL type D is not typically configured in FR1. The 1st bullet seems QCL type A {Doppler shift, Doppler spread, average delay, delay spread} of CJT PDSCH from 4 TRPs are the same as that of 1st TCI state. It looks like up to 1 TCI state can be used for CJT PDSCH. |
| CATT | **Proposal 1.A:** Support.  **Proposal 1.B:** We are fine with the proposal.  We have also updated our views for issue 1.3. Alt.1, i.e. reuse Rel-17 design, is preferred. |
| LG | **Proposal 1.A:** Not support.  As mentioned in pre-discussion, the motivation of both joint and separate TCI combination is unclear since the MPE issue considering main use case on that can occur on any TRPs. Moreover, the situation is firstly known by UE using internal sensors and gNB cannot predict it.  **Proposal 1.B:** Not support with similar understanding as Qualcomm and OPPO mentioned above. |

# Issue 2 – TCI state update and activation

Table 2-1 Summary for Issue 2

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 2.1 | TCI state update for M-DCI based MTRP (down-selection from the alternatives agreed in RAN1#109) | Q1: Whether to support cross-TRP TCI update based on DCI?   * Support: ZTE, Google, Xiaomi, Spreadtrum, NEC, Samsung, Fraunhofer, InterDigital * Concern: Qualcomm, vivo, Huawei/HiSilicon, Docomo, OPPO, Futurewei, Sharp, LG, Fujitsu, Apple, CMCC, CATT, Intel, Lenovo, Nokia, Panasonic   **FL note: Based on feedback from proponents of cross-TRP TCI update, one main use case is beam recovery for the failed TRP link. However, as mentioned by opponents of cross-TRP TCI update, cross-TRP TCI update still can be enabled by MAC-CE-based TCI update (when only one TCI codepoint is activated), if a *coresetPoolIndex* value is included in the TCI activation command as in Rel-16 (the TCI activation command can be transmitted from any of the TRPs). From FL’s perspective, the TCI activation command for Rel-17 unified TCI doesn’t include any *coresetPoolIndex* value but including it in the TCI activation command for M-DCI based MTRP in Rel-18 unified TCI extension can be captured as a part of potential agreement. I hope this can address the concern from proponents of cross-TRP TCI update. Proposal 2.A is recommended for this issue.** |
| 2.2 | Mapping the activated TCI state(s) to the TCI codepoint(s) for M-DCI based MTRP | **FL note: According to contributions, majority prefer the same TCI state mapping to TCI codepoint as Rel-17 unified TCI framework for M-DCI based MTRP, thus Proposal 2.B is recommended for this issue. Whether a CC can be configured with both joint and separate DL/UL TCI modes is still under discussion in Issue 1.1, thus corresponding TCI state mapping can be further discussed if supported.** |
| 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:   **FL note: If no consensus can be reached in this issue, then Alt1 will be the natural outcome.** |

**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 CORESET(s) associated with the same *coresetPoolIndex* value if the CORESET(s) is associated only with USS and/or Type3 CSS (except CORESET#0) or configured with *followUnifiedTCIstate* = 'enabled'
  + The UE shall apply the indicated joint/DL/UL TCI state(s) to PDSCH/PUSCH scheduled/activated by PDCCH on CORESET(s) associated with the same *coresetPoolIndex* value if the CORESET(s) is associated only with USS and/or Type3 CSS (except CORESET#0) or configured with *followUnifiedTCIstate* = 'enabled'
  + The UE shall apply the indicated joint/DL/UL TCI state(s) to aperiodic CSI-RS/SRS triggered by PDCCH on CORESET(s) associated with the same *coresetPoolIndex* value if the aperiodic CSI-RS/SRS is configured to follow the indicated joint/DL/UL TCI state
  + FFS: The indicated joint/DL/UL TCI state(s) applied to channels/signals other than above
* 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, 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

Table 2-2 Company inputs for Issue 2

|  |  |
| --- | --- |
| **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~~ |
| 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. |
| 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. |
| 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.  **Proposal 2.B:** Support. |
| LG | **Proposal 2.A:** Support the proposal and the applicability on PDSCH/PUSCH and the RSs.  **Proposal 2.B:** Support |

# 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 * 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 * 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 * 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 * 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 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 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

**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

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 |
| 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.  **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~~  **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].  **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 |

# Issue 4 – UL power Control for UL MTRP

Table 4-1 Summary for Issue 4

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| --- | --- | --- |
| **#** | **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 * 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

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| --- | --- |
| **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. |

# Issue 5 – Beam reporting and beam failure recovery

Table 5-1 Summary for Issue 5-1

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| --- | --- | --- |
| **#** | **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  Prefer to discuss in AI 9.1.4.1: Ericsson  **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  Prefer to discuss in AI 9.1.4.1: Ericsson  **FL note: Lower priority in this meeting** |

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. |
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# 3Appendix: Agreements before/in RAN1#110bis-e

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