**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:

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

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

Please upload your inputs to the draft folder corresponding to this AI, if any, **by Monday 10/10 @10:00 UTC.** 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)** |
| MediaTek | Darcy | darcy.tsai@mediatek.com |
| MediaTek | Rebecca Chen | rebecca.chen@mediatek.com |
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# Issue 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
* Support X = 4: Google, vivo, Huawei/HiSilicon, Docomo, Fraunhofer, Futurewei, FGI, CATT, Intel, Ericsson, InterDigital, 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) is not within the scope of this AI, however, it is still possible to support X=4 by extension of legacy MTRP scheme. Proposal 1.B is recommended for this issue.** |
| 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, InterDigital

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 configuration of both joint and separate DL/UL TCI modes in a serving cell

* FFS: Signaling for the configuration

**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 PDSCH-SFN with 'sfnSchemeA'
* Up to 4 indicated joint TCI states can be associated/applied to PDSCH-SFN with 'sfnSchemeA'
* QCL-TypeD source RS is absent in each of the indicated joint TCI states

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 TCIFor 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

R1-2209967, R1-2209969**Figure 5: Worst case of Doppler shift difference between two TRPs**Some example phase errors ($2π⋅2\frac{v}{c}f\_{c}⋅t$) 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** $\pm f\_{D}$ **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** $\pm f\_{D}$ **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. |
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# Issue 2 – TCI state update and activation

Table 2-1 Summary for Issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2.1 | 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
* Concern: Qualcomm, vivo, Huawei/HiSilicon, Docomo, OPPO, Futurewei, Sharp, LG, Fujitsu, Apple, CMCC, CATT, Intel, InterDigital, 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

, * Concern:

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, InterDigital, 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 the CORESET(s) associated with the same *coresetPoolIndex* value
	+ 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
	+ 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

**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

Table 2-2 Company inputs for Issue 2

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| **Company** | **Input** |
| Mod | * **Please update your view on those sub-issues in Table 2-1 (especially Issue 2.3)**
* **Please also share your view on Proposal 2.A – 2.B**
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| 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.  |
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# Issue 3 – How to associate the indicated TCI state(s) with each target channel/signal

Table 3-1 Summary for Issue 3

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| **#** | **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, InterDigital, 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, InterDigital, Nokia, Panasonic
* 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, InterDigital, Lenovo, TCL
* Concern:

Alt2 (RRC with CORESET group)* Support: ZTE, CMCC, Spreadtrum, Samsung, Fraunhofer
* Concern:

Alt3 (MAC-CE)* Support: Google, Xiaomi, DOCOMO, Futurewei, InterDigital, ITRI, PUCCH
* 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

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| --- | --- |
| **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 groupFor 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. |
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# 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
* 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
* 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:
* 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
* Alt3: A joint/UL TCI state indicated for PUCCH/PUSCH transmission is always associated with a UL PC parameter setting for PUCCH/PUSCH

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. |
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# 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
* Concern:

Enhancement to beam update after NW response to the TRP-specific BFR request* Support: Qualcomm, vivo
* Concern:

**FL note: Lower priority in this meeting** |
| 5.2 | Enhance/extend group-based reporting to support STxMP | Support: Qualcomm, Docomo, ZTE, vivo, Nokia, SamsungConcern: OPPO, Huawei/HiSiliconPrefer 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, SamsungConcern: Huawei/HiSiliconPrefer 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. |
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Appendix A: Agreements before/in RAN1#110

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| **RAN1#110** |
| **Agreement**On unified TCI framework extension, for the target use cases agreed in RAN1#109-e in AI 9.1.1.1, up to 4 TCI states can be indicated in a CC/BWP or a set of CCs/BWPs in a CC list to DL receptions and/or UL transmissions, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation* FFS: The possible combination(s) of joint/DL/UL TCI states that can be indicated to DL receptions and/or UL transmissions in a BWP/CC/TRP
* Note: This agreement does not imply that there will be more than 2 DL or UL or joint TCI states indicated in a CC/BWP for the target use cases agreed in RAN1#109-e in AI 9.1.1.1
* Note: The maximum number of TCI states that can be indicated to each of the target use cases agreed in RAN1#109-e in AI 9.1.1.1 is remained the same as in Rel-16/17

Note: The maximum number of TCI states that can be indicated simultaneously to CJT-based PDSCH reception and the required type(s) of TCI states (i.e., DL /UL/joint) are independently discussed in this AI**Agreement**On unified TCI framework extension for S-DCI based MTRP, to inform the association with the joint/DL TCI state(s) indicated by DCI/MAC-CE for PDCCH repetition, PDCCH-SFN, and PDCCH w/o repetition/SFN, down-selection at least one alternative from the followings:* Alt1-1: Use RRC parameter(s) in a CORESET configuration to inform the UE whether and/or which indicated joint/DL TCI state(s) shall be applied to the corresponding PDCCH receptions on the CORESET
	+ FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the joint/DL TCI state(s) indicated by DCI/MAC-CE
* Alt1-2: Use an RRC parameter in a CORESET configuration to inform that the CORESET belongs to which CORESET group(s), and the indicated joint/DL TCI state(s) is associated with each CORESET group
	+ FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the CORESET group(s)
	+ FFS: How to associate the indicated joint/DL TCI state(s) with each CORESET group
	+ FFS: The UE applies the indicated joint/DL TCI state(s) to a CORESET according to the CORESET group(s) the CORESET belongs to, or the UE applies the indicated joint/DL TCI state(s) associated with the CORESET group(s) in which the beam indication DCI is received to all PDCCH receptions
* Alt2: The association between a CORESET and the indicated joint/DL TCI state(s) is determined based on a fixed rule, and the UE shall apply the indicated joint/DL TCI state(s) to the corresponding PDCCH receptions on the CORESET
	+ FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the joint/DL TCI state(s) indicated by DCI/MAC-CE
* Alt3: Use MAC-CE to inform the UE whether and/or which indicated joint/DL TCI state(s) shall be applied to the corresponding PDCCH receptions on a CORESET
	+ FFS: Whether only the CORESET(s) that always/can share the unified TCI state as defined in Rel-17 unified TCI framework can be associated with the joint/DL TCI state(s) indicated by DCI/MAC-CE

Switching between multi-TRP and single TRP operation is not precluded**Agreement**On unified TCI framework extension for S-DCI based MTRP, for PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2, down-selection one alternative from the followings:* Alt1: Use an indicator field (could be reusing an existing DCI field or introducing a new DCI field) in a DCI format 0\_1/0\_2 to inform which joint/UL TCI state(s) indicated by MAC-CE/DCI the UE shall apply to PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2
* Alt2: PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2 follows the spatial domain transmission filter(s) used for the SRS resource(s) indicated by the DCI format 0\_1/0\_2
* Alt3: Use an RRC parameter in a CORESET configuration to inform that the CORESET belongs to which CORESET group(s), and the indicated joint/UL TCI state(s) is associated with each CORESET group. When a scheduling/activation DCI format 0\_1/0\_2 is received in a CORESET group, the indicated joint/UL TCI state(s) associated with the CORESET group is applied to PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2
	+ FFS: Details of CORESET group(s)

FFS: PUSCH transmission scheduled/activated by a DCI format 0\_0 and Type-1 CG-PUSCH**Agreement**On unified TCI framework extension for S-DCI based MTRP, to inform the association with joint/UL TCI state(s) indicated by DCI/MAC-CE for PUCCH transmission, down-selection at least one alternative from the followings:* Alt1: Use RRC configuration to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/ group
* Alt2: Use RRC configuration to inform the association between a CORESET group and a PUCCH resource/group, and the indicated joint/UL TCI state(s) associated with the CORESET group applies to the PUCCH resource/group
* Alt3: Use MAC-CE to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/group
* Alt4: Use DCI to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/group
 |
| **RAN1#109e** |
| **Agreement**On unified TCI framework extension, consider all the intra and inter-cell MTRP schemes specified in Rel-16 and Rel-17* Consider, if STxMP is supported, Rel-18 MTRP scheme(s) with STxMP

**Agreement**On unified TCI framework extension at least for single-DCI based MTRP, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate multiple joint/DL/UL TCI states in a CC/BWP or a set of CCs/BWPs in a CC list* FFS: Detail of mapping joint/DL/UL TCI state ID(s) to a TCI codepoint, e.g., possible combinations of joint, DL, and/or UL TCI state IDs that can be mapped to a TCI codepoint
* FFS: Whether to increase the max number of MAC CE activated TCI codepoints, i.e., more than 8 codepoints
* FFS: Whether to increase the max number of TCI field bits, i.e., more than 3 bits
* Note: This doesn't imply that support of one additional TCI field or a field associating the TCI field to the TRP(s) is precluded

Note: The term TRP is used only for the purposes of discussions in RAN1 and whether/how to capture this is FFS**Agreement**On unified TCI framework extension for M-DCI based MTRP, consider the following alternatives for TCI state update:* Alt1: Reuse the same TCI state update scheme for S-DCI based MTRP
* Atl2: Use the existing TCI field in the DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *CORESETPoolIndex* values to indicate the joint/DL/UL TCI state(s) corresponding to the same *CORESETPoolIndex* value
* Alt3: Use the existing TCI field in any DCI format 1\_1/1\_2 (with or without DL assignment) to indicate all joint/DL/UL TCI states corresponding to both *CORESETPoolIndex* values
	+ Study the association between the indicated joint/DL/UL TCI state(s) and a *CORESETPoolIndex* value
* Alt4: Use the existing TCI field in the DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *CORESETPoolIndex* values to indicate joint/DL/UL TCI state(s) corresponding to the same or different *CORESETPoolIndex* value.
	+ Study whether the indicated joint/DL/UL TCI state(s) applies to the channels/signals associated with the same *CORESETPoolIndex* value or different *CORESETPoolIndex* value is indicated by DCI

**Agreement**On unified TCI framework extension for S-DCI based MTRP, consider at least the following alternatives to map/associate a joint/DL TCI state to PDCCH reception(s)* Atl1: Use RRC configuration to inform the mapping/association between a configured or indicated joint/DL TCI state and a CORESET or a CORESET group
* Alt2: Use RRC configuration to inform the mapping/association between a configured or indicated joint/DL TCI state and a search space set
* Alt3: Use MAC-CE to inform the mapping/association between an activated or indicated joint/DL TCI state and a CORESET or a CORESET group
* Alt4: Use DCI to inform the mapping/association between an indicated joint/DL TCI state and a CORESET or a CORESET group
* Alt5: Based on a fixed mapping/association rule, e.g., the first indicated joint/DL TCI state always applies to PDCCH receptions

Consider above alternatives for PDCCH repetition, PDCCH-SFN, PDCCH w/o repetition/SFN, and potential support of dynamic switching between S-TRP and M-TRP for PDCCH. It is not precluded to adopt one single alternative or multiple alternatives to support these cases.**Agreement**On unified TCI framework extension, if an indicated joint or UL TCI state applies to a PUSCH/PUCCH transmission occasion at least for S-DCI based PUSCH/PUCCH repetition with TDM and the indicated joint or UL TCI state is associated with an UL PC parameter setting for PUSCH /PUCCH (including P0, alpha for PUSCH, and closed loop index) and a PL-RS, the UE should apply the UL PC parameter setting and the PL-RS for the PUSCH /PUCCH transmission occasion.* FFS: How to extend to other Rel-18 MTRP scheme(s) with STxMP, if supported
* FFS: UL PC enhancement for CB and non-CB SRS in above case

FFS: The applied UL PC parameter setting if one or both indicated joint or UL TCI state(s) is not associated with an UL PC parameter setting (including P0, alpha for PUSCH, and closed loop index) for PUCCH/PUSCH**Agreement**On UE power limitation for STxMP for FR2, send LS to RAN4 to check the followings:* Whether it is feasible to assume power limitation per panel for STxMP (Assumption 1)
* Whether it is feasible to assume a total power limitation per UE over all UE panels used for STxMP (Assumption 2)
* In either of Assumption1 or Assumption 2, whether the total power limitation per UE over all UE panels used for STxMP or the sum of per-panel power limitation for STxMP can be different from (greater than) the existing power limitation for a given power class?
* If both Assumption 1 and Assumption 2 are feasible, whether both assumptions can be applied to a same UE, and what is the relationship between the per-panel power limitation and total power limitation if both are applied (e.g., the sum of per-panel power limitation can be larger than the total power limitation per UE, or should be always the same)?

FFS: Detail of exact LS if agreedNote: Scenarios of above include at least single carrier scenario for FR2Note: Above power limitation includes both total radiated power and EIRPLS 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 |