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

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

**Agenda item:** 9.1.1.1

**Source:** Moderator (MediaTek)

**Title:** Moderator summary on extension of unified TCI framework (Round 2)

**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 inform UE which indicated TCI state(s) that UE shall apply to target channel/signal
	+ Issue 4 – UL power control for UL MTRP
	+ Issue 5 – Beam reporting and beam failure recovery
* Observations and recommended proposals based on the summary of companies’ views

This FL summary (Round 2) is prepared for our 3rd GTW discussion (potential Monday 10/17 @03:00 UTC). Please upload your inputs to the corresponding draft folder, if any, **by Monday 10/17 @01:00 UTC.**

# Contact Person

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

Table 0 Contact Information

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

# Issue 1 – General framework for unified TCI extension

**Proposal 1.B.1**: On unified TCI framework extension, up to 2 joint TCI states can be indicated by MAC-CE/DCI and applied to CJT-based PDSCH reception (PDSCH-CJT) in a BWP /CC configured with joint DL/UL TCI mode

* ~~FFS:~~ Support of 1 or 2 indicated joint TCI states for PDSCH-CJT is up to UE capability
* FFS: QCL type(s)/assumption(s) of the indicated joint TCI state(s) applied to PDSCH-CJT
* Note: On how to inform UE to apply which indicated joint TCI state(s) to target channel(s)/signal(s) in the BWP/CC, it is discussed individually in AI 9.1.1.1

# Issue 2 – TCI state update and activation

Table 2-1 Summary for Issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2.3 | For S-DCI based MTRP, whether to introduce/re-interpret DCI field(s) other than the existing TCI field for TCI state update | Alt1: Use only the existing TCI field for TCI state update* Support: Apple, CATT, CEWiT, Fraunhofer, Futurewei, Intel, Lenovo, Nokia, OPPO, Qualcomm, Sharp, Spreadtrum, vivo, InterDigital, Xiaomi

, * Concern: Huawei/HiSilicon

Alt2: Use the existing TCI field and one additional DCI field (could be reusing an existing DCI field or introducing a new DCI field) for TCI state update* Support: Huawei/HiSilicon, Ericsson, FGI, Google, Samsung
* Concern:
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**Proposal 2.D:** On unified TCI framework extension for S-DCI based MTRP, down-select one alternative from the followings in RAN1#111:

* Alt1: Use the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) to indicate joint/DL/UL TCI states for both TRPs in a CC/BWP
* Alt2: Use the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) to indicate joint/DL/UL TCI state(s) specific to one of the two TRPs in a CC/BWP
	+ FFS: Use an indicator field (could be reusing an existing DCI field other than the existing TCI field or introducing a new DCI field) in DCI format 1\_1/1\_2 (with or without DL assignment) to inform that the joint/DL/UL TCI state(s) is indicated for which TRP

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

Note: The term TRP is used only for discussion purpose in RAN1 and whether/how to capture this is FFS

Table 2-2 Company inputs for Issue 2

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| --- | --- |
| **Company** | **Input** |
| Mod | **Please share your view on Proposal 2.D** |
| Sharp | We are fine with Proposal 2.D. |
| Xiaomi | Support the proposal 2.D and prefer Alt 1.And we want to know the motivation of Alt 2. Why restrict to indicate the TCI state of only one TRP for S-DCI based M-TRP? If the TCI state of both TRPs need to be updated, two DCIs will be needed? That will increase the signaling overhead and latency, but we don’t see the benefit. |
| OPPO | Thanks for providing Proposal 2.D. In our understanding, if the existing TCI field in DCI indicates a codepoint corresponding to two unified TCI states, then these two TCI states surely would be applied to two TRPs. If the codepoint corresponding to a single unified TCI state, then it would be applied to one of the TRPs. And how to associate the indicated TCI state and TRP can be further discussed. It seems the flexibility was enjoyed by legacy Rel.16 TCI state (via MAC CE). So, we somehow failed to see the benefits of having this proposal, please clarify a bit, if I get anything wrong. Thanks.  |
| Fujitsu | We are fine with Proposal 2.D and prefer Alt1. For Alt2, we have the similar question with Xiaomi. |
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# Issue 3 – How to inform UE which indicated TCI state(s) that UE shall apply to target channel/signal

Table 3-1 Summary for Issue 3

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| **#** | **Issue** | **Companies’ views** |
| 3.5 | CORESET group configuration for S-DCI based MTRP | Whether to support CORESET group configuration for S-DCI based MTRP* Support:
* Not support: OPPO, Fujitsu
* Leave it to RAN2:
 |

**Proposal 3.A:** On unified TCI framework extension for S-DCI based MTRP, down-select one or combine following alternatives for PDSCH reception (make decision in RAN1#111):

* 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.A.1:** On unified TCI framework extension for S-DCI based MTRP, the followings are supported for PDSCH reception:

* RRC configuration is used to inform which joint/DL TCI state(s) indicated by MAC-CE/DCI that the UE shall apply to PDSCH reception by default
	+ FFS: The RRC configuration is provided in the *PDSCH-Config* or a CORESET/CORESET group
* A DCI field (either a new DCI field or an existing field) in a DCI format 1\_1/1\_2 is used to indicate which of the indicated joint/DL TCI state(s) the UE shall apply for PDSCH reception starting from an application time (if defined) after the DCI format 1\_1/1\_2
	+ The presence of a new DCI field (if supported) is configurable by RRC
	+ The UE applies the default indicated joint/DL TCI state(s) informed by above RRC configuration to PDSCH reception if the DCI field is not configured, or before the application time (if defined)
* FFS: The application time

**Proposal 3.E:** On unified TCI framework extension for M-DCI based MTRP:

* The UE shall apply the indicated joint/DL TCI state specific to a *coresetPoolIndex* value to PDCCH on a CORESET that is associated with the same *coresetPoolIndex* value
* The UE shall apply the indicated joint/DL TCI state specific to a *coresetPoolIndex* value to PDSCH scheduled/activated by PDCCH on a CORESET that is associated with the same *coresetPoolIndex* value
* The UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to PUSCH scheduled/activated by PDCCH on a CORESET that is associated with the same *coresetPoolIndex* value

Above is applicable only if the CORESET (other than CORESET#0) is associated only with USS and/or Type3 CSS, or is configured with *followUnifiedTCIstate* = 'enabled'

Table 3-2 Company inputs for Issue 3

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| --- | --- |
| **Company** | **Input** |
| Mod | **Please share your view on Proposal 3.A.1, as a potential compromise between RRC and DCI based schemes** |
| Lenovo | Proposal 3.A: SupportProposal 3.A.1: It seems RRC signaling is always needed to indicate one or more default TCI state for the PDSCH reception, and whether DCI based signaling is used is determined by another RRC signaling. We understand that the signaling either RRC signaling or DCI signing is just used to indicate one or two of the indicated TCI states for the PDSCH reception, if RRC based signaling is always needed, why DCI based signaling in Proposal 3.A.1 is needed? |
| ZTE | Proposal 3.A.1: Thank you so much for this compromise proposal. In technical, we do not know why we still need an RRC configuration for informing? PDSCH is dynamically scheduled, if having RRC level, I think that the simplified/efficient way is to update the activated TCI state(s) corresponding to the sTRP.Then, for DCI level, we do not need the following part. As mentioned in our contribution:* Having above functionality, it does not mean that we need to further consider default beam as in Rel-15/16 (due to latency of DCI decoding). On the contrary, UE should buffer received signals based on the both indicated TCI state(s), and then when decoding DCI, UE can further determine how to demodulate the received signals accordingly. It means that the DCI further indicates which indicated and effective TCI state(s) at the time instance of the PDSCH transmission should be used, rather than selecting the currently indicated TCI state(s) in the DCI.
* A DCI field (either a new DCI field or an existing field) in a DCI format 1\_1/1\_2 is used to indicate which of the indicated joint/DL TCI state(s) the UE shall apply for PDSCH reception scheduled by the DCI format 1\_1/1\_2

  |
| Google | **Proposal 3.A.1**: We appreciate Ericsson for providing a compromised solution. We understand Proposal 3.A.1 trying to address potential switching delay issues by configuring a DCI field. We have a couple of questions on this compromised proposal. * Q1: Whether the RRC configuration/the DCI field applies to both dynamic PDSCH and DL SPS, or just to dynamic PDSCH.
* Q2: It seems both DCI with or without DL assignment can be configured with such DCI field?

In addition, we think the second sub-bullet should be modified with below wordings, since original wordings read like “if the DCI field is not configured” and “before the application time (if defined)” are bundled conditions. * A DCI field (either a new DCI field or an existing field) in a DCI format 1\_1/1\_2 is used to indicate which of the indicated joint/DL TCI state(s) the UE shall apply for PDSCH reception starting from an application time (if defined) after the DCI format 1\_1/1\_2
	+ The presence of a new DCI field (if supported) is configurable by RRC
	+ The UE applies the default indicated joint/DL TCI state(s) informed by above RRC configuration to PDSCH reception if the DCI field is not configured, ~~and~~or before the application time (if defined)
 |
| Panasonic | Proposal 3.A.1:We echo what Docomo mentioned in the FFS thez added as well as Xiaomi’s comments. We think that the PDSCH follows the unified TCI framework and use predetermined rule to define the default TCI states instead of RRC signaling. To be able to agree, we would like to ask for further clarification: For RRC signaling, we still do not understand to what TCI states the RRC index (that is being proposed) is pointing to. This issue is also related to updating the TCI states of the UE when receiving a TCI codepoint, for example do you overwrite the previous TCI states, or you just modify the relevant parts. For example, in release 17, when you receive an UL state, you only update the UL state and not touch the DL state. I think using RRC config will be messy in this case.  |
| Mod | * **Please share your preference on Issue 3.5 in Table 3-1**
* **Please share your view on Proposal 3.A, Proposal 3.A.1, and Proposal 3.E**
* **Proposal 3.A.1 is a potential compromise between RRC based and DCI based schemes (i.e., w/o down-selection)**
* **Another suggestion is we don’t preclude the possibility to combine RRC based and DCI based schemes in Proposal 3.A, thus I revised the main bullet to keep the door open and we can make decision in the next meeting.**
 |
| Sharp | Proposal 3.A: SupportProposal 3.A.1: We are generally fine with the proposal, but in the second bullet, an application time for the indicated TCI state was already defined as BeamAppTime-r17. If it is different from the application time, we’d like to change to “switching time”, instead of “application time”. |
| Xiaomi | **Proposal 3.A and proposal 3.A.1**For proposal 3.A.1, we prefer to use a fixed rule to define the default TCI state instead of RRC signalling before the first DCI. And we can accept proposal 3.A.1 with the following update**Updated Proposal 3.A.1:** On unified TCI framework extension for S-DCI based MTRP, the followings are supported for PDSCH reception:* ~~RRC configuration~~ Fixed rule is used to ~~inform~~ decide which joint/DL TCI state(s) indicated by MAC-CE/DCI that the UE shall apply to PDSCH reception by default
	+ ~~FFS: The RRC configuration is provided in the~~ *~~PDSCH-Config~~* ~~or a CORESET/CORESET group~~
* A DCI field (either a new DCI field or an existing field) in a DCI format 1\_1/1\_2 is used to indicate which of the indicated joint/DL TCI state(s) the UE shall apply for PDSCH reception starting from an application time (if defined) after the DCI format 1\_1/1\_2
	+ The presence of a new DCI field (if supported) is configurable by RRC
	+ The UE applies the default indicated joint/DL TCI state(s) ~~informed by above RRC configuration~~ to PDSCH reception if the DCI field is not configured, or before the application time (if defined)
* FFS: The application time

And we also support Proposal 3.A and prefer Alt 1 only. In addition, a default TCI state can be defined with fixed rule and will be used before the application time (if defined) of the first DCI for TCI association. The application time of the DCI can be larger than a threshold. And the association can be updated only when receiving new association. The association should be applied to the PDSCH reception(s) scheduled/activated by the DCI format 1\_1/1\_2 at least. For other PDSCH reception, either the default TCI state or the association is OK. Both DCI format 1\_1/1\_2 with and without DL assignment can inform the TCI association.**Proposal 3.E**Support. But what will be applied for PUCCH?**Issue 3.5**Since there are at most 3 CORESETs for S-DCI based MTRP. It is OK for us to configure CORESET group or not. And we are also fine with leaving it to RAN2. |
| OPPO | **Issue 3.5:** not support.If we create the CORESET group for S-DCI, then in essence we turn it into M-DCI MTRP and somehow loose the flexibility of S-DCI MTRP in our view. **Proposal 3.A**: support. Hopefully we could make a down selection next meeting. **Proposal 3.A.1**: we see the great effort from FL to forge a compromised solution. But our general impression on controlling indicated TCI state(s) follows the normal procedure of RRC configuration, MAC CE activation, and DCI indication. It seems unusual to put another RRC control over MAC CE and/or DCI signalling. This would complicate UE’s behaviour, thinking about whether the RRC configuration is there or not. Moreover, the dynamic switch between STRP/MTRP PDSCH would be disabled by RRC controlling, if I don’t understand the intention in a wrong way.**Proposal 3.E:** support. |
| Fujitsu | **Proposal 3.A and Proposal 3.A.1**: We slightly prefer Proposal 3.A. It seems that Proposal 3.A.1 is the next level detail of Proposal 3.A, where some FFS points in Proposal 3.A are addressed by Proposal 3.A.1. **Proposal 3.E**We are fine with the proposal.**Issue 3.5**We do not see the need to support CORESET group. |

# 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, LG, Docomo, Transsion
* Concern:

Alt2: No change from Rel-17 unified TCI framework (i.e., if the UL PC parameter setting is absent from any of the indicated joint/UL TCI states, the UE shall apply the one single default UL PC parameter setting configured in the corresponding UL BWP instead)* Support: Ericsson, Samsung, ZTE
* Concern:

**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

**Support/fine: QC, MTK, Futurewei, vivo, Nokia, Lenovo, ZTE, Apple, OPPO, Samsung, Xiaomi, Spreadtrum, Huawei, CMCC, Intel, Docomo, CATT, LG, CATT, Transsion, Sharp**

**Not support: Ericsson**

# 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, CATTConcern: OPPO, Huawei/HiSilicon**FL note: Lower priority in this meeting** |
| 5.3 | Enhance/extend Rel-17 UE capability index reporting to support STxMP | Support: Qualcomm, OPPO, Docomo, NEC, ZTE, InterDigital, LG, Nokia, CMCC, Samsung, Xiaomi, CATTConcern: Huawei/HiSilicon**FL note: Lower priority in this meeting** |
| 5.4 | Prefer to discuss Issue 5.2 and 5.3 in which AIs | Prefer to discuss in AI 9.1.1.1: QC, OPPO, CMCC, Docomo, ZTE, vivoPrefer to discuss in AI 9.1.4.1: Ericsson, NEC, Xiaomi, Huawei, HiSilicon |

**Proposal 5.A:** On unified TCI framework extension, study the following enhancements for TRP-specific BFR:

* Implicit BFD-RS determination based on the indicated joint/DL TCI states for S-DCI based MTRP
* Enhancement to beam update after NW response to TRP-specific BFR request

Table 5-2 Company inputs for Issue 5

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| **Company** | **Input** |
| Mod | * **Please share your view on Proposal 5.A**
* **Since it is unclear whether to handle Issue 5.2 and 5.3 in this AI or in AI 9.1.4.1, I’d loke to check companies’ view on this. Please update your preference in Table 5-1 for Issue 5.4.**
 |
| Xiaomi | **Proposal 5.A**For the first sub-bullet, for S-DCI based MTRP, implicit BFD-RS determination is not supported in Rel-17. We slightly not prefer to enhance it since it is not agreed during the discussion in Rel-17. In addition, it is related to issue 3.5, in order to support implicit BFD-RS determination for S-DCI based MTRP, CORESET group need to be supported.For the second bullet, is it about M-DCI based MTRP or both S-DCI and M-DCI based MTRP? We can discuss it for M-DCI based MTRP first. |
| OPPO | Similar view as Xiaomi that implicit BFR RS determination via UTCI was not supported in Rel.17. And we are extending the R17 UTCI feature into MTRP in R18, rather than adding new ones.  |
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# Appendix: Agreements/conclusions before/in RAN1#110bis-e

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| **RAN1#110bis-e** |
| **Conclusion** On unified TCI framework extension in Rel-18, there is no consensus to support simultaneous configuration of both joint and separate DL/UL TCI modes in a serving cell**Conclusion**On unified TCI framework extension in Rel-18, there is no consensus to support separate RRC-configured TCI state list(s) for each of TRPs**Agreement**On unified TCI framework extension for M-DCI based MTRP:* The existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) associated with one *coresetPoolIndex* value can indicate the joint/DL/UL TCI state(s) specific to the same *coresetPoolIndex* value
	+ FFS: The UE shall apply the indicated joint/DL/UL TCI state(s) specific to a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the same *coresetPoolIndex* value
* A *coresetPoolIndex* value field is included in TCI state activation command (MAC-CE) to indicate that the mapping between the activated TCI state(s) and the TCI codepoint(s) is specific to which *coresetPoolIndex* value

**Agreement**On unified TCI framework extension for S-DCI based MTRP, to inform the association with the joint/DL TCI state(s) indicated by DCI/MAC-CE for PDCCH repetition, PDCCH-SFN, and PDCCH w/o repetition/SFN, support the following:* Use RRC configuration to inform that the UE shall apply the first one, the second one, both, or none of the joint/DL TCI states indicated by DCI/MAC-CE to a CORESET or a group of CORESETs (if CORESET group configuration is supported)

**Agreement**On unified TCI framework extension for M-DCI based MTRP:* For a serving cell configured with joint DL/UL TCI mode, one joint TCI state can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment)
* For a serving cell configured with separate DL/UL TCI mode, a DL TCI state, an UL TCI state, or a pair of DL and UL TCI states can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment)

**Agreement**On unified TCI framework extension for S-DCI based MTRP, down-select one alternative from the followings in RAN1#111 for PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2:* Alt1: Use an indicator field (could be reusing an existing DCI field or introducing a new DCI field) in the DCI format 0\_1/0\_2 to inform which joint/UL TCI state(s) indicated by MAC-CE/DCI the UE shall apply to PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2
* Alt2: PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2 follows the spatial domain transmission filter(s) used for the SRS resource(s) indicated by the DCI format 0\_1/0\_2
	+ - FFS: PL-RS(s), and UL PC parameter setting(s) (including P0, alpha, and closed loop index) for the PUSCH

**Agreement**On unified TCI framework extension for S-DCI based MTRP, down-select one alternative from the followings in RAN1#111 for PUCCH transmission:* Alt1: Use RRC configuration to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/ group
* Alt2: Use RRC configuration to inform the association between a CORESET group and a PUCCH resource/group, and the indicated joint/UL TCI state(s) associated with the CORESET group applies to the PUCCH resource/group associated with the same CORESET group
* Alt3: Use MAC-CE to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/group
* Note: the association indicates whether the UE shall apply the first one, the second one, or both of the joint/UL TCI states indicated by DCI/MAC-CE to a PUCCH resource/group
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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
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| **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

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| --- | --- | --- | --- |
| 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 |