**3GPP TSG RAN WG1 #112bis-e DRAFT R1-2303812**

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

**Agenda item:** 9.1.1.1

**Source:** Moderator (MediaTek)

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

**Document for:** Discussion and Decision

# Introduction

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

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

For the case of simultaneous UL transmission from multiple panels, the operation will only be limited to the objective 6 scenarios. |

# Plan

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

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

# Contact Person

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

Table 0 Contact Information

|  |  |  |
| --- | --- | --- |
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# Proposal to be discussed in the online session

# Discussion

# Issue 1 – General issue for unified TCI extension

Table 1-1 Summary for Issue 1

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| --- | --- | --- |
| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 1.1 | Support of inter-cell (M-DCI based) MTRP operation | **FL note: Based on Tdoc contributions to RAN1#112b [3]-[34], some companies prefer an explicit agreement to support the association between activated joint/DL/UL TCI state(s) and PCI(s) for inter-cell MTRP since current specification may be applicable only for legacy TCI framework.** **FL note: The highlighted part in current spec TS 38.214 as follows may not cover the TCI state activation command (MAC-CE) that will be used for M-DCI based MTRP operation in unified TCI framework extension.****TS 38.214**If the UE is configured with *SSB-MTC-AddtionalPCI* and with *PDCCH-Config* that contains two different values of *coresetPoolIndex* in *ControlResourceSet*, the UE receives an activation command for CORESET associated with each *coresetPoolIndex*, as described in clause 6.1.3.14 of [10, TS 38.321], used to map up to 8 TCI states to the codepoints of the DCI field *'Transmission Configuration Indication'* in one CC/DL BWP. When a set of TCI state IDs are activated for a *coresetPoolIndex*, the activated TCI states corresponding to one *coresetPoolIndex* is associated with the serving cell physical cell ID and activated TCI states corresponding to another *coresetPoolIndex* can be associated with another physical cell ID.**Proposal 1.1:** If the UE is configured with *SSB-MTC-AdditionalPCI* and receives TCI state activation command (MAC-CE) that activates a set of joint/DL/UL TCI state(s) specific to each *coresetPoolIndex* value for M-DCI based MTRP in unified TCI framework extension, the activated joint/DL/UL TCI state(s) specific to one *coresetPoolIndex* value can be associated with the serving cell PCI and the activated joint/DL/UL TCI state(s) specific to another *coresetPoolIndex* value can be associated with a PCI other than the serving cell PCI.Support: vivo, QC, Xiaomi, Google, Nokia, Samsung, ZTE, CMCC, Apple, Futurewei, Spreadtrum, Huawei/HiSilicon, Sharp, NEC, Fujitsu, CATT, Docomo, Panasonic, IDC, Intel, FGI, LenovoNo need: OPPO, Ericsson |
| 1.2 | Support of inter-cell S-DCI based MTRP operation | Question 1: In Rel-18 unified TCI framework extension, whether to support inter-cell S-DCI based MTRP?* Yes: Samsung, Apple (if time permits), Intel (open), FGI (if time permits)
* No: vivo, QC, CMCC, OPPO, Xiaomi, Google, Nokia, CMCC, ZTE, Spreadtrum, Panasonic, Futurewei, Huawei/HiSilicon, Sharp, NEC, Fujitsu, CATT, Docomo, Lenovo

**FL note: Based on feedback from companies, it seems majority think it is not proper to introduce new MTRP scheme in this AI at this moment, and I will not recommend any proposal (for conclusion/agreement) in this meeting if situation is not changed.** |
| 1.3 | Common beam for PDCCH/PDSCH | Question 1: In Rel-17 unified TCI framework, it can be guaranteed that PDCCH and respective PDSCH follow the common beam for DL reception. In Rel-18 unified TCI framework extension, it is possible that PDCCH and respective PDSCH follow different beams for DL reception if they apply different indicated joint/DL TCI states. Then, whether specification should restrict that two indicated joint/DL TCI states must be associated with different TRPs, i.e., following different beams for PDCCH and PDSCH is only allowed for MTRP operation? If yes, proponents can elaborate more on how to enable the restriction.* Yes: Samsung, NEC
* No: Google, Futurewei, CATT, vivo, Panasonic, Panasonic, Ericsson, Lenovo, OPPO
* Not critical: Docomo, Huawei/HiSilicon
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Table 1-2 Company input for Issue 1

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| --- | --- |
| **Company** | **Input to Round 0 summary** |
| Mod V00 | * Please input your comment to Proposal 1.1, if any.
* Please also update your preference on the question in Issue 1.2.
 |
| OPPO | **On Proposal 1.1**: In our reading of the current related spec as referred by FL, it seems the terminology, i.e. TCI state, can be understood as legacy and unified TCI states. It is also commonly and widely used for other parts in RAN1 spec (e.g. TS 38.214). Moreover, in higher layer spec (e.g. TS 38.331), both legacy and unified TCI state are configured as the same IE. From this sense, the captured spec seems sufficient and valid for the case of inter-cell M-DCI MTRP. Therefore, we believe no more progress needed. **On Issue 1.2**: No extension to the inter-cell S-DCI based MTRP. In our view, the inter-cell S-DCI based MTRP is a totally new feature which hasn’t been supported and specified in Rel.17 yet. Technically, the S-DCI implies the cross-cell DL scheduling that could bring some uncertainty when compared with M-DCI based MTRP.  |
| vivo | Proposal 1.1: Support.@OPPO: Current TS38.214 only considers the MAC CE in clause 6.1.3.14 of [10, TS 38.321], which doesn’t cover unified TCI states.Issue 1.2: We think supporting inter-cell S-DCI based MTRP is out of scope. Besides, we have an agreement in RAN1#109-e.**Agreement**On unified TCI framework extension, consider all the intra and inter-cell MTRP schemes specified in Rel-16 and Rel-17* Consider, if STxMP is supported, Rel-18 MTRP scheme(s) with STxMP
 |
| QC | For Proposal 1.1, fineFor 1.2, prefer not to support to maintain legacy behavior on this |
| Xiaomi | Proposal 1.1: supportProposal 1.2: not support since it is not supported in Rel-16/Rel-17. |
| Mod V05 | Add Issue 1.3 per request, please check. |
| Google | **Proposal 1.1:** Support**Issue 1.2:** This should be deprioritized since it is not supported in legacy. At this stage, we should focus on more essential topics. **Issue 1.3**: No. We don’t see the critical reason to have such restriction.  |
| Nokia | **Proposal 1.1:** Fine1.2: Not to support.  |
| Samsung | **Proposal 1.1**: Support**Issue 1.2**: To support inter-cell SDCI based MTRP operation, a TCI state mapped to a TCI codepoint needs to be associated to a PCI. This can already be supported by the current specifications such that a TCI state can be associated to a PCI by providing the additional PCI index in the TCI-State. Based on this, only some corresponding UE’s behaviors such as reception of dedicated/non-dedicated PDSCH and etc. under unified TCI framework need to be specified to make the framework complete, which can also be discussed together with inter-cell MDCI based MTRP operation to avoid duplicating efforts.**Issue 1.3**: This is an important issue, which needs to be addressed first. As pointed out by the FL, if the new [TCI selection field] is present for PDSCH reception, it has become possible that a UE can use two different beams for PDCCH and PDSCH receptions, which may result in the following two cases (assuming that a TCI codepoint corresponds to {TCI #1, TCI #2}):Case 1 (SDCI MTRP):* TCI #1 is for PDCCH Rx from TRP-1
* TCI #2 is for PDSCH Rx from TRP-2

Case 2 (STRP):* TCI #1 is for PDCCH Rx from TRP-1
* TCI #2 is for PDSCH Rx from TRP-1

Case 2 is definitely NOT the use case in Rel-18, and is not aligned with the common beam design principle under unified TCI framework. But without any restriction on the network side and also due to the lack of TRP identification/differentiation for SDCI, Case 2 has become possible with the current agreements made in 9.1.1.1 so far. To address this issue, we need to properly identify or differentiate TRPs for SDCI, and one simple way to do it is to configure per TRP resources such as RRC-level TRP-specific TCI state grouping. With this setting, the two indicated/applied TCI states can be respectively from the two TCI state groups, hence the two TRPs. |
| ZTE | Proposal 1.1: SupportQuestion 1: The motivation is unclear for us. Per WID, the inter-cell operation is dedicated to MDCI based mTRP operation. If something is incorrect, please feel free to correct it. |
| CMCC | Proposal 1.1: SupportQuestion 1: Not Support. Inter-cell S-DCI based MTRP has not been supported in Rel-17. |
| Apple  | Proposal 1.1: Support. Question 1 (Issue 1.2): We tend to agree with Samsung that the standard effort is limited to support sDCI-based inter-cell mTRP assuming TCI state framework for intra-cell mTRP is anyway to be specified and can be reused by sDCI inter-cell mTRP. On the other hand, prioritization the TCI framework extension for all existing scenario is explicitly written in WID and should be completed first. Hence, we support to deprioritize sDCI-based inter-cell mTRP at this moment and discuss it if time permits. Question 1 (Issue 1.3):We agree with Samsung that the objective is to extend unified TCI framework defined in Rel-17 from sTRP to mTRP and the Rel-17 unified TCI framework should be kept for a single TRP among the multiple TRPs. In this sense, PDCCH and PDSCH from a single TRP should follow a single DL/joint TCI-state as in Rel-17. On the other hand, the discussion point is whether we relax this and allow different TCI-states for PDCCHs and PDSCHs if the total number of DL TCI-states is still capped at ‘2’ at UE side.  |
| Futurewei | **Proposal 1.1:** Support.**Issue 1.2:** More studies are needed for inter-cell S-DCI based MTRP.**Issue 1.3:** Not support. In our view, such a restriction is unnecessary. |
| Spreadtrum | **Proposal 1.1:** Support.**For issue 1.2**: Not support. |
| Huawei, HiSilicon | **Proposal 1.1:** Support.Note: The text from 38.214 is misquoted. The correct quote is as follows:**TS 38.214**If the UE is configured with *SSB-MTC-AddtionalPCI* and with PDCCH-Config that contains two different values of *coresetPoolIndex* in *ControlResourceSet*, the UE receives an activation command for CORESET associated with each *coresetPoolIndex*, as described in clause 6.1.3.14 of [10, TS 38.321], used to map up to 8 TCI states to the codepoints of the DCI field 'Transmission Configuration Indication' in one CC/DL BWP. When a set of TCI state IDs are activated for a *coresetPoolIndex*, the activated TCI states corresponding to one *coresetPoolIndex* ~~can be~~ is associated with ~~one~~ the serving cell physical cell ID and activated TCI states corresponding to another *coresetPoolIndex* can be associated with another physical cell ID.[Mod] Thanks for the correction**Issue 1.2:** No. inter-cell S-DCI based MTRP is out of the scope as it is not supported in legacy releases.**Issue 1.3:** We don’t think it is a critical issue. A gNB is expected to indicate appropriate beam(s) for receiving PDCCH and PDSCH. If two different beams are indicated for receiving PDCCH and PDSCH, it wouldn’t change UE behavior whether they are from two different TRPs or the same TRP: UE should simply use the indicated beams to receive the corresponding channels. So, we are not convinced that indicating two different beams from the same TRP for PDCCH and PDSCH must be excluded.  |
| Sharp | Proposal 1.1: SupportIssue 1.2 Question 1: Not support |
| NEC | **Proposal 1.1:** Support.**Issue 1.2:** Seems out of scope.**Issue 1.3:** Support the intention to have common beam since that is why unified TCI is introduced. Restrictions like “UE does not expect different TCI states applied for PDCCH/PDSCH” could be introduced. |
| Fujitsu | Proposal 1.1: Support.Issue 1.2: Not support. Inter-cell MTRP is not supported in Rel-16/17, we don't konw why it should be supported in Rel-18. |
| CATT | Proposal 1.1: Support.Issue 1.2: Not support. This feature has not been specified in Rel-17, and more discussions are needed for the scheme.Issue 1.3: Not support. This restriction is not needed. |
| vivo2 | Issue 1.3: No, we don’t see any need to have such restriction.For S-DCI based MTRP, the design principle can be extended, i.e., any channels and RSs following the UTCI state including PDCCH, PDSCH, PUCCH, PUSCH, etc., can apply one or both of the two indicated TCI states, as long as the applied TCI state(s) is/are within the two indicated TCI states. Such an extension has its valid use case for DPS which has been supported in Rel-16. Besides, the previous agreements try to avoid explicitly separating the TCI states into groups. Actually, it’s up to network to indicate the TCI states belonging to same TRPs or different TRPs. At the UE side, there is no problem to apply either one for reception since the UE has tracked both indicated TCI states. |
| Docomo | Proposal 1.1: Support.Proposal 1.2: Not support. We think the inter-cell S-DCI based MTRP is a new feature from Rel.17.Proposal 1.2: We don’t think it is a critical issue. We haven’t introduced terminology of “TRP” into sDCI mTRP in spec. But, if the following Rel.16 behaviors are not precluded, we have no concern to discuss the restriction.* Either TRP1 or TRP2 can transmit PDCCH. The PDSCH can be mTRP PDSCH transmitted from both TRP1 and TRP2.
* Either TRP1 or TRP2 can transmit PDCCH. The PDSCH can be sTRP PDSCH transmitted from either TRP1 or TRP2.
 |
| Ericsson | Proposal 1.1: Do not support. This is unnecessary.Proposal 1.2: We should not put any effort to support this. On the other hand, we should not put any effort to forbid it. If the standard supports it without modification, we should not preclude it.Proposal 1.3: Do not see the motivation.  |
| Panasonic | Proposal 1.1: SupportIssue 1.2 Q1: NoIssue 1.3 Q1: No: We don’t see a reason to introduce restrictions. |
| IDC | Proposal 1.1: OKIssue 1.2 Q1: NoIssue 1.3 Q1: Not clear on benefits. Needs more discussions. |
| Samsung2 | Issue 1.2: We would like to first point out that there are no agreements or descriptions in the WID that would preclude SDCI based inter-cell MTRP operation. The Rel-17 inter-cell MTRP was MDCI based, but it should not limit the Rel-18 scope. Besides, the specification can already support such feature (at least in terms of TCI indication/update), hence it is unclear why we cannot further study it. Issue 1.3: Our understanding of the question is: whether/how the common beam design principle can be retained in Rel-18 (i.e., common beam per TRP), which is the essence of the unified TCI framework. As elaborated by the FL in the question, it has become possible that with the TCI selection field present, different unified TCI states from the ***same*** TRP can be used for PDCCH/PDSCH (similarly, for PUCCH/PUSCH), which clearly, is not aligned with the common beam design principle. We are not sure whether or not companies that claim such “restriction” is not needed want to reject the common beam principle of unified TCI – if not, can these companies explain why they think that such “restriction” is not needed rather than just simply saying so?@Huawei, vivo: if your concern is the corresponding UE’s operations/behaviors, we do not think they would be limited as the restriction is only for the network side – the UE would just simply track and apply the two beams. We do not follow why you said that the network can indicate different unified TCI states for the same TRP – this is clearly not common beam hence not under the unified TCI framework.@Docomo: we do not think the Rel-16 MTRP schemes you provided would or should be precluded – based on the current agreements, the unified TCI states can be separately indicated for PDCCH and PDSCH as long as they are not from the same TRP. We are open to add additional clarifications to the following proposal.*Proposal: On unified TCI framework extension for SDCI based MTRP, support RRC configuring two TCI state groups each for a separate TRP.* * *The 1st and 2nd TCI states of a TCI codepoint should be respectively from the two TCI state groups.*
* *The TRP selection for PDCCH reception is based on the RRC configuration, and the dynamic TRP switching for PDSCH reception is based on the [TCI selection field] if present.*
 |
| Intel | **Proposal 1.1:** OK**Issue 1.2 (Question 1):** We understand the motivation and can be open to further discussion.**Issue 1.3 (Question 1):** In Rel-17 we explicitly agreed to not support M=N=2 such that PDCCH and PDSCH from same TRP follow the same common beam. While this is also good to have in Rel-18 for mTRP extension, we need to further discuss the specification impact of defining TRP based TCI state grouping since TRP does not really exist in current specification.  |
| FGI | **Proposal 1.1:** Support**Issue 1.2 (Question 1):** If time permits, we could have further discussion on this scenario with lower priority.**Issue 1.3 (Question 1):** It seems that more clarifications/discussions on the issue are needed. For example, even in mTRP case, whether the two indicated joint TCI applied to PDCCH and PDSCH means that these two channels are expected to apply same two beams in mTRP operation?  |
| Lenovo | For Proposal 1.1: SupportIssue 1.2: Q1: NoIssue 1.3: Q2: The motivation is not clear. We understand such restriction is unnecessary at least in mTRP scenario. |
| OPPO2 | **Proposal 1**: We think the comment we provided in our 1st round on TCI state is more generic, rather than on the activated UTCI states by MAC CE. The intention is to address the concern that the TCI state in current spec as re-captured by Huawei (thanks for providing the latest version) is not only for legacy ones, but also refers to UTCI specified in Rel.17. Hence, we don’t think this proposal is incorrect, but just unnecessary. **Q1 of Issue 1.3**: Not necessary for PDCCH and PDSCH to be from two different TRPs.  |
| TCL | Proposal 1: Support.Issue 1.2: It is out of scope. However, we can study it with lower priority if time is permitted.Issue 1.3: It is not necessary to set this limitation. |
| **Company** | **Input to Round 1 summary** |
| Mod V00 | No update from Round 0 |
| Mod V05 | Proposal 1.1 is updated based on the discussion in Email Endorsement 1, please check |
| Google | **Updated Proposal 1.1:** We are OK with updated Proposal 1.1.  |
| Sharp | Updated Proposal 1.1: We are fine with the proposal. |
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# Issue 2 – TCI state update and activation

Table 2-1 Summary for Issue 2

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 2.1 | (S-DCI) How to switch between Rel-17 unified TCI framework and Rel-18 unified TCI framework extension | **Conclusion**On unified TCI framework extension for S-DCI based MTRP operation, there is no consensus to support dynamic switching between single-TRP operation and multi-TRP operation for channels/signals based on the number of TCI states mapped to the received TCI codepoint in DCI format 1\_1/1\_2* FFS: How to switch between Rel-17 sTRP operation and Rel-18 mTRP operation

**FL note: Based on the FFS in above conclusion, the following question is raised:**Question 1: How to switch between Rel-17 unified TCI framework (STRP operation only) and Rel-18 unified TCI framework extension (both STRP and MTRP operations)?* Alt1: Based on RRC configuration
* Alt2: Based on TCI state activation command (e.g., whether there is any TCI codepoint is mapped with more than one joint/DL/UL TCI states by TCI state activation command)
 |
| 2.2 | (S-DCI) Combinations of joint/DL/UL TCI states that can be mapped to a TCI codepoint of the existing TCI field, and corresponding UE behaviors | **FL note: Based on the previous RAN1 agreement, it should be able to use the existing TCI field to indicate joint/DL/UL TCI state(s) for one of the two TRPs or both TRPs. Thus, Proposal 2.2 is recommended accordingly. Regarding the FFS in this proposal, since there are different proposals (e.g., based on RRC, MAC-CE, or DCI) for indicating/determining that each activated joint/DL/UL TCI state(s) is the 1st or 2nd joint/DL/UL TCI state(s), I suggest to leave the sub-issue for further discussion/study (please check Issue 2.3).** **Proposal 2.2:** On unified TCI framework extension for S-DCI based MTRP operation, support the followings:* For a serving cell configured with joint DL/UL TCI mode, a full-set or any sub-set of {first joint TCI state, second joint TCI state} can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 by TCI state activation command (MAC-CE)
* For a serving cell configured with separate DL/UL TCI mode, a full-set or any sub-set of {first DL TCI state, first UL TCI state, second DL TCI state, second UL TCI state} can be mapped to a TCI codepoint of the existing TCI field in a DCI format 1\_1/1\_2 by TCI state activation command (MAC-CE)
* The first/second indicated joint/DL/UL TCI state(s) is updated according to the first/second joint/DL/UL TCI state(s) mapped to the TCI codepoint received by the UE
	+ If the UE receives a TCI codepoint mapped with a sub-set of {first joint TCI state, second joint TCI state} or {first DL TCI state, first UL TCI state, second DL TCI state, second UL TCI state}, the UE shall update the first/second indicated joint/DL/UL TCI state(s) according to the first/second joint/DL/UL TCI state(s) in the subset and keep other indicated first/second joint/DL/UL TCI state(s) that is not updated by the received TCI codepoint
* FFS: How to indicate/determine each activated joint/DL/UL TCI state in TCI state activation command (MAC-CE) corresponds to the first or second joint/DL/UL TCI state
 |
| 2.3 | (S-DCI) How to indicate/determine each activated joint/DL/UL TCI state in TCI state activation command (MAC-CE) corresponds to the first or second joint/DL/UL TCI state | Alt1: Using RRC-level TCI state grouping (i.e., separate the configured joint/DL/UL TCI states into two groups by RRC configuration), so that the UE can determine that each activated joint/DL/UL TCI state in TCI state activation command (MAC-CE) corresponds to the first or second joint/DL/UL TCI state based on RRC-level TCI state grouping* Support: Samsung, ZTE, IDC (2nd preference), FGI

Alt2: TCI state activation command (MAC-CE) should indicate that each activated joint/DL/UL TCI state in TCI state activation command (MAC-CE) corresponds to the first or second joint/DL/UL TCI state (detail on how to indicate above is up to RAN2 design)* Support: Huawei/HiSilicon, CATT, Futurewei, IDC, Intel, OPPO, Spreadtrum, TransHold, QC, vivo, Xiaomi, Google, Nokia, Sharp, NEC, Docomo, IDC, Apple (2nd), Futurewei, Fujitsu, FGI

Alt3: Beam indication DCI should also indicate the activated joint/DL/UL TCI state(s) mapped to the indicated TCI codepoint is the first or second joint/DL/UL TCI state(s)* Support: Apple, CMCC, NEC
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| 2.4 | Timeline to update the indicated joint/DL/UL TCI state(s) | **Agreement** On unified TCI framework extension, the Rel-17 timeline for updating the indicated joint/DL/UL TCI state(s) is retained, i.e., the indicated joint/DL/UL TCI state(s) applied to the DL reception or UL transmission in each slot is updated based on the Rel-17 beam application time |
| 2.5 | (CA) Common TCI state ID activation/update for a CC list comprised of a mix of STRP CC(s) and MTRP CC(s) | Question 1: Whether a CC list can be comprised of a mix of STRP CC(s) and MTRP CC(s)?* Yes: OPPO, Spreadtrum, IDC, Huawei/HiSilicon, Hyundai, Google, MediaTek, Docomo, vivo, CATT, LG, Fujitsu, Apple
* No: Xiaomi, QC, NEC, CMCC, FGI

Question 2: Whether a CC list can be comprised of a mix of S-DCI based MTRP CC(s) and M-DCI based MTRP CC(s)?* Yes: OPPO, IDC, Huawei/HiSilicon, Hyundai, Google, Docomo, CATT, LG
* No: Xiaomi, Spreadtrum, QC, NEC, CMCC, ZTE, vivo, FGI, MediaTek, Apple

**FL note: Based on feedback to above two questions, more companies are supportive to a CC list including the mix of STRP CC(s) and MTRP CC(s), however, views on support a CC list including the mix of S-DCI based MTRP CC(s) and M-DCI based MTRP CC(s) are quite diverse. Based on above observations, the following proposal is recommended:****Proposal 2.5:** On unified TCI framework extension, support the following cases for CA operation:* A set of CCs configured for common TCI state ID activation/update can include CC(s) operating in STRP and CC(s) operating in S-DCI based MTRP
* A set of CCs configured for common TCI state ID activation/update can include CC(s) operating in STRP and CC(s) operating in M-DCI based MTRP
* FFS: How to support common TCI state ID activation/update for above two cases

FFS: Whether/how to support a set of CCs configured for common TCI state ID activation/update can include CC(s) operating in S-DCI based MTRP and CC(s) operating in M-DCI based MTRPSupport: Intel, IDC, Ericsson, Docomo, CATT, Fujitsu, NEC, Sharp, Huawei/HiSilicon, Spreadtrum, Futurewei, Apple, LG, ZTE, Nokia, Google, vivo, OPPOConcern: CMCC, Samsung, QC, FGI, Lenovo |
| 2.7 | (CA) Reference TCI state list configuration | Question 1: Whether a CC operating in STRP can apply the TCI state configuration(s) from a reference CC operating in MTRP, or a CC operating in MTRP can apply the TCI state configurations from a reference CC operating in STRP?* Yes: OPPO
* No:
 |

Table 2-2 Company input for Issue 2

|  |  |
| --- | --- |
| **Company** | **Input to Round 0 summary** |
| Mod V00 | * Please input your comment to Proposal 1.1, if any.
* Please also update your preference on the question in Issue 1.2.
 |
| OPPO | **Proposal 2.2**: Supportive. If conclusion 2.1 is acceptable, it says no dynamic switch between STRP and MTRP operation for channels/signals. As a consequence, the UE behavior on indicated all set or sub-set of joint/DL/UL TCI state(s) should follow the rules as listed in Proposal 2.2. UE updates the indicated joint/DL/UL TCI state(s) and maintains the parts not in the indicated set for channel/signals under STRP or MTRP operation. **Issue 2.3**: On Alt.1, it seems the RRC based TCI state grouping conflicts the conclusion RAN1 made in RAN1#110bis-e, assuming the 1st and 2nd joint/DL/UL TCI states refers to 1st and 2nd TRP respectively. **Conclusion**On unified TCI framework extension in Rel-18, there is no consensus to support separate RRC-configured TCI state list(s) for each of TRPs.On Alt.2, the MAC CE based approach aligns with legacy design of TCI state activation in Rel.16. And there seems no issue to reuse it for unified TCI states.On Alt.3, this approach requires large TCI field extension. For example, assuming one separate DL/UL TCI state indicated, it needs at least 2 additional bits to be associated with it. These 2 bits should express the indicated TCI state is 1st DL TCI state, 1st UL TCI state, 2nd UL TCI state or 2nd UL TCI state. **Proposal 2.5**: Supportive. For instance, the PDSCH on a CC can be dynamically switched back to S-TRP by using the newly added [TCI selection field]. For flexibility and signalling overhead reduction, this CC should be allowed to be configured in the CC list, e.g. *simultaneousTCI-UpdateListX* with another CC operating under MTRP for PDSCH. If Proposal 2.5 is not agreeable, then the above case is unfortunately not allowed in our understanding.  |
| vivo | Proposal 2.3: We think Alt2, i.e., MAC CE, is more appropriate for the indication including whether to switch to STRP operation or not. Alt1, the RRC-level TCI state grouping for S-DCI based is not necessary. How to utilize beam indication DCI in Alt3 is not clear to us.Proposal 2.5: Support. |
| QC | For Proposal 2.2, if it is supported, a natural way without RRC reconfig interruption is to use MAC-CE to switch sTRP/mTRP sticky mode? If so, we can accept Proposal 2.2 with MAC-CE switch as part of the proposalFor Proposal 2.3, support Alt2For Proposal 2.5, not support, unless the FFS rule is clear and simple. In our view, it is sufficient for the reference CC to always be a mTRP CC, and 1st indicated TCI is applied to sTRP CCs. However, we are fine to add a note to say “Mixed sTRP and mTRP CCs are not allowed in the same CC list if no consensus on above FFSs” |
| Xiaomi | Conclusion 2.1 and Proposal 2.2: In Rel-16/Rel-17, dynamic switching between Single-TRP operation and Multi-TRP operation is supported for each channel. Thus we slightly prefer to support it in Rel-18. And we suggest to comprise it by the updated text as below:“……the UE shall keep or release the current indicated first/second joint/DL/UL TCI state(s) not updated by the sub-set according to the UE capability”Issue 2.3: It can be discussed after conclusion 2.1 and proposal 2.2. For down-selection, we prefer Alt 2. Proposal 2.5: We can support the second sub-bullet on STRP CC and M-DCI based MTRP. But for the first sub-bullet on the STRP CC and S-DCI based MTRP, we have a question that, if TCI state of only one TRP is activated for a codepoint of existing TCI field for S-DCI based MTRP CC, does it mean for some S-TRP CC, no TCI state is activated for that codepoint? E.g., * for S-DCI based MTRP CC, {000}=>{TCI#0, TCI#1} , {001}=>{TCI#3, --}, {011}=>{--,TCI#4}……
* so for STRP CC1, {000}=>{TCI#0} , {001}=>{TCI#3}, {011}=>{--}……
* and for STRP CC2, {000}=>{ TCI#1} , {001}=>{--}, {011}=>{TCI#4}……

It means with mixed STRP and S-DCI based MTRP CC grouping, either case 1 or case 2 will occur.* Case 1 is that, S-DCI MTRP CC can support some codepoint map to TCI state of only one TRP, but for some sTRP CCs, less than 8 TCI states will be activated.
* Case 2 is that, 8 TCI states for all sTRP CCs can be activated, but for S-DCI MTRP CCs, each codepoint must map to TCI states of two TRPs.

If without mixed STRP and S-DCI based MTRP CC grouping, in addition to case 1 and case 2, case 3 can be supported. But case 3 can’t be supported with mixed CC grouping.* Case 3 is that, 8 TCI states for all sTRP CCs can be activated. And for S-DCI MTRP CCs, some codepoint can map to TCI state of only one TRP.

[Mod] Please check the comment from HW |
| Google | **Proposal 2.2:** SupportIssue 2.3: We support Alt2, which is more straightforward and simple. Alt1 seems to be essentially separate RRC-configured TCI state list(s), which already concluded no consensus in RAN1#110b. **Proposal 2.5:** Support. But one question on the FFS. If the FFS is supported, does it mean a CC list can possibly contain S-TRP, S-DCI M-TRP and M-DCI M-TRP? [Mod] Yes |
| Nokia | **Proposal 2.2:** SupportIssue 2.3: Support Alt2.**Proposal 2.5:** Support |
| Samsung | **Proposal 2.2**: it is fine to first specify the TCI codepoint mapping, and then specify means to identify each activated joint/DL/UL TCI state in MAC CE being the first or second joint/DL/UL TCI state (issue 2.3). But it is not a correct discussion order to specify the TCI codepoint mapping first without specifying how the indicated TCI states of a TCI codepoint are associated to different TRPs (i.e., issue 1.3) – this has been the hanging issue since the first meeting. Regarding the corresponding UE behaviors of subset level TCI state update (i.e., the third bullet), we are generally fine.**Issue 2.3**: we are open to MAC CE or DCI based solution to identify an activated TCI state in the MAC CE as the first or second joint/DL/UL TCI state. To our understanding, the main intention of the RRC-level TRP specific TCI state grouping is not to identify an activated TCI state in the MAC CE as the first or second. As explained in our comments to issue 1.3, the main intention of introducing the RRC-level TRP specific TCI state grouping is to retain the common beam principle of unified TCI framework in Rel-18.**Proposal 2.5**: not support. We do not see clear benefit nor emergency of supporting mixing STRP and MTRP CCs for TCI state update. It seems that it would only complicate things not simplifying them. |
| ZTE | **Proposal 2.2**: Support. **Issue 2.3**: Technically speaking, semi-static mapping between a TCI state and ‘a TRP’ should be assumed as a baseline. Otherwise, we have to experience that a TCI state may correspond to a first state in a codepoint, but then for another codepoint it can corresponds to another state. In other words, the dynamic update (in L1/L2 level) of mapping a TCI state to first/second state may be out of WID scope (like sTRP scenario). Therefore, we prefer Alt1.**Proposal 2.5**: After rethinking the companies’ feedback, we can understand the motivation of this proposal. For progress, we can agree with sTRP+S-DCI/M-DCI cases, but sTRP+S-DCI+M-DCI seems to be too complicated. |
| LG | Proposal 2.2: SupportProposal 2.5: Support |
| CMCC | Proposal 2.2: Support.Issue 2.3: Support Alt3. If MAC CE indicates each activated joint TCI state in TCI state activation command corresponds to the 1st joint TCI state or 2nd joint TCI state, additional bits are needed for the indication depends on the number of TCI states for each codepoints, and the flexibility of TCI state activation is restricted compared to DCI indication. If DCI indicates the single joint TCI state in existing TCI field corresponds to the 1st joint TCI state or 2nd joint TCI state, the 2-bit [TCI selection field] can be further reused to indicate the mapping to not increased the DCI overhead.Proposal 2.5: Not support. If a CC list can be comprised of a mix of STRP CC(s) and MTRP CC(s), the freedom to transmit PDCCH/PDSCH from either of the TRP1 or TRP2 will be lost. For example, there are two mixed CC lists corresponding to TRP1 and TRP2: {mDCI CC1, STRP CC2} and {mDCI CC1, STRP CC3}. TCI state for CORESET pool 0 of mDCI CC1 is updated together with STRP CC2, and TCI state for CORESET pool 1 of mDCI CC1 is updated together with STRP CC3. STRP CC2 is always transmitted from TRP1, when CORESET pool 0 is associated to the CC list of {mDCI CC1, STRP CC2}, then the reference RS of TCI state for CORESET pool 0 must be from TRP1, and PDCCH and PDSCH associated to CORESET pool 0 will be ALWAYS transmitted from TRP1 and CANNOT transmitted from TRP2. |
| Apple  | **Proposal 2.2**: Ok for progress. **Proposal 2.3**: Our preference is Alt.3 to provide the best flexibility. We are also fine to go with Alt.2 if we can make progress on this issue. Compared to MAC-CE approach, Alt.3 allows NW to select which TCI-state pair to update when transmitting the DCI 1-1 and 1-2 at the cost of 1-bit signaling overhead. **Issue 2.5: adding our position for Q1 and Q2.** Our understanding is that for mix of sTRP CC and mTRP CC, NW will select two pairs of TCI-states targeting from mTRP CC. Then, one of these pairs will be used to update the TCI-states for sTRP CC. On Q2, different TCI-state update frameworks are specified for sDCI-based mTRP and mDCI-based mTRP. We did not find a way to update TCI-state of mDCI-based by using the indicated TCI-states from CC with sDCI-based mTRP and vice versa.  |
| Google2 | In addition to TCI activation/update in Proposal 2.5, we may also need to discuss/clarify reference TCI state list configuration. For example, if RRC-configured TCI state list is absent in *PDSCH-Config* for a MTRP CC, whether it can be referred to a RRC-configured TCI state list in a reference CC, which is a STRP CC, vice versa.  |
| Futurewei | **Proposal 2.2:** Support.**Issue 2.3:** We prefer Alt2 (MAC-CE based approach). As pointed out by other companies, Alt1 is against the conclusion made in RAN1 #110b-e meeting that “there is no consensus to support separate RRC-configured TCI state list(s) for each of TRPs”. **Proposal 2.5:** Support. |
| Spreadtrum | **Proposal 2.2**: Support.**Proposal 2.5:** Support. |
| Huawei, HiSilicon | **Proposal 2.2:** Support in principle. This is aligned with Conclusion 2.1 and Rel-17 behavior: In Rel-17, it is possible that only a DL (UL) uTCI is updated in which case UE keeps using the current UL (DL) uTCI. However, the sub-bullet to the third bullet may be misinterpreted. We suggest the following change:**[…]*** + If the UE receives a TCI codepoint mapped with a sub-set of {first joint TCI state, second joint TCI state} or {first DL TCI state, first UL TCI state, second DL TCI state, second UL TCI state}, the UE shall use the indicated ~~keep the current indicated first/second~~ joint/DL/UL TCI state(s) in the sub-set to update the corresponding applied joint/DL/UL TCI state(s) and shall keep other applied joint/DL/UL TCI state(s) that are not updated by the received TCI codepoint ~~sub-set~~

 […]**Issue 2.3:** Support Alt2. Our understanding is that the conclusion brought to our attention by OPPO in fact precludes Alt1. Alt2 is more straightforward and can also be used to switch between mTRP and sTRP schemes. A MAC-CE based switching between sTRP and mTRP is much lighter and faster than a RRC-based switching.**Proposal 2.5:** Support. As discussed in details in R1-2302370 Section 2.3, supporting a mix of mTRP and sTRP CC groups include reduces the number of required CC lists and the signaling overhead of TCI configuration/activation/indication. As for the first FFS, this can be addressed using a simple rule. For instance, a mTRP CC may be configured in two CC groups and a sTRP CC in only one CC group. Let’s, as an example, assume that a sDCI-based mTRP CC1 is the reference CC for both *simultaneousTCI-UpdateListx* and *simultaneousTCI-UpdateListy* where (1<=x<y<=4). Then, the first joint (or pair of UL/DL) TCI state of CC1 applies to all sTRP CCs in *simultaneousTCI-UpdateListx* (the first group that CC1 is a member of) and the second joint (or pair of UL/DL) TCI state of CC1 applies to all sTRP CCs in *simultaneousTCI-UpdateListy* (the second gropu that CC1 is a member of). **@ Xiaomi:** Thanks for the analysis. We think the original intention of grouping CCs into CC lists is to reduce the number of beams that UE has to maintain for each TRP. If there is no CC list, UE has to maintain up to 8 activated beams for each CC. However, if multiple CCs are associated with the same TRP, in most practical scenarios, UE does not need to maintain 8 beams for each of those CCs as, in practice, the same beams are used to communicate with the TRP in all those CCs. In other words, CC grouping reduces the number of unique beams that UE needs to maintain from up to 8 per CC to up to 8 per TRP. With mixed CC grouping of mTRP and sTRP, UE can show exactly the same behavior: UE keeps 8 beams corresponding to each of TRP1 and TRP2. Then, for sTRP CCs, an activated beam corresponding to one of the TRP1 or TRP2 (whichever that corresponds to the sTRP CC) is applied and for mTRP CCs, one of the activated beams corresponding to each of the TRP1 and TRP2 is applied (totally two beams). In other words, in a mixed grouping, UE still maintains 8 beams per TRP although it may not maintain 8 beams per every sTRP CC within a group. We think that if the CC groups are restricted to sTRP CCs only and mTRP CCs only, then, the total number of maintained beams for each TRP can increase to up to 16. For instance, {TCI1,…,TCI8} are activated for sTRP CC with TRP1 and {(TCI9,TCIx1),…(TCI16,TCIx8)} are activated for mTRP CC with TRP1 and TRP2. Then, UE needs to maintain 16 beams corresponding to {TCI1,…,TCI16} for TRP1. This would be too complex for the UE and is not aligned with the legacy behavior.  |
| Sharp | Proposal 2.2: SupportIssue 2.3: Support Alt 2.Proposal 2.5: Support |
| NEC | **Proposal 2.2**: We think it should be discussed together with Issue 2.3, otherwise it is not complete.**Issue 2.3**: we are fine with Alt2 and Alt3, and added our position in the table.**Proposal 2.5:** OK. |
| Fujitsu | Proposal 2.2: Support. Issue 2.3: Alt2 is preferred.Proposal 2.5: Support. And one small correction to point out is that the CC list of unified TCI states is *simultaneousU-TCI-UpdateListX*, while *simultaneousTCI-UpdateListX* is for a legacy CC list.[Mod] Thanks for the correction |
| CATT | Proposal 2.2: Not support. This feature has not been specified in Rel-17, and more discussions are needed for the scheme. Issue 2.3: Not support. This restriction is not needed.[Mod] You above comments are replying to Issue 1.2 and Issue 1.3?Proposal 2.5: Support |
| Docomo | **Proposal 2.2:** We should clarify whether “2nd joint/DL/UL TCI only” can be indicated or not, because it impacts MAC CE design. If we want to indicate “2nd joint/DL/UL TCI only”, MAC CE should have a field to indicate “1st or 2nd” for each TCI state ID. If we don’t need to indicate “2nd joint/DL/UL TCI only”, i.e. if one joint/DL/UL TCI is indicated, it means “1st joint/DL/UL TCI only”, MAC CE does not need to have no field of “1st or 2nd” per TCI state ID field.From our perspective, we think we don’t need to indicate “2nd joint/DL/UL TCI only”, to save MAC CE field size.[Mod] However, to my understanding to our previous agreement, the existing TCI field can support TCI state indication for anyone of the TRPs.**Issue 2.3**: We prefer Alt.2. If one TCI ID is indicated per a TCI codepoint, it means 1st TCI. If two TCI IDs are indicated per a TCI codepoint, it means 1st TCI and 2nd TCI.**Proposal *2.5***: Support. |
| Ericsson | Proposal 2.2: We would prefer not to allow this partial update, but this is the reasonable way to support the previous agreement, and it is an extension of the R17 rule, which becomes *really* messy in the mTRP case. Issue 2.3: Support Alt2, it’s the R17 way.Proposal 2.5: Do not support as it’s written. The functionality is relevant, but I understand from my RAN2 colleagues there is much nicer way to capture this in RRC: as an index in each serving cell configuration. We propose to send an LS to RAN2 to describe the desired functionality. |
| Panasonic | Proposal 2.2: SupportIssue 2.3: Alt1 (first choice) or Alt2 The conclusion made in RAN1#110bis-e does not preclude Alt1. Proposal 2.5: Not against having: * A CC list (simultaneousTCI-UpdateListX) for common TCI state ID activation/update can include CC(s) operating in STRP and CC(s) operating in S-DCI based MTRP

but our preference is to further discuss the motivation for this proposal (example reducing the number of required CC lists and the signaling overhead of TCI configuration/activation/indication) in order get a better idea of what design criteria to follow to support this. For example, if the motivation is signaling overhead, RAN1 should avoid supporting this by adding signaling overhead somewhere else. |
| IDC | Proposal 2.2: Support the FL proposal.Issue 2.3: Support Alt2 (first preference), and OK with Alt1 (as second preference).Proposal 2.5: Support the FL proposal which captures properly the common ground among companies at this moment. |
| Intel | **Proposal 2.2:** Support the first two main bullets. The third bullet and the FFS should be part of a unified solution i.e., the MAC-CE always indicates 1st or 2nd indicated TCI label with each mapped TCI state for a codepoint. **Issue 2.3:** Support Alt-2 i.e., MAC-CE based indication. We do not support DCI based indication of 1st or 2nd indicated TCI state when MAC-CE maps subset of TCI states to a codepoint since the extra DCI overhead is not warranted. **Proposal 2.5:** Support |
| FGI | **Proposal 2.2:** Support**.****Proposal 2.3:** Support alt 1 and alt 2.**Proposal 2.5:** Not support unless how to update TCI state for sTRP and mTRP with a more clear solution is specified. For example, any update on the reference CC indication? |
| Lenovo | **Proposal 2.2:** Support**.****Proposal 2.3:** Support Alt3.**Proposal 2.5:** Not support. A simply way is to include STRP CCs or MTRP CCs in a same CC list other than to mix them in a same list.  |
| Huawei, HiSilicon | **Proposal 2.5:** To alleviate some companies concerns, it might be worthwhile to mention that supporting mixed CC grouping does not preclude the support of separate CC grouping. In mixed CC grouping, in general, M mTRP CCs and N sTRP CCs are grouped together. Separate CC grouping is just a special case of mixed CC grouping where M=0 or N=0. Also, in the updated Proposal, the added word “enhancements to” makes the proposal a bit confusing as it wrongly implies that the mixed CC grouping is already supported but RAN1 only want to make some enhancement to it. Suggest to remove “enhancements to”. **Proposal 2.5:** On unified TCI framework extension, support ~~enhancements to~~ the following cases for CA operation:* A set of CCs configured for common TCI state ID activation/update can include CC(s) operating in STRP and CC(s) operating in S-DCI based MTRP
* A set of CCs configured for common TCI state ID activation/update can include CC(s) operating in STRP and CC(s) operating in M-DCI based MTRP
* FFS: How to support common TCI state ID activation/update for above two cases

FFS: Whether/how to support a set of CCs configured for common TCI state ID activation/update can include CC(s) operating in S-DCI based MTRP and CC(s) operating in M-DCI based MTRPNote: In addition to the above supported set of CCs, a set of CCs configured for common TCI state ID activation/update can also include only CC(s) operating in STRP or CC(s) operating in S-DCI/M-DCI based MTRP. |
| **Company** | **Input to Round 1 summary** |
| Mod V00 | * Two questions are added for Issue 2.1 and Issue 2.7, please share view, if any
* Please provide your further comment to Proposal 2.2 and Proposal 2.5, if any
 |
| Xiaomi | **Issue 2.1:**Alt 1 can’t support dynamic switching.Alt 2 seems feasible. But if for PDCCH/PUCCH/Type I CG grant PUSCH, which is configured by RRC to follow two unified TCI states, when no TCI codepoint mapping to more than one joint/DL/UL TCI states by TCI state activation command, the UE behavior need to be specified.**Proposal 2.2**We can accept it if dynamic switching between STRP and MTRP can be supported**Proposal 2.5**Thanks HW for more explanation. We can accept this proposal.**Issue 2.7**It can be discussed after proposal 2-5. If it is supported, there is still another problem that how to apply the TCI state configuration(s) from a reference CC operating in MTRP for a CC operating in STRP since only one TCI state list is configured for the reference CC and two TCI state lists was not agreed in legacy. While for ‘whether a CC operating in MTRP can apply the TCI state configurations from a reference CC operating in STRP’, two reference CCs must be needed. |
| OPPO | **Issue 2.1:** Thanks to FL for asking next-level question regarding the FFS. Q1: It seems very generic when we mentioned the Rel-17 sTRP and Rel-18 mTRP. To step down, we would like to be more specific. In our mind, there seems no harm to reuse the legacy rules for each DL/UL channel (specified in Rel.16/17) to switch between sTRP and mTRP. For instance, SRS resource set indicator can be used for DG and Type 2 CG PUSCH. RRC signaling can be used for PDCCH sTRP/mTRP. In addition, during online discussion and by now, we failed to find the motivation to differentiate Rel-17 sTRP and Rel-18 mTRP, which in our view can be merged into the same framework, e.g. Rel.18 sTRP/mTRP using unified TCI state(s).If by any chance we have to down-select the alternatives, should we also consider another one, e.g. Alt.3 Based on legacy rules?**Issue 2.7:** Yes.We tend to believe the X-CC common beam update/indication should be applicable. Of course, more details can be further discussed when other related proposal (e.g. P2.2.) is stable.  |
| ZTE | **Issue 2.1:** Support Alt2 (just as legacy design).**Proposal 2.2:** Support**Issue 2.7:** As a beginning, we think the following should be supported as a starting point* In CA, the legacy procedure of RRC parameter (i.e., unifiedTCI-StateRef) pointing to RRC-configured TCI state pool(s) in a reference CC/BWP is reused.

Then, regarding the question, our answer is “Yes”. In general, the sTRP reference CC can be configured with a pointer to the mTRP reference CC. BTW, for S-DCI operation, it is assumed that the s-DCI and sTRP operation can be dynamically updated according to whether there is an activated codepoint associated with more than one TCI state(s). |
| Futurewei | **Issue 2.1:** Regarding Alt2, some clarifications are needed. In our understanding, in separate DL/UL TCI case, when a TCI codepoint is mapped with one DL TCI state and one UL TCI state in TCI state activation command, although the number of TCI states mapped to one TCI codepoint is more than one, it may still indicate STRP operation.**Issue 2.7:** Yes. |
| Google | **Issue 2.1 Question 1:** Alt 2 seems to be related to Issue 2.3. If Alt 2 in Issue 2.3 is adopted, even there no TCI codepoint is mapped with more than one joint/DL/UL TCI states, each TCI codepoint could be still mapped to either the first or second indicated TCI state. This looks like MTRP operation to us. **Issue 2.7:** We tend to agree with ZTE we should first confirm RRC-configured TCI state pool(s) in a reference CC/BWP is reused.  |
| Sharp | **Issue 2.1 Question 1:** We prefer Alt 2 that has higher flexibility than Alt 1.**Issue 2.7:** Yes. |
|  |  |
|  |  |
|  |  |
|  |  |

# Issue 3 – How to inform UE which indicated TCI state(s) that UE shall apply to target channel/signal

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

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

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

Table 3-2 Summary for Issue 3

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 3.1 | (S-DCI) PDCCH, whether Rel-17 rule/parameter is reused when provide the RRC configuration for TCI selection | **FL note: PLEASE note that this issue has been discussed in several meetings. If no consensus can be reached, we may conclude the status in this meeting.****Proposal 3.1:** On unified TCI framework extension for S-DCI based MTRP:* If a CORESET other than a CORESET with index 0 is associated only with USS sets and/or Type3-PDCCH CSS sets, the CORESET is configured by RRC to apply the first one, the second one, or both of the indicated joint/DL TCI states to PDCCH reception on the CORESET
* If a CORESET other than a CORESET with index 0 is associated at least with CSS sets other than Type3-PDCCH CSS sets and *followUnifiedTCIstate* = 'enabled' is configured for the CORESET, the CORESET is configured by RRC to apply the first one, the second one, or both of the indicated joint/DL TCI states to PDCCH reception on the CORESET
* If a CORESET with index 0 is configured with *followUnifiedTCIstate* = 'enabled':
	+ If the CORESET is associated with SS#0 for Type 0/0A/2 CSS sets, the CORESET is configured by RRC to apply the first one or the second one of the indicated joint/DL TCI states to PDCCH reception on the CORESET
	+ Otherwise, the CORESET is configured by RRC to apply the first one, the second one, or both of the indicated joint/DL TCI states to PDCCH reception on the CORESET

Support/fine: OPPO, vivo, QC, Xiaomi, Nokia, Samsung, ZTE, LG, CMCC, Apple, Futurewei, Spreadtrum, Huawei/HiSilicon, Sharp, NEC, Fujitsu, CATT, Docomo, Panasonic, IDC, Intel, MTK, FGI, Lenovo, TCLConcern: Ericsson**Proposal 3.1.A:** On unified TCI framework extension for S-DCI based MTRP:* If a CORESET other than a CORESET with index 0 is associated only with USS sets and/or Type3-PDCCH CSS sets, the CORESET is configured by RRC to apply the first one, the second one, or both of the indicated joint/DL TCI states to PDCCH reception on the CORESET
* If a CORESET other than a CORESET with index 0 is associated at least with CSS sets other than Type3-PDCCH CSS sets, the CORESET is configured by RRC to apply the first one, the second one, both, or none of the indicated joint/DL TCI states to PDCCH reception on the CORESET
* For a CORESET with index 0:
	+ If the CORESET is associated with SS#0 for Type 0/0A/2 CSS sets, the CORESET is configured by RRC to apply the first one, the second one, or none of the indicated joint/DL TCI state to PDCCH reception on the CORESET
	+ Otherwise, the CORESET is configured by RRC to apply the first one, the second one, both, or none of the indicated joint/DL TCI states to PDCCH reception on the CORESET

Note: RAN1 already agrees to use RRC configuration to inform that the UE shall apply the first one, the second one, both, or none of the indicated joint/DL TCI states to a CORESET in S-DCI based MTRPSupport/fine: EricssonConcern: |
| 3.2 | (S-DCI) PDSCH scheduled/activated by DCI format 1\_1/1\_2 if the [TCI selection field] is not present in DCI format 1\_1/1\_2 | Alt1: Using RRC configuration to inform that the UE shall apply the first one, the second one, or both of two indicated joint/DL TCI states to the scheduled/activated PDSCH reception* Support: Apple, CEWiT, Docomo, MediaTek, FGI, Huawei, HiSilicon, ITRI, NEC, OPPO, Panasonic, Sharp, Samsung, TransHold

Alt2: The UE shall apply the first indicated joint/DL TCI state to the scheduled/activated PDSCH reception* Support: CATT, OPPO, Spreadtrum, vivo, IDC

Alt3: The UE shall apply both indicated joint/DL TCI states to the scheduled/activated PDSCH reception* Support: Docomo, Huawei, HiSilicon, Intel, NEC, Nokia, OPPO, Samsung, TCL, MTK, ZTE

Alt3A: The UE shall apply the same joint/DL TCI state(s) that is applied to the PDCCH reception with the scheduling/activation DCI to the scheduled/activated PDSCH reception* Support: CMCC, Fraunhofer, Google

Alt4: Which indicated joint/DL TCI state(s) is/are applied to the scheduled/activated PDSCH reception is determined according to the existing TCI field of the most recently applied beam indication DCI* Support: CEWiT, LG, Qualcomm, IDC

**FL note: Given that Alt1 is the majority view and some proponents of Alt3 also support Alt1, Proposal 3.2 is recommended.****Proposal 3.2:** On unified TCI framework extension for S-DCI based MTRP, for PDSCH reception scheduled/activated by DCI format 1\_1/1\_2 configured w/o the [TCI selection field], using RRC configuration to inform that the UE shall apply the first, the second, or both indicated joint/DL TCI states to the scheduled/activated PDSCH reception* If the UE is in FR1, or the UE supports the capability of two default beams for S-DCI based MTRP in FR2, above applies regardless of the offset between the reception of the scheduling DCI format 1\_1/1\_2 and the scheduled/activated PDSCH reception
* If the UE doesn’t support the capability of two default beams for S-DCI based MTRP in FR2, above applies when the offset between the reception of the scheduling DCI format 1\_1/1\_2 and the scheduled/activated PDSCH reception is equal to or larger than a threshold

Support/fine: OPPO, Apple, Futurewei, Huawei/HiSilicon, Sharp, NEC, MTK, Docomo, Ericsson, Panasonic, Intel, FGIConcern: vivo, QC, Xiaomi, Nokia, LG, CMCC, Fujitsu, CATT, IDC, ZTE**FL note: Given that several companies have concern on the necessity of RRC configuration, Proposal 3.2.A is provided as one alternative:****Proposal 3.2.A:** On unified TCI framework extension for S-DCI based MTRP, for PDSCH reception scheduled/activated by DCI format 1\_1/1\_2 configured w/o the [TCI selection field], the UE shall apply both indicated joint/DL TCI states to the scheduled/activated PDSCH reception* If the UE is in FR1, or the UE supports the capability of two default beams for S-DCI based MTRP in FR2, above applies regardless of the offset between the reception of the scheduling DCI format 1\_1/1\_2 and the scheduled/activated PDSCH reception
* If the UE doesn’t support the capability of two default beams for S-DCI based MTRP in FR2, above applies when the offset between the reception of the scheduling DCI format 1\_1/1\_2 and the scheduled/activated PDSCH reception is equal to or larger than a threshold

Support: Concern: |
| 3.3 | (S-DCI) PDSCH scheduled/activated by DCI format 1\_0 (including DG and SPS) | Alt1: If the UE is configured with PDSCH-SFN/PDSCH-CJT, the UE shall apply both indicated joint/DL TCI states to PDSCH reception scheduled/activated by DCI format 1\_0. Otherwise, the UE shall apply the first indicated joint/DL TCI state to PDSCH reception scheduled/activated by DCI format 1\_0.* Support: CMCC, Docomo, Panasonic, Xiaomi, Spreadtrum, Sharp

Alt2: The UE shall apply the first indicated joint/DL TCI state to PDSCH reception scheduled/activated by DCI format 1\_0.* Support: Huawei/HiSilicon (at least for non-SFN/CJT), Fujitsu, Nokia, Qualcomm, vivo (at least for non-SFN/CJT), OPPO, LG, IDC, Intel, CATT, Fujitsu, Futurewei, LG, FGI

Alt3: Using RRC configuration to inform that the TCI selection for PDSCH reception scheduled/activated by DCI format 1\_0* Support: Ericsson, Docomo, OPPO, Apple, Sharp, FGI

Alt4: The UE shall apply the same joint/DL TCI state(s) that is applied to the PDCCH reception with the scheduling/activation DCI to the scheduled/activated PDSCH reception* Support: Samsung, ZTE, Google, Spreadtrum, NEC, FGI

**FL note: It seems more discussions are needed for issue, please input your preference and view on this issue. Some companies prefer to have the same TCI selection scheme for Issue 3.2 and Issue 3.3.** |
| 3.4 | (S-DCI) PUSCH scheduled/activated by DCI format 0\_0 (including DG and Type2 CG) | **Agreement**On unified TCI framework extension for S-DCI based MTRP, the UE shall apply the first indicated joint/UL TCI state to PUSCH transmission(s) scheduled/activated by DCI format 0\_0 (including DG and Type2 CG) |
| 3.5 | (S-DCI) Type1 CG-PUSCH | **Agreement**On unified TCI framework extension for S-DCI based MTRP, an RRC configuration is provided to a Type1 CG configuration to inform that the UE shall apply the first, the second, or both indicated joint/UL TCI states to the corresponding CG-PUSCH transmission* If the first or the second indicated joint/UL TCI state is applied, the UE shall apply the first or the second indicated joint/UL TCI state to all PUSCH antenna port(s) of corresponding PUSCH transmission occasions(s)
* If both indicated joint/UL TCI states are applied:
	+ For TDM based PUSCH Tx scheme, the UE shall apply the first indicated joint/UL TCI state to the PUSCH transmission occasions(s) associated with the first SRS resource set for CB/NCB, and the second indicated joint/UL TCI state to the PUSCH transmission occasions(s) associated with the second SRS resource set for CB/NCB
	+ FFS: SDM and SFN based PUSCH Tx schemes
 |
| 3.6 | (M-DCI) PUCCH | Opt1: A *coresetPoolIndex* value can be provided per PUCCH resource/resource group, and the UE shall apply the indicated joint/UL TCI state specific to the *coresetPoolIndex* value to the corresponding PUCCH transmission* Support: CATT, CMCC, Docomo, Fraunhofer, Fujitsu, Futurewei, Intel, Lenovo, TCL, Xiaomi, ZTE, OPPO, Spreadtrum, FGI

Opt2: An RRC configuration can be provided per PUCCH resource/resource group to inform that the UE shall apply the first or the second indicated joint/UL TCI state to the corresponding PUCCH transmission, where the first and the second indicated joint/DL TCI states correspond to the indicated joint/UL TCI states specific to *coresetPoolIndex* value 0 and value 1, respectively.* Support: Ericsson, Nokia, MediaTek, Panasonic, QC, Samsung, Spreadtrum, TransHold, LG, Google, NEC

Opt3: For a PUCCH transmission triggered by PDCCH on a CORESET when the UCI in the PUCCH transmission carries HARQ-ACK information only, the UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to the PUCCH transmission, where the *coresetPoolIndex* value is determined from the one associated with the CORESET. Otherwise, either Opt1 or Opt2 is adopted.* Support: Apple (with Opt1), Futurewei (with Opt1), Huawei/HiSilicon (with Opt2), OPPO (with Opt1), Sharp, vivo

Opt4: For a PUCCH transmission with an LRR trigged for either the first BFD-RS set ($\overbar{q}\_{0,0}$) or the second BFD-RS set ($\overbar{q}\_{0,1}$) when the UE is provided only one or two *schedulingRequestID-BFR* configuration, the UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to the PUCCH transmission, where the *coresetPoolIndex* value is 1 when the LRR is trigged for the first BFD-RS set ($\overbar{q}\_{0,0}$) and the *coresetPoolIndex* value is 0 when the LRR is trigged for the second BFD-RS set ($\overbar{q}\_{0,1}$). Otherwise, either Opt1 or Opt2 is adopted.* Support: Futurewei (with Opt1), Huawei/HiSilicon (with Opt2), vivo

**FL note: Proponents of Opt1 are slightly more than proponents of Opt2. Since these two alternatives achieve the same purpose, I would suggest to adopt at least Opt1 based on the current status. Also, the outcome (selection between Opt1 and Opt2) may impact the design for Type1 CG, AP CSI-RS, and SRS. Therefore, Proposal 3.6 is recommended. Note that Opt3 and Opt4 are not precluded by this proposal.****Proposal 3.6:** On unified TCI framework extension for M-DCI based MTRP, support at least Opt1 for PUCCH transmission, and Opt2 is not supported* Note: Opt3 and Opt4 are not precluded

Support: OPPO, vivo, QC, Xiaomi, ZTE, CMCC, Apple, Spreadtrum, Sharp, Fujitsu, CATT, Docomo, Lenovo, TCLConcern: LG, Nokia, Samsung, Huawei/HiSilicon, NEC, Panasonic, Ericsson, FGI**Proposal 3.6.A:** On unified TCI framework extension for M-DCI based MTRP, support at least Opt2 for PUCCH transmission, and Opt1 is not supported* Note: Opt3 and Opt4 are not precluded

Support: Concern:  |
| 3.7 | (S-DCI) AP CSI-RS for CSI/BM | Alt1: For all CSI/BM cases, using RRC configuration to inform the TCI selection for an AP CSI-RS resource set* Support: ZTE, vivo (also for two Resource Groups for NCJT CSI), QC, Fujitsu, Sharp, Docomo, IDC, OPPO, Samsung, Intel, CATT, Ericsson, Nokia, Spreadtrum

Alt2: For special case(s), e.g., NCJT CSI and/or enhanced group-based beam report, using a fixed rule to determine the TCI selection for an AP CSI-RS resource set. For other CSI/BM cases, using RRC configuration to inform the TCI selection for an AP CSI-RS resource set.* Support: Huawei/HiSilicon, CMCC, Apple, LG, FGI, Futurewei

**FL note: Considering only there are 3 meetings remained, I would suggest to make down-selection from above two alternatives in this meeting instead of just listing/agreeing on the alternatives. Based on pre-RAN1#112b offline discussion [1] and Tdoc contributions to RAN1#112b [3]-[34], # of proponents to above two alternatives are quite closed.** * **According to comments from proponents of Alt2, one major concern on Alt1 is it may not be able to properly support two beams applying to an AP CSI-RS resource set configured for NCJT CSI with two Resource Groups, which are associated with different TRPs, respectively.**
* **According to comments from proponents of Alt1, the issue from NCJT CSI can be resolved by providing qcl-info to AP CSI-RS resource set, i.e., each CSI-RS resource in the AP CSI-RS resource set is RRC-configured with a joint/DL TCI state instead of following the indicted joint/DL TCI state. However, additional signaling and inflexibility can be seen in order to align the beams used for PDSCH and NCJT CSI.**
* **According to comments from proponents of Alt1, there is no issue from enhanced group-based reporting since NW can properly assign different indicated joint/DL TCI states to the two CMR sets by Alt1.**

**Based on above observations, one potential compromise proposal between Alt1 and Alt2 is recommended as follows:****Proposal 3.7:** On unified TCI framework extension for S-DCI based MTRP, an RRC configuration can be provided in *CSI-AssociatedReportConfigInfo* of *CSI-AperiodicTrigger State* for each aperiodic CSI-RS resource set for CSI/BM to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the aperiodic CSI-RS resource set if the aperiodic CSI-RS resource set is configured to follow unified TCI state* For an aperiodic CSI-RS resource set configured with two Resource Groups for NCJT CSI and configured to follow unified TCI state, if above RRC configuration is not provided to the aperiodic CSI-RS resource set, the UE shall apply the first indicated joint/DL TCI state to the CSI-RS resource(s) in Group 1 and the second indicated joint/DL TCI state to the CSI-RS resource(s) in Group 2.

**FL note: Some companies suggest another “compromise” proposal to make the RRC configuration per-resource provided. Then, the issue from NCJT CSI can be resolved as well. Please check Proposal 3.7.A.****Proposal 3.7.A:** On unified TCI framework extension for S-DCI based MTRP, an RRC configuration can be provided in *CSI-AssociatedReportConfigInfo* of *CSI-AperiodicTrigger State* for each CSI-RS resource in each aperiodic CSI-RS resource set to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the CSI-RS resource if the aperiodic CSI-RS resource set for CSI/BM is configured to follow unified TCI state |
| 3.8 | (S-DCI) SRS for CB/NCB/AS and AP SRS for BM | Opt1: For a P/SP/AP SRS resource set for CB/NCB/AS or an AP SRS resource set for BM, if the SRS resource set is configured to follow unified TCI state, using RRC configuration to inform the TCI selection for the SRS resource setOpt2: If two SRS resource sets for CB/NCB are configured, and if the two SRS resource sets for CB/NCB are configured to follow unified TCI state, the UE shall apply the first indicated joint/UL TCI state to the first SRS resource set for CB/NCB (the one with lower resource set ID) and the second indicated joint/UL TCI state to second SRS resource set for CB/NCB. Otherwise, Opt1 is adopted.Support Opt1 only: Apple, Ericsson, Qualcomm, vivo, Google, ZTE, NEC, Fujitsu, CATT, IntelSupport Opt1+Opt2: Huawei/HiSilicon, OPPO, Panasonic, Xiaomi, CMCC, Docomo, Futurewei, TCL**FL note: Based on comments to Opt1 and Opt2, Proposal 3.8 is recommended as a potential compromise:****Proposal 3.8:** On unified TCI framework extension for S-DCI based MTRP, for a P/SP/AP SRS resource set for CB/NCB/AS or an AP SRS resource set for BM, if the SRS resource set is configured to follow unified TCI state, using RRC configuration to inform that the UE shall apply the first or the second indicated joint/UL TCI state to the SRS resource set* If two SRS resource sets for CB/NCB are configured and the two SRS resource sets for CB/NCB are configured to follow unified TCI state, and if above RRC configurations are not provided to the two SRS resource sets for CB/NCB, the UE shall apply the first indicated joint/UL TCI state to the first SRS resource set for CB/NCB (the one with lower resource set ID) and the second indicated joint/UL TCI state to second SRS resource set for CB/NCB.
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| 3.9 | (S-DCI) PDSCH scheduled/activated by DCI format 1\_1/1\_2, details of the [TCI selection field] in DCI format 1\_1/1\_2 | Question 1: Whether to use the codepoint “11” of the [TCI selection field]?* Yes: CMCC, FGI, LGE, Spreadtrum, vivo, ZTE, Docomo (for TDM)
* No (reserved): ITRI, Samsung, OPPO, QC, Xiaomi, Nokia, Sharp, Docomo (for SDM/SFN), Intel, Huawei/HiSilicon, Ericsson

**FL note: The outcome of Q1 may impact the design of applying/mapping order of two indicated joint/DL TCI states if both are applied, e.g., Rel-16 rules is reused, or the order can be changed according to the codepoints “10” and “11”. Based on the feedback from companies, Conclusion 3.9 is recommended:****Conclusion 3.9:** On unified TCI framework extension for S-DCI based MTRP, there is no consensus to use the codepoint “11” of the [TCI selection field], i.e., the codepoint “11” is reserved.Question 2: Presence of the [TCI selection field] is RRC-configured per CORESET, per BWP, per serving cell, or others?* Per CORESET: CMCC, ZTE, NEC, CATT
* Per BWP: vivo (per DCI format 1\_1/1\_2), QC, Xiaomi, Nokia, Docomo, Panasonic, Intel, Apple, Huawei/HiSilicon, FGI, Lenovo

**FL note: Based on above feedback to Q2, Proposal 3.9 is recommended:****Proposal 3.10:** On unified TCI framework extension for S-DCI based MTRP, the presence of the [TCI selection field] can be RRC-configured per DL BWP |
| 3.10 | How to handle the case that the spatial Tx filter(s) determined from the indicated joint/UL TCI state(s) applied to a PUSCH transmission is different from the spatial Tx filter(s) used for the SRS transmission corresponding to the SRS resource(s) indicated to the PUSCH transmission | Alt1-1: The UE uses the spatial Tx filter(s) determined from the indicated joint/UL TCI state(s) applied to the PUSCH transmission in this case, and an agreement for this behavior is preferred.* Support: ZTE

Alt1-2: Based on current agreement, the UE uses the spatial Tx filter(s) determined from the indicated joint/UL TCI state(s) applied to the PUSCH transmission in this case, and no additional handling is needed.* Support: vivo, Ericsson

Alt2: The UE uses the spatial Tx filter(s) used for the SRS transmission corresponding to the SRS resource(s) indicated to the PUSCH transmission in this case, i.e., the indicated joint/UL TCI state(s) for the PUSCH transmission is ignored* Support: ZTE, NEC

Alt3: The case can be avoided by NW implementation, i.e., no additional handing in specification to this case is needed* Support: Docomo, Huawei/HiSilicon, OPPO, Spreadtrum, QC, CMCC, Xiaomi, Google, Apple, Sharp, Futurewei, CATT, FGI
* Concern: ZTE

**FL note: More discussions are needed for issue, please input your preference on above alternatives. Based on feedback from some companies, Alt1 is the agreed behavior for this case, thus no additional handling is needed.** |

Table 3-3 Company input for Issue 3

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| **Company** | **Input to Round 1 summary** |
| Mod V00 | * Please share your view to the alternative proposals (i.e., Proposal 3.X.A) in Issue 3
* Please check new proposals and conclusion recommended for Issue 3.8 and 3.9
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| Xiaomi | **Proposal 3.1 or 3.1.A**Either one is ok for us, it can be up to RAN2**Proposal 3.2 or 3.2.A**Prefer 3.2.A since RRC is not needed.**Proposal 3.6 or 3.6.A**Either one is ok for us.**Proposal 3.7 or 3.7.A**Prefer 3.7 since RRC configuration per resource is not needed.**Proposal 3.8**Support **Conclusion 3.9 and Proposal 3.10**Support  |
| OPPO | **Proposal 3.2.A**: Fine to remove the involvement of RRC configuration on this UE behavior. **Proposal 3.6.A**: Not supportive. When the existing RRC parameter, i.e. CORESETPoolIndex (already associated with UL transmission, i.e. SRS resource set) is available, it seems unnecessary to introduce a new RRC parameter for the same purpose. **Proposal 3.7.A**: Fine with the update. |
| ZTE | **Proposal 3.1.A:** We can NOT support it. Clearly, we need to provide the indicator of “following unified TCI” individually, and otherwise the legacy procedure of MAC-CE level of s-DCI and sTRP switching can NOT be achieved. **Proposal 3.2.A:** Support.**Proposal 3.6.A:** Not support. It seems that we have a separate flag of first/second TCI states, but which is associated with an individual CORESET pool. It is complicated, and why we can NOT configured CORESET\_pool\_Id directly in RRC level. **Proposal 3.7.A:** Support. **Proposal 3.8:** Support the main bullet, and the sub-bullet seems unnecessary. **Conclusion 3.9/proposal 3.10:** For progress, we can be flexible. But it should be noticed that, if having proposal 3.10, the RRC level configuration for first/second/both TCI states for PDSCH (as in proposal 3.2) seems not to make sense. It seems to be no different from the configuration of legacy transmission mode (e.g., enabling SFN/CJT). **Issue 3.10:** We can be flexible for support Alt 1-2. But, a conclusion seems to be needed. |
| Futurewei | **Proposal 3.1.A:** Not support. We prefer Proposal 3.1.**Proposal 3.2.A:** We are open to support it. **Proposal 3.6.A:** For both Proposal 3.6 and Proposal 3.6.A, the proposal in its current form implies that Opt1/Opt2 alone is sufficient to cover all scenarios, which is not true. For example, neither Opt1 nor Opt2 can work properly for the case of PUCCH scheduling request for per-TRP BFR case. In that case, when the UE is provided only one configuration for PUCCH transmission with a link recovery request (LRR), the PUCCH is for transmitting scheduling request targeting either TRP0 or TRP1, depending on which one is the working TRP. However, in Opt1/Opt2, the UE can only apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value configured for the PUCCH resource to the corresponding PUCCH transmission, thus the PUCCH can only be targeted at one specific TRP, but that specific TRP may not be the working TRP. Therefore Opt1 and Opt2 will result in BFR failure in this case. We are open to support Proposal 3.6.A with the following modifications to make it clear on this aspect:[Mod] This proposal does NOT imply Opt1/Opt2 alone is sufficient. PLEASE CHECK the note that Opt4 is not precluded.**Modified Proposal 3.6.A:** On unified TCI framework extension for M-DCI based MTRP, support at least Opt2 for PUCCH transmission except for PUCCH transmission with an LRR triggered for either the first or the second BFD-RS set, and Opt1 is not supported* Note: Opt3 and Opt4 are not precluded

**Proposal 3.7.A:** Support in principle.**Proposal 3.8:** Support.**Conclusion 3.9:** Support.**Proposal 3.10:** Support. |
| Google | **Proposal 3.6.A:** Support. Since we also need such RRC configuration for PUCCH in S-DCI. It would better to use the same RRC configuration, instead of CORESETPoolIndex. **Proposal 3.7.A:** Support. **Conclusion 3.9:** Support. **Proposal 3.10:** Fine |
| Sharp | **Proposal 3.1.A:** We prefer to keep followUnifiedTCIstate, while it is not needed technically. However, it is helpful for reusing the current spec that both followUnifiedTCIstate and RRC parameter for TCI selection are configured.**Proposal 3.2.A:** We have a concern about Proposal 3.2.A. If the UE doesn’t support the capability of two default beams for S-DCI based MTRP, we think both indicated joint/DL TCI states should not be applied to PDSCH. Furthermore, since STRP PDSCH cannot be used, Proposal 3.2.A has less flexibility than Proposal 3.2. In our view, only Alt 1 or Alt 2 + Alt 3 are acceptable.**Proposal 3.6.A:** Not support. We prefer to use coresetPoolIndex directly (i.e., Opt1) to align with other TCI selection schemes for MDCI-based MTRP. Opt2 seems like TCI selection for SDCI-based MTRP.**Proposal 3.7.A:** We are fine with Proposal 3.7.A.**Proposal 3.8:** We are fine with Proposal 3.8.**Conclusion 3.9:** We are fine with Conclusion 3.9.**Proposal 3.10:** Support. |
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# Issue 4 – UL power control for UL MTRP operation

Table 4-1 Summary for Issue 4

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 4.1 | UL PC for S-DCI based STxMP (including SDM/SFN based PUSCH Tx and SFN based PUCCH Tx) | **FL note: In the last meeting, per-indicated-TCI PC parameter setting and PL-RS were agreed to be used for determining UL Tx power for MTRP operation. However, how to assume the UE-configured maximum output power for STxMP was left as FFS. According to the RAN4 LS reply on UE power limitation for STxMP [2], both per-UE and per-panel power limitation are feasible and should be applied to a same UE for STxMP. To meet/enable the per-panel power limitation, one question is raised as follows:** Question 1: At least for S-DCI based STxMP, whether to introduce per-panel/indicated-TCI UE-configured maximum output power, i.e., the UE shall determine UL Tx power per panel or per indicated joint/UL TCI state based on per-pane/indicated-TCI UE-configured maximum output power?* Yes: CATT, Docomo, Lenovo, LG, Panasonic, MediaTek, vivo, OPPO, QC, ZTE, LG, Xiaomi, Nokia (M-DCI also), Sharp, FGI, Lenovo
* No: Intel, Samsung, Ericsson, Apple

**FL note: For M-DCI based STxMP, per-panel power limitation can be enabled by the per-Tx-occasion UE-configured maximum output power in current spec.****TS 38.213**If a UE transmits a PUSCH on active UL BWP $b$ of carrier $f$ of serving cell $c$ using parameter set configuration with index $j$ and PUSCH power control adjustment state with index $l$, the UE determines the PUSCH transmission power $P\_{PUSCH,b,f,c}(i,j,q\_{d},l)$ in PUSCH transmission occasion $i$ as**Proposal 4.1:** On unified TCI framework extension for S-DCI based MTRP, down-select one from the followings for PUSCH/PUCCH STxMP:* Alt1: The UE determines two UL Tx power values for the PUSCH/PUCCH STxMP based on one single UE-configured maximum output power value as defined in Rel-17 spec
* Alt2: The UE determines two UL Tx power values for PUSCH/PUCCH STxMP based on two UE-configured maximum output power values (FFS: how to define in RAN1 spec)
 |
| 4.2 | Power allocation for STxMP (including both S-DCI and M-DCI based STxMP) | **FL note: According to the RAN4 LS reply on UE power limitation for STxMP [2], both per-UE and per-panel power limitation are feasible and should be applied to a same UE for STxMP. To meet/enable the per-UE power limitation, one question is raised as follows:** Question 1: Whether prioritization for Tx power allocation/reduction is needed for STxMP so that the total UE Tx power for transmissions on serving cells in the frequency range wouldn’t exceed a total power limitation, e.g., $\hat{P}\_{CMAX}(i)$ used in TS 38.213 (clause 7.5) and defined in TS 38.101?* Yes: Nokia, MediaTek, Panasonic, ZTE, OPPO, QC, LG, Xiaomi, Apple, Sharp, Lenovo
* No: vivo (concern on the target condition), Intel, Samsung, Ericsson
 |

Table 4-2 Company input for Issue 4

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| **Company** | **Input to Round 0 summary** |
| Mod V00 | Please update your preference on the two questions in Issue 4.1 and Issue 4.2, respectively. |
| OPPO | **Q1 of Issue 4.1**: Yes. **Q1 of Issue 4.2**: Yes.  |
| vivo | Issue 4.1: Yes.Issue 4.2: No. We don’t think total UE Tx power across multiple panels for simultaneous transmission on serving cells in the frequency range has a fixed relation with the total power limitation Pc,max. RAN4 focuses on per-UE measured peak EIRP Pumax rather than Pc,max, where Pumax is relevant to beam direction. We can’t assign Tx power, which doesn’t reflect any beam direction information, in per-panel level. If Tx power is allocated by restricting the total UE Tx power for transmissions less than the total power limitation, the actual measured peak EIRP may not reach Pumax. |
| QC | For 4.1 Q1: Yes. To FL, could you provide the spec section # on the per-Tx-occasion UE configured max power?For 4.2 Q1: Yes |
| Xiaomi | Issue 4.1: YesWe want to clarify that RAN4 only agreed that at least the current per UE power limitation which is defined based on regulation compliance should be considered for STxMP. In addition, a total power limitation over all panels, which is difference from the current per UE power limitation and power limitation per panel are feasible. But whether a total power limitation over all panels and per panel power limitation should be introduced is up to RAN1. Hence, both whether to introduce per-panel maximum output power and whether to introduce a total power limitation over all panels should be discussed in RAN1.Issue 4.2: YesBut for SDCI based STxMP, the data transmitted from these panels simultaneously belongs to the same PUSCH, then how to define the prioritization might be difficult. |
| Nokia/NSB | On 4.1: Yes. Also, we think that similar discussion would be also needed for the M-DCI case.On 4.2: Yes. |
| ZTE | For issue 4.1, we agree to have panel-specific maximum output power Pc,max. Sine the UE determines the UL Tx power based on the indicated joint/UL TCI state, calculating the transmission power for each panel separately based on the corresponding PC parameters and panel-specific Pc,max is a straightforward solution.For issue 4.2, we support to study prioritization for Tx power allocation/reduction for STxMP transmission. Regarding the relationship between the per-panel power limitation and per-UE power limitation, we prefer that the sum over all panels of the per-panel power limitation can be greater than the per-UE power limitation, which is beneficial for maximizing UL Tx transmission power. In this case, we have to handle the issue of exceeding the power limitation and study associated priority rules or power allocation/reduction mechanisms. For example, the calculated transmission power for each panel does not exceed the panel-specific power limitation, but the total calculated transmission power exceeds the power limitation for a power class, as shown in the i+2 occasion in the figure below. 绘图8 |
| LG | Issue 4.1: YesAs RAN4 mentioned, the concept of ‘panel’ has not been defined and then it needs to be clarified on the panel and the panel association for handling each assumption of UE power limitation. To this end, extending the usage of UE capability value index reporting introduced in Rel-17 can be the one of promising approaches.Issue 4.2: Yes |
| Apple  | **Issue 4.1:** Our understanding on RAN4 LS response is a bit different:

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| However, whether and how to introduce per-panel power limitation or similar concept and/or requirements in RAN4 is still under discussion. |

As highlighted above, the per-panel limitation is still FFS. There were similar discussions in the earlier releases on this regard and per-Panel limitation was not introduced by RAN4 so far. [Mod] My understanding to this sentence is that whether and how to introduce per-panel limitation “in RAN4” is still under discussion in RAN4, which doesn’t preclude RAN1 to further discuss and define the per-panel limitation in RAN1 procedure/ specification.In brief, we are not sure whether RAN1 can decide to introduce per-panel maximum out power or not as it is being discussed in RAN4 as business as usual. **Issue 4.2**: We also think prioritization rule is needed in general.  |
| Google2 | **Issue 4.1** Question 1: Yes**Issue 4.2** Question 1: Yes |
| Spreadtrum | **Issue 4.1**:Support to have panel-specific maximum output power. |
| Huawei, HiSilicon | **Issue 4.1:** We are OK to introduce per-panel UE-configured max output power.**Issue 4.2:** Yes. This is an important issue since RAN4 confirmed that “per-UE power limitation would be applicable at all the time”.  |
| NEC | **Issue 4.1:** Yes, and per-panel UE-configured max output power could be enough, not see the need of per-TCI max power.**Issue 4.2:** Yes. |
| CATT | Issue 4.1 Q1: YesIssue 4.2 Q1: Basically Yes. The detailed total power limitation value Pcmax need to be further studied to determine whether the original value in TS38.213(clause 7.5) can be reused.  |
| vivo2 | Issue 4.2: We are fine to study but the target condition is not correct in our mind, i.e., “the total UE Tx power for transmissions on serving cells in the frequency range wouldn’t exceed a total power limitation, e.g., P ̂\_CMAX (i) used in TS 38.213”. We have similar understanding as ZTE, i.e., the total UE Tx power for transmissions on serving cells in the frequency range can exceed the Pc,max. |
| Docomo | **Issue 4.1** Question 1: Yes. Even for M-DCI STxMP, we are not sure whether per panel UE power limitation can be enabled by per Tx occasion UE configured maximum output power. In current spec., transmission occasion is defined as: “*A PUSCH/PUCCH/SRS/PRACH transmission occasion* $i$ *is defined by a slot index* $n\_{s,f}^{μ}$ *within a frame with system frame number* $SFN$*, a first symbol* $S$ *within the slot, and a number of consecutive symbols* $L$.”. When two PUSCHs overlap in time, per panel UE power limitation may also need to be defined for M-DCI STxMP.**Issue 4.2** Question 1: Yes. We are fine to study this issue. |
| Ericsson | Issue 4.1: This is not our interpretation of the LS response. RAN4 may define per panel Pcmax, but before that, RAN1 should not go ahead and define anything.Issue 4.2: Leave to RAN4. RAN4 will – if there is a need – define per-panel Pcmax that will ensure that regulatory limits are fulfilled – that’s what RAN4 does. Before RAN4 comes back, specifying anything in RAN1 is premature. |
| Samsung | For 4.1. Q1: NoActually we are open for further discussion, but currently we do not support. We wonder whether panel specific peak power per TCI state needs RRC based association between TCI state and UE panel. If so, we don’t see a reason to do that. In addition, current UE can report PHR in beam specific way and we think that reporting enables network to understand Pc value. For 4.2. Q1: NoIn case of SDCI, we assume gNB can have clear understanding on UE’s available power. In case of MDCI, we are open to have more discussion. But currently we do not think specification based prioritization is essential between two TRPs. |
| Intel | **Issue 4.1:** Q1 – No.We want to clarify that for 2 logical panels, the Pc\_max is set based on EIRP which is per UE and directional. Then it’s not clear to us what issue we are addressing by introducing two different Pc\_max values. **Issue 4.2:** Similar view as Ericsson. We should wait for RAN4 to first decide if 2 different power limitations in different directions are required. If so, we can discuss prioritization in RAN1. |
| Lenovo | Issue 4.1: Q1: YesIssue 4.2: Q2: Yes. At least for MDCI MTRP, when two overlapped PUSCHs are scheduled and the total transmit power is exceed UE’s max out put power, one of them can be transmitted by prioritization. |
| ZTE | Issue 4.1: If we do not have panel-specific/TCI-specific Pc,max but we have TCI-specific UL power control setting, we fail to understand how to scale the calculated Tx power (by the following legacy formula) for respective ports. Or, the consensus may be start from whether we need to update the following formulaAny further clarification is appreciated. |
| TCL | Issue 4.1: No. It is enough to set per-UE maximum power limitation. The UE can calculate per-panel scheduling power first. Then the UE compare the per-UE maximum power and the sum of per-panel scheduling powers. If the per-UE maximum power is larger than the sum of per-panel scheduling powers, introduce priority of power allocation for per-panel.Issue 4.2: Yes. |
| **Company** | **Input to Round 1 summary** |
| Mod V00 | Please input your comment to Proposal 4.1 |
| Xiaomi | First, for both alternatives, UE will determine a total transmit power, $P\_{PUSCH}$, then how to splits the power across multiple panels should be further studied.Secondly, there is another alternative that UE can determines the transmit power for each panel, or each TCI state, independently based on the indicated two sets of power control parameters. Therefore, we suggest the following modification to Proposal 4.1:**Proposal 4.1:** On unified TCI framework extension for S-DCI based MTRP, down-select one from the followings for PUSCH/PUCCH STxMP:* Alt1: The UE determines UL Tx power for the PUSCH/PUCCH STxMP based on one UE-configured maximum output power value as defined in Rel-17 spec
	+ FFS: how to splits UL Tx power for the PUSCH/PUCCH STxMP across multiple panels
* Alt2: The UE determines UL Tx power for PUSCH/PUCCH STxMP based on two UE-configured maximum output power values (FFS: how to define in RAN1 spec)
	+ FFS: how to splits UL Tx power for the PUSCH/PUCCH STxMP across multiple panels
* Alt3: UE determines the transmit power for each panel independently based on the indicated two sets of power control parameters
	+ UL Tx power for the PUSCH/PUCCH STxMP is the sum of transmission power for each panel

[Mod] In fact, we already have an agreement as follows that allows determine two UL Tx power for STxMP (per-indicated-TCI). This proposal mainly focuses on the first FFS item.**Agreement**On unified TCI framework extension, if an indicated joint/UL TCI state(s) applies to a PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s), the UE shall determine UL Tx power for the PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s) based on the UL PC parameter setting for PUSCH/PUCCH/SRS, if any, and the PL-RS included in the indicated joint/UL TCI state* FFS: For STxMP, the maximum Tx power when the UE determines UL Tx power for the PUSCH/PUCCH transmission occasion(s) or antenna port(s) (discussed after receiving RAN4 reply on UE power limitation for STxMP in FR2)
* FFS: Default UL PC parameter setting(s) if one or both of indicated joint/UL TCI states applied to PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s) does/do not include the UL PC parameter setting(s) for PUCCH/PUSCH/SRS
 |
| OPPO | Generally okay with **Proposal 4.1**. Regarding the wording, the term “UE-configured” confused us a bit. Could we suggest to modify it for better clarity, if we understand the intention correctly?**Proposal 4.1:** On unified TCI framework extension for S-DCI based MTRP, down-select one from the followings for PUSCH/PUCCH STxMP:* Alt1: The UE determines UL Tx power for the PUSCH/PUCCH STxMP based on one ~~UE-configured~~ per UE maximum output power value as defined in Rel-17 spec

[Mod] I try to capture that the legacy one defined in Rel-17 is reused in this alternative, and it may no be necessary to re-define it.* Alt2: The UE determines UL Tx power for PUSCH/PUCCH STxMP based on two ~~UE-configured~~ per panel maximum output power values (FFS: how to define in RAN1 spec)

[Mod] I try not to define the two Pcmax values are per-panel, per-TCI, or something else at this moment. Further definition is needed, and it is captured in the FFS |
| ZTE | Support the FL proposal. We prefer to have panel-specific/TCI-specific Pc,max for the Tx power calculation of each panel. OPPO’s update is also fine to us. |
| Google | We can support proposal 4.1.  |
| Sharp | Support Proposal 4.1. |
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# Issue 5 – PDSCH-CJT Tx scheme

Table 5-1 Summary for Issue 5

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 5.1 | Switching between PDSCH-CJT Tx scheme and other S-DCI based PDSCH Tx scheme(s) | **FL note: Based on pre-RAN1#112b offline discussion [1] and Tdoc contributions to RAN1#112b [3]-[34], Proposal 5.1 is recommended. Note that since this is not an essential issue in this AI, it is unlikely to treat it in the GTW discussion. I hope we can converge through the offline discussion.****Proposal 5.1:** On unified TCI framework extension for S-DCI based MTRP, PDSCH-CJT Tx scheme is RRC-configured, and dynamic switching between PDSCH-CJT and other S-DCI based PDSCH Tx schemes is not supported* Support: Xiaomi, Huawei, HiSilicon, QC, Docomo, CMCC, Apple, Sharp, LG, IDC, FGI, Intel, Futurewei, OPPO, ZTE (okay if this is majority)
* Not support: ~~ZTE~~
 |
| 5.2 | QCL type(s)/assumption(s) if two indicated joint TCI states are applied to PDSCH-CJT | Alt1: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA* Support: Huawei, Spreadtrum, OPPO, Ericsson, Xiaomi, CATT, Qualcomm, Nokia, Docomo, CMCC, Lenovo, NEC, LG, Intel, Samsung, Sharp
* Concern: ZTE

Alt2: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA except for QCL parameters {Doppler shift, Doppler spread} of the second indicated joint TCI state* Support: Huawei, ZTE, Ericsson, Xiaomi, Qualcomm, Docomo, CMCC, Samsung
* Concern:

Alt3: PDSCH DMRS port(s) is QCLed with the DL RS of the first indicated joint TCI state with respect to QCL-TypeA and QCLed with the DL RS of the second indicated joint TCI state with respect to QCL-TypeB* Support: ZTE, Ericsson
* Concern: Huawei, QC, Samsung

**FL note: Based on feedback from companies, all the alternatives have their use cases. Thus, Proposal 5.2 is recommended. Note that since this is not an essential issue in this AI, it is unlikely to treat it in the GTW discussion. I hope we can converge through the offline discussion.****Proposal 5.2:** On unified TCI framework extension for S-DCI based MTRP, the following three alternatives are supported for PDSCH-CJT applying both indicated joint TCI states (if the UE supports two indicated joint/DL states for PDSCH-CJT):* Alt1: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA
* Alt2: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA except for QCL parameters {Doppler shift, Doppler spread} of the second indicated joint TCI state
* Alt3: PDSCH DMRS port(s) is QCLed with the DL RS of the first indicated joint TCI state with respect to QCL-TypeA and QCLed with the DL RS of the second indicated joint TCI state with respect to QCL-TypeB

Introduce a UE capability on support each of above alternatives, and either one of above alternatives can be configured by RRC according to the UE capabilitySupport: ZTE, Huawei/HiSilicon, Docomo, Ericsson, LenovoConcern: OPPO, QC  |

Table 5-2 Company input for Issue 5

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| --- | --- |
| **Company** | **Input to Round 0 summary** |
| Mod V00 | * Please input your comment to Proposal 5.1 and Proposal 5.2, if any.
* Please also update your preference on those alternatives in Issue 5.2, if needed.
 |
| OPPO | **Proposal 5.1**: Fine. **Proposal 5.2**: Not supportive. For PDSCH-CJT at FR1, we think the TRP-specific time/freq. domain compensation lacks of validity, thus UE behavior on dropping certain QCL parameter is not necessary. QCL-TypeA would be enough to serve. We don’t need to specify different UE capability on this issue.  |
| QC | Proposal 5.1, supportProposal 5.2, not support. Alt3 has no evaluation.  |
| Xiaomi | Proposal 5.1: support |
| Google | **Proposal 5.1:** Support  |
| Nokia | **Proposal 5.1:** SupportIssue 5.2: Support Alt1. |
| ZTE | Proposal 5.1: Not our first preference. But we can live with that if having majority companies support.Proposal 5.2: As a compromise, we can live with that. In our contribution, we have the following evaluation results which proves that there may be significant performance benefits if having Alt2/3, compared with Alt1. Figure 1 UPT comparison in second TCI state: (a) Alt 2, i.e., with Doppler compensation vs Alt 1 w.r.t. QCL-TypeA, i.e., without any compensation (in a case of 0.025ppm per TRP); (b) Alt 2, i.e., only w.r.t. QCL-TypeB with delay compensation vs Alt 1 w.r.t. QCL-TypeA, i.e., without any compensation (for inter-site scenario) |
| LG | **Proposal 5.1**: Fine.  |
| CMCC | Proposal 5.1: SupportProposal 5.2: Support Alt1+Alt2. |
| Apple  | **Proposal 5.1**: Support.  |
| Futurewei | **Proposal 5.1:** Support. |
| Huawei, HiSilicon | **Proposal 5.1:** Support**Proposal 5.2:** Support. We can accept all three alternatives to make progress. |
| Sharp | Proposal 5.1: Support |
| CATT | Proposal 5.1: SupportProposal 5.2: Support Alt1 |
| vivo | Proposal 5.1: Support. |
| Docomo | Proposal 5.1: OK.Proposal 5.2: OK. |
| Ericsson | Proposal 5.1: SupportProposal 5.2: Support. |
| Samsung | Proposal 5.1: SupportIssue 5.2: We think at least Alt 1 and Alt 2 should be supported. For Alt 3, we have small concerns on UE implementation. |
| Intel | **Proposal 5.1:** OK**Issue 5.2:** We support Alt-1.  |
| Lenovo | Proposal 5.1: SupportProposal 5.2: Support |
| OPPO2 | **Proposal 5.2**: Thanks to @ZTE for providing the simulation results on 3 different alternatives. Given the 0.025 ppm on oscillator per TRP, the impairment by hardware could be very comparable or higher than the impact introduced by Doppler effect (e.g. 3km/h at @2GHz). We are not sure whether this value is determined in the section of PDSCH-CJT or up to each company to carry out the evaluation. Hence, to make Alt.2 more valid, we would be glad to see more evaluation on it from companies to testify the benefits.  |
| ZTE | @OPPO, thank you so much for your comment. In the simulation, the value of evaluation assumption for TRP oscillator is based on RAN4 spec TS 38.104. Recently, ‘0.025 ppm on oscillator per TRP’ is an optimistic assumption for TRP modulated carrier frequency in deployment.  |
| TCL | Issue 5.1: OK.Issue 5.2: Support Alt1 and Alt 2. |
| **Company** | **Input to Round 1 summary** |
| Mod V00 | * Proposal 5.1 will be moved to checking email for endorsement, if no further concern is raised by company
* Please check Proposal 5.2. Note that all three alternatives are supported by the proposal, which is not intended for down-selection
 |
| OPPO | Thanks to @ZTE for capturing the gNB side spec and more technical discussion on it. We have no concern on the evaluation assumptions. Thanks to FL for reminding that all 3 alternatives is to be supported based on UE cap. in this proposal. Regarding the UE capability, shall we try a rewording to avoid the case that UE has to support all alternatives, once UE supports one of the alternatives?**Proposal 5.2:** On unified TCI framework extension for S-DCI based MTRP, the following three alternatives are supported for PDSCH-CJT applying both indicated joint TCI states (if the UE supports two indicated joint/DL states for PDSCH-CJT):* Alt1: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA
* Alt2: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA except for QCL parameters {Doppler shift, Doppler spread} of the second indicated joint TCI state
* Alt3: PDSCH DMRS port(s) is QCLed with the DL RS of the first indicated joint TCI state with respect to QCL-TypeA and QCLed with the DL RS of the second indicated joint TCI state with respect to QCL-TypeB

Introduce a UE capability on whether to support and which one(s) of above alternatives (if supported), and either one of above alternatives can be configured by RRC according to the UE capability  |
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# Issue 6 – Beam failure recovery

Table 6-1 Summary for Issue 6

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| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 6.1 | Implicit BFD-RS determination for S-DCI based MTRP | **Proposal 6.1:** On unified TCI framework extension for S-DCI based MTRP, if the UE is provided the first candidate beam RS list ($\overbar{q}\_{1,0}$) and the second candidate beam RS set ($\overbar{q}\_{1,1}$) but not explicitly provided the first BFD-RS set ($\overbar{q}\_{0,0}$) and the second BFD-RS set ($\overbar{q}\_{0,1}$) for TRP-specific BFR and if both first and second indicated joint/DL TCI states are configured by RRC to be applied to CORESETs for PDCCH reception, the UE determines the BFD-RS for the first and second BFD-RS sets from the first and second indicated joint/DL TCI states, respectively.* FFS: The case if any CORESET is configured to apply both first and second indicated joint/DL TCI states for PDCCH-SFN
* FFS: Whether and how to handle the case if one or both of the first and second indicated joint/DL TCI states is/are NOT configured by RRC to be applied to CORESET(s) for PDCCH reception

**Current TS 38.213 for link recovery procedures**If the UE is not provided $\overbar{q}\_{0,0}$ and $ \overbar{q}\_{0,1}$ for a BWP of the serving cell, the UE determines the set $\overbar{q}\_{0,0}$ and $ \overbar{q}\_{0,1}$ to include periodic CSI-RS resource configuration indexes with same values as the RS indexes in the RS sets indicated by TCI-State for first and second CORESETs that the UE uses for monitoring PDCCH, respectively, where the UE is provided twocoresetPoolIndex values 0 and 1 for the first and second CORESETs, or is not provided coresetPoolIndex value for the first CORESETs and is provided coresetPoolIndex value of 1 for the second CORESETs, respectively*.***FL note: This proposal was provided in the last meeting but no chance to discuss it online/offline, please input your comment to this proposal, if any. Note that since this is not an essential issue in this AI, it is unlikely to treat it in the GTW discussion. I hope we can converge through the offline discussion.** |
| 6.2 | Enhancement to beam update after NW response to TRP-specific BFR request | For M-DCI based MTPR, after NW response to TRP-specific BFR request to a BFD-RS set associated with a *coresetPoolIndex* value, QCL assumption/spatial Tx filter/PL-RS for channel(s)/signal(s) that applies the indicated joint/DL/UL TCI state specific to the *coresetPoolIndex* value is updated according to the new beam (qnew) corresponding to the BFD-RS set.* Support: Docomo (also S-DCI), CATT, Qualcomm, Xiaomi, OPPO, Google, Samsung, ZTE (also S-DCI), Apple, CATT, vivo, Intel (also S-DCI), FGI (also S-DCI), TCL
* Concern: Ericsson (?)

**FL note: S-DCI based MTRP case can be discussed after there is a conclusion on Issue 6.1. Note that since this is not an essential issue in this AI, it is unlikely to treat it in the GTW discussion. I hope we can converge through the offline discussion.** |
| 6.3 | Enhancement to beam reporting for STxMP | **FL note: After discussed with FL of STxMP, we prefer to handle this issue in the AI 9.1.4.1. For the discussion on this issue, please refer to AI 9.1.4.1.** |

Table 6-2 Company input for Issue 6

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| **Company** | **Input to Round 0 summary** |
| Mod V00 | * Please input your comment to Proposal 6.1, if any.
* Please also update your preference on Issue 6.2, if needed.
 |
| OPPO | **Proposal 6.1**: Supportive.**Issue 6.2**: Support. This is to reset/update the new beam in the similar way as that in Rel.17 for S-TRP using unified TCI state.  |
| QC | Proposal 6.1, support |
| Xiaomi | Proposal 6.1: support Issue 6.2: support for M-DCI based MTRP at least. |
| Google | **Issue 6.2:** Support  |
| Samsung | Issue 6.1 and Issue 6.2: support in principle |
| ZTE | We support proposal 6.1.For issue 6.2, we support to further consider the SDCI based MTRP case. In general, once a given TRP fails, QCL assumption/spatial filter corresponding to DL/UL channel/RS associated with the same configured ID/coresetPoolIndex as the failed BFD-RS set should be updated according to the new identified beam q\_new. |
| LG | Proposal 6.1: Fine |
| Apple  | Proposal 6.1: Support. Proposal 6.2: Support. This is a simple extension of Rel-17 TRP-specific BFR to apply unified TCI framework.  |
| Google2 | **Proposal 6.1:** Since we are three meetings away from completing Rel-18, we turn to not support it. As mentioned by FL, this proposal is not quite essential. Without this proposal, BFD for S-DCI M-TRP can still work. In addition, FFS parts are critical for supporting this feature. Without clear ways to resolve them, we suggest deferring the discussion.  |
| Futurewei | **Proposal 6.1:** Support in principle. |
| Spreadtrum | **Proposal 6.1:** Support. |
| Huawei, HiSilicon | **Proposal 6.1:** Support |
| CATT | Proposal 6.1: SupportProposal 6.2: Support |
| vivo | Proposal 6.1: Support.Proposal 6.2: Support. |
| Docomo | We believe BFR is very essential for FR2 operation. Especially, if we don’t update indicated joint/DL/UL TCI state after BFR completion, gNB cannot update indicated TCI state by MAC CE/DCI, because UE received the MAC CE/DCI in old/failed beam, and BFR happens again. It means system does not work to us.Proposal 6.1: Support. Proposal 6.2: Support. We agree with ZTE to discuss sDCI mTRP case as well. |
| Ericsson | Proposal 6.1: SupportIssue 6.2: Indicated TCI states are handled by the NW. A statement saying that the UE uses the qnew until it receives an update from the NW would serve the same purpose. So this could be OK with a slight reformulation. |
| Intel | **Proposal 6.1:** OK**Issue 6.2:** OK to discuss both M-DCI and S-DCI |
| FGI | **Proposal 6.1:** Support**Issue 6.2:** Support and agree to discuss sDCI case. |
| Lenovo | Proposal 6.1: Fine |
| TCL | Proposal 6.1: Support.Issue 6.2: Support. |
| **Company** | **Input to Round 1 summary** |
| Mod V00 | Proposal 6.1 will be moved to checking email for endorsement, if no further concern is raised by company |
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# Other issue

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

Table 7-1 Company inputs for other issue

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| **Company** | **Input** |
| ZTE | As agreed in RAN1#112, the maximum Tx power when the UE determines UL Tx power for the PUSCH/PUCCH transmission occasion(s) or antenna port(s) is to be discussed after receiving RAN4 reply on UE power limitation. Since RAN4 has provided their answers in R4-2303494, we prefer to prioritize the discussion about the following UL PC related issues for STxMP.

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

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

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| **RAN1#112b-e** |
| Hope we will have 10+ agreements here |
| **RAN1#112** |
| **Agreement**On unified TCI framework extension for S-DCI based MTRP, a 2-bit [TCI selection field] can be configured by RRC to be present in a DCI format 1\_1/1\_2 that schedules/activates PDSCH reception (including dynamic PDSCH and SPS PDSCH) according to the followings:* If the DCI format 1\_1/1\_2 indicates codepoint "00" for the [TCI selection field], the UE shall apply the first one of two indicated joint/DL TCI states to all PDSCH DMRS port(s) of corresponding PDSCH transmission occasions(s) scheduled/activated by the DCI format 1\_1/1\_2
* If the DCI format 1\_1/1\_2 indicates codepoint "01" for the [TCI selection field], the UE shall apply the second one of two indicated joint/DL TCI states to all PDSCH DMRS port(s) of corresponding PDSCH transmission occasions(s) scheduled/activated by the DCI format 1\_1/1\_2
* If the DCI format 1\_1/1\_2 indicates codepoint "10" for the [TCI selection field], the UE shall apply both indicated joint/DL TCI states to the PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2
* FFS: Whether and how to use the codepoint "11" of the [TCI selection field]

If the UE is in FR1, or the UE supports the capability of two default beams for S-DCI based MTRP in FR2 regardless of threshold, above apply to PDSCH reception(s) scheduled/activated by the DCI format 1\_1/1\_2. * Note: If the UE supports the capability of two default beams for S-DCI based MTRP in FR2, UE uses both indicated joint/DL TCI states to buffer the received signal before a threshold.

If the UE doesn’t support the capability of two default beams for S-DCI based MTRP in FR2, above apply to the scheduled/activated PDSCH reception when the offset between the reception of the scheduling DCI format 1\_1/1\_2 and the scheduled/activated PDSCH reception is equal to or larger than a threshold* FFS: How to apply the indicated joint/DL TCI state(s) to the scheduled/activated PDSCH reception if the offset between the reception of the scheduling DCI format 1\_1/1\_2 and the scheduled/activated PDSCH reception is less than a threshold in FR2

FFS: Detail of the capability of two default beams for S-DCI based MTRP FFS: The threshold value**Agreement**On unified TCI framework extension for S-DCI based MTRP, when two SRS resource sets for CB/NCB are configured, support the followings for PUSCH transmission scheduled/activated by a DCI format 0\_1/0\_2 (including DG and Type2 CG):* If the DCI format 0\_1/0\_2 indicates codepoint "00" for the existing SRS resource set indicator, the UE shall apply the first indicated joint/UL TCI state to all PUSCH antenna port(s) of corresponding PUSCH transmission occasions(s)
* If the DCI format 0\_1/0\_2 indicates codepoint "01" for the existing SRS resource set indicator, the UE shall apply the second indicated joint/UL TCI state to all PUSCH antenna port(s) of corresponding PUSCH transmission occasions(s)
* If the DCI format 0\_1/0\_2 indicates codepoint "10" or “11” for the existing SRS resource set indicator:
	+ For TDM based PUSCH Tx scheme, the UE shall apply the first indicated joint/UL TCI state to the PUSCH transmission occasions(s) associated with the first SRS resource set for CB/NCB, and the second indicated joint/UL TCI state to the PUSCH transmission occasions(s) associated with the second SRS resource set for CB/NCB (note: the association between an SRS resource set for CB/NCB and PUSCH transmission occasions(s) is defined according to TS 38.214)
	+ FFS: SDM and SFN based PUSCH Tx schemes

FFS: The case that the spatial Tx filter(s) determined from the indicated joint/UL TCI state(s) applied to a PUSCH transmission is different from the spatial Tx filter(s) used for the SRS transmission corresponding to the SRS resource(s) indicated to the PUSCH transmission**Agreement**On unified TCI framework extension, if an indicated joint/UL TCI state(s) applies to a PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s), the UE shall determine UL Tx power for the PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s) based on the UL PC parameter setting for PUSCH/PUCCH/SRS, if any, and the PL-RS included in the indicated joint/UL TCI state* FFS: For STxMP, the maximum Tx power when the UE determines UL Tx power for the PUSCH/PUCCH transmission occasion(s) or antenna port(s) (discussed after receiving RAN4 reply on UE power limitation for STxMP in FR2)
* FFS: Default UL PC parameter setting(s) if one or both of indicated joint/UL TCI states applied to PUSCH/PUCCH/SRS transmission occasion(s) or antenna port(s) does/do not include the UL PC parameter setting(s) for PUCCH/PUSCH/SRS

**Agreement**On unified TCI framework extension for M-DCI based MTRP, down-select from the following options for PUCCH transmission:* Opt1: A *coresetPoolIndex* value can be provided per PUCCH resource/resource group, and the UE shall apply the indicated joint/UL TCI state specific to the *coresetPoolIndex* value to the corresponding PUCCH transmission
* Opt2: An RRC configuration can be provided per PUCCH resource/resource group to inform that the UE shall apply the first or the second indicated joint/UL TCI state to the corresponding PUCCH transmission, where the first and the second indicated joint/DL TCI states correspond to the indicated joint/UL TCI states specific to *coresetPoolIndex* value 0 and value 1, respectively.
* Opt3: For a PUCCH transmission triggered by PDCCH on a CORESET when the UCI in the PUCCH transmission carries HARQ-ACK information only, the UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to the PUCCH transmission, where the *coresetPoolIndex* value is determined from the one associated with the CORESET. Otherwise, either Opt1 or Opt2 is adopted.
	+ FFS: Whether Opt3 applies only when the UE is not provided with *ackNackFeedbackMode* = *joint*
* Opt4: For a PUCCH transmission with an LRR trigged for either the first BFD-RS set ($\overbar{q}\_{0,0}$) or the second BFD-RS set ($\overbar{q}\_{0,1}$) when the UE is provided only one or two *schedulingRequestID-BFR* configuration, the UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to the PUCCH transmission, where the *coresetPoolIndex* value is 1 when the LRR is trigged for the first BFD-RS set ($\overbar{q}\_{0,0}$) and the *coresetPoolIndex* value is 0 when the LRR is trigged for the second BFD-RS set ($\overbar{q}\_{0,1}$). Otherwise, either Opt1 or Opt2 is adopted.

Note: Either Opt1 or Opt2 must be supported**Agreement**On unified TCI framework extension for S-DCI based MTRP, down-select at least one of the followings for PDSCH reception scheduled/activated by DCI format 1\_1/1\_2 configured w/o the [TCI selection field]:* Alt1: Using RRC configuration to inform that the UE shall apply the first one, the second one, or both of two indicated joint/DL TCI states to the scheduled/activated PDSCH reception
* Alt2: The UE shall apply the first one of two indicated joint/DL TCI state(s) to the scheduled/activated PDSCH reception
* Alt3: The UE shall apply both of two indicated joint/DL TCI states to the scheduled/activated PDSCH reception
* Alt3A: The UE shall apply the same joint/DL TCI state(s) that is applied to the PDCCH reception with the scheduling/activation DCI to the scheduled/activated PDSCH reception
* Alt4: Which indicated joint/DL TCI state(s) is/are applied to the scheduled/activated PDSCH reception is determined according to the existing TCI field of the most recently applied beam indication DCI

Above applies at least if the offset between the reception of the scheduling DCI format 1\_1/1\_2 and the scheduled/activated PDSCH reception is equal to or larger than a threshold (if the threshold is needed) |
| **RAN1#111** |
| **Agreement**On unified TCI framework extension for S-DCI based MTRP, in one beam indication instance, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate joint/DL/UL TCI state(s) for one or both of the two TRPs in a CC/BWP or a set of CCs/BWPs in a CC list* FFS: Increase on the size of the TCI field
* Note: The term TRP is used only for discussion purpose in RAN1 and whether/how to capture this is FFS

**Agreement**On unified TCI framework extension for S-DCI based MTRP, a DCI field in DCI format 1\_1/1\_2 that schedules/activates PDSCH reception is used to determine which one or both of the indicated joint/DL TCI states shall be applied to the scheduled/activated PDSCH reception* The presence of the DCI field is configurable by RRC; when the DCI field is not present in DCI format 1\_1/1\_2, the UE shall apply the default indicated joint/DL TCI state(s) to PDSCH reception
	+ FFS: Details on the default indicated joint/DL TCI state(s) to PDSCH reception
* FFS: The DCI field is a new indicator field or an existing field (e.g., the existing TCI field)
* FFS: Regardless the DCI field is present or not present, how to apply the indicated joint/DL TCI state(s) to PDSCH reception if the offset between the reception of the DCI format 1\_1/1\_2 and the corresponding PDSCH reception is less than a threshold

FFS: How to apply the indicated joint/DL TCI state(s) to PDSCH reception scheduled/activated by DCI format 1\_0.Above applies for the case where PDSCHs scheduled by the same DCI.**Agreement** On unified TCI framework extension for S-DCI based MTRP, use RRC configuration to inform that the UE shall apply the first one, the second one, or both of the indicated joint/UL TCI states to a PUCCH resource/group* Note: Detail of the RRC configuration is left to RAN2 design

**Agreement**On unified TCI framework extension, PDSCH-CJT is supported as a S-DCI based MTRP schemeNote: Above does not preclude discussions specific to PDSCH-CJT design in the unified TCI framework**Agreement**On unified TCI framework extension for S-DCI based MTRP, use an indicator field (could be reusing an existing DCI field or introducing a new DCI field) in the DCI format 0\_1/0\_2 to inform which joint/UL TCI state(s) indicated by MAC-CE/DCI the UE shall apply to PUSCH transmission scheduled/activated by the DCI format 0\_1/0\_2**Agreement**On unified TCI framework extension, down-select at least one of the following alternatives for PDSCH-CJT applying both indicated joint TCI states (if the UE supports two indicated joint/DL states for PDSCH-CJT):* Alt1: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA
* Alt2: PDSCH DMRS port(s) is QCLed with the DL RSs of both indicated joint TCI states with respect to QCL-TypeA except for QCL parameters {Doppler shift, Doppler spread} of the second indicated joint TCI state
* Alt3: PDSCH DMRS port(s) is QCLed with the DL RS of the first indicated joint TCI state with respect to QCL-TypeA and QCLed with the DL RS of the second indicated joint TCI state with respect to QCL-TypeB

**Agreement**On unified TCI framework extension for M-DCI based MTRP, the same configuration/rule used in Rel-17 unified TCI framework (for determining whether the UE shall apply the indicated joint/DL TCI state to PDCCH on a CORESET and respective PDSCH) is reused to determine whether the UE shall apply the indicated joint/DL TCI state specific to a *coresetPoolIndex* value to PDCCH on a CORESET associated with the same *coresetPoolIndex* value and PDSCH scheduled/activated by the PDCCH.**Agreement**On unified TCI framework extension for M-DCI based MTRP, the UE shall apply the indicated joint/UL TCI state specific to a *coresetPoolIndex* value to PUSCH transmission scheduled/activated by PDCCH (including DG-PUSCH and Type2 CG-PUSCH) on a CORESET that is associated with the same *coresetPoolIndex* value**Agreement**On unified TCI framework extension for S-DCI based MTRP, a new indicator field is supported as the DCI field in DCI format 1\_1/1\_2 that schedules/activates PDSCH reception to determine which one or both of the indicated joint/DL TCI states shall be applied to the scheduled/activated PDSCH reception* FFS: Detail design of the new indicator field
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| **RAN1#110b-e** |
| **Conclusion** On unified TCI framework extension in Rel-18, there is no consensus to support simultaneous configuration of both joint and separate DL/UL TCI modes in a serving cell**Conclusion**On unified TCI framework extension in Rel-18, there is no consensus to support separate RRC-configured TCI state list(s) for each of TRPs**Agreement**On unified TCI framework extension for M-DCI based MTRP:* The existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) associated with one *coresetPoolIndex* value can indicate the joint/DL/UL TCI state(s) specific to the same *coresetPoolIndex* value
	+ FFS: The UE shall apply the indicated joint/DL/UL TCI state(s) specific to a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the same *coresetPoolIndex* value
* A *coresetPoolIndex* value field is included in TCI state activation command (MAC-CE) to indicate that the mapping between the activated TCI state(s) and the TCI codepoint(s) is specific to which *coresetPoolIndex* value

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

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

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

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

**Agreement**On unified TCI framework extension, up to 2 joint TCI states can be indicated by MAC-CE/DCI and applied to CJT-based PDSCH reception (PDSCH-CJT) in a BWP/CC configured with joint DL/UL TCI mode* Support of 1 or 2 indicated joint TCI states for PDSCH-CJT is up to UE capability
* FFS: QCL type(s)/assumption(s) of the indicated joint TCI state(s) applied to PDSCH-CJT
* Note: On how to inform UE to apply which indicated joint TCI state(s) to target channel(s)/signal(s) in the BWP/CC, it is discussed individually in AI 9.1.1.1

**Agreement** On unified TCI framework extension for M-DCI based MTRP:* The UE shall apply the indicated joint/DL TCI state specific to a *coresetPoolIndex* value to PDCCH on a CORESET that is associated with the same *coresetPoolIndex* value
* The UE shall apply the indicated joint/DL TCI state specific to a *coresetPoolIndex* value to PDSCH scheduled/activated by PDCCH on a CORESET that is associated with the same *coresetPoolIndex* value
* FFS: Other channel(s)/signal(s) that has explicit or implicit association with a *coresetPoolIndex* value
* FFS: Other channel(s)/signal(s) that doesn’t have association with a *coresetPoolIndex* value

Above are applicable to the CORESET(s) that is configured/allowed to follow the indicated joint/DL TCI stateFFS: The configuration/rule to configure/allow CORESET(s) to follow the indicated joint/DL TCI state, including the option to reuse the same configuration/rule as in Rel-17 unified TCI framework**Agreement**On unified TCI framework extension, study the following enhancements for TRP-specific BFR:* Implicit BFD-RS determination based on the indicated joint/DL TCI states for S-DCI based MTRP
* Enhancement to beam update after NW response to TRP-specific BFR request

**Agreement**On unified TCI framework extension for S-DCI based MTRP, down-select one alternative from the followings in RAN1#111:* Alt1: In one beam indication instance, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate joint/DL /UL TCI state(s) for one of the two TRPs or both TRPs in a CC/BWP or a set of CCs/BWPs in a CC list
* Alt2: In one beam indication instance, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate joint/DL /UL TCI state(s) only specific to one of the two TRPs in a CC/BWP or a set of CCs/BWPs in a CC list
	+ Note: According to the agreement in RAN1#109-e, support of one additional TCI field or a field associating the TCI field to the TRP(s) is not precluded

Note: It has been agreed to use the existing TCI field for TCI state indication for S-DCI based MTRP in RAN1#109eNote: The term TRP is used only for discussion purpose in RAN1 and whether/how to capture this is FFSFFS: The behavior if the UE receives a beam indication DCI that indicates joint/DL/UL TCI state(s) for one TRP |
| **RAN1#110** |
| **Agreement**On unified TCI framework extension, for the target use cases agreed in RAN1#109-e in AI 9.1.1.1, up to 4 TCI states can be indicated in a CC/BWP or a set of CCs/BWPs in a CC list to DL receptions and/or UL transmissions, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation* FFS: The possible combination(s) of joint/DL/UL TCI states that can be indicated to DL receptions and/or UL transmissions in a BWP/CC/TRP
* Note: This agreement does not imply that there will be more than 2 DL or UL or joint TCI states indicated in a CC/BWP for the target use cases agreed in RAN1#109-e in AI 9.1.1.1
* Note: The maximum number of TCI states that can be indicated to each of the target use cases agreed in RAN1#109-e in AI 9.1.1.1 is remained the same as in Rel-16/17

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

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

FFS: PUSCH transmission scheduled/activated by a DCI format 0\_0 and Type-1 CG-PUSCH**Agreement**On unified TCI framework extension for S-DCI based MTRP, to inform the association with joint/UL TCI state(s) indicated by DCI/MAC-CE for PUCCH transmission, down-selection at least one alternative from the followings:* Alt1: Use RRC configuration to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/ group
* Alt2: Use RRC configuration to inform the association between a CORESET group and a PUCCH resource/group, and the indicated joint/UL TCI state(s) associated with the CORESET group applies to the PUCCH resource/group
* Alt3: Use MAC-CE to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/group
* Alt4: Use DCI to inform the association between the indicated joint/UL TCI state(s) and a PUCCH resource/group
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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

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