**3GPP TSG RAN WG1 #112bis-e R1-** **2303806**

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

**Agenda item:** 9.1.1.1

**Source:** Moderator (MediaTek)

**Title:** Summary of pre-meeting offline discussion on extension of unified TCI framework

**Document for:** Discussion

For better progress and convergence in RAN1#112bis, this pre-meeting offline is triggered for some issues that have been discussed in the last meeting. I would suggest to conclude on these issues ASAP so that we can have more time to handle other important issues (especially Issue 3 and 4) in RAN1#112bis. Thus, I'd appreciate it if you can share your views and comments on the issues and corresponding proposals in this pre-meeting offline. This offline discussion will be closed **@Wednesday 5th April, 11:59 pm UTC**.

# Discussion

# Issue 2 – TCI state update and activation

Table 2-1 Summary for Issue 2

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| **#** | **Issue** | **Companies’ view and summary** |
| 2.1 | Combinations of joint/DL/UL TCI states that can be mapped to a TCI codepoint of the existing TCI field for S-DCI based MTRP, and corresponding UE behaviors | **FL note: Based on the previous RAN1 agreement, it should be able to use the existing TCI field in DCI format 1\_1/1\_2 to indicate joint/DL/UL TCI state(s) for one of the two TRPs or both TRPs. Thus, Proposal 2.1 is recommended accordingly:****Proposal 2.1:** 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, one or two joint 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)
* For a serving cell configured with separate DL/UL TCI mode, one or two DL TCI states and/or one or two 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)
* The indicated joint/DL/UL TCI state(s) is updated according to the joint/DL/UL TCI state(s) mapped to a TCI codepoint received by the UE
* FFS: If the UE receives a TCI codepoint mapped with one single joint TCI state in a serving cell configured with joint DL/UL TCI mode, or receives a TCI codepoint mapped with one single DL and/or UL TCI state in a serving cell configured with separate DL/UL TCI mode, whether the UE shall switch to single TRP operation in the serving cell?
* FFS: Whether TCI state activation command (MAC-CE) should indicate the followings?
	+ For a serving cell configured with joint DL/UL TCI mode, each activated joint TCI state in TCI state activation command corresponds to the 1st joint TCI state or 2nd joint TCI state.
	+ For a serving cell configured with separate DL/UL TCI mode, each activated DL/UL TCI state in TCI state activation command corresponds the 1st DL TCI state, 1st UL TCI state, 2nd DL TCI state, or 2nd UL TCI state.
	+ Note: Detail on how to indicate above is up to RAN2 design

Question 1: Yes or No to the 1st FFS in Proposal 2.1* Yes: vivo, Xiaomi, QC, Fujitsu
* No: ZTE, Huawei, HiSilicon, Docomo, CMCC, Apple, Sharp, NEC, LG, IDC, FGI, Futurewei, OPPO, Samsung

Question 2: Yes or No to the 2nd FFS in Proposal 2.1* Yes: ZTE, Huawei, HiSilicon, Fujitsu, Apple, Sharp, NEC, IDC, FGI, OPPO
* No: vivo, Xiaomi, QC, Docomo, CMCC, Samsung
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| 2.2 | Timeline to apply the indicated joint/DL/UL TCI state(s) to channels/signals | Question 1: In Rel-18 unified TCI framework extension for MTRP operation, whether 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 is updated based on the Rel-17 beam application time?* Yes: Xiaomi, Google, Docomo, OPPO, IDC, QC, Apple, ZTE, Panasonic, Sharp, CEWiT, Huawei, Fujitsu, NEC, LG, FGI, Futurewei
* No:

**FL note: Based above feedback from RAN1#112 meeting, the following proposal is recommended:****Proposal 2.2**: 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 |

Table 2-2 Company inputs for Issue 2

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| --- | --- |
| **Company** | **Input** |
| Mod V00 | * Please check Proposal 2.1 and Proposal 2.2
* Please also share your view on the two questions under Proposal 2.1
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| ZTE | Our views are provided. Then, regarding proposal 2.1, in our views, we need to support separate update of TCI state per TRP in S-DCI/M-DCI based operation. Then, how to distinguish S-DCI from sTRP operation, it should be based on: more than one DL/joint-TCI state for at least one TCI codepoint is activated in MAC-CE or a new MAC-CE type. Then, we are fine to clarify the above.  |
| vivo | Proposal 2.1: Fine.Q1: Yes.Q2: Not needed if yes to the 1st FFS.In our view, the UE shall switch to single TRP operation if the UE receives a TCI codepoint mapped with one single joint TCI state or one single DL and/or UL TCI state. Depending on the number of indicated TCI states, dynamic switching between STRP operation and MTRP operation for all channels can be easily achieved.Proposal 2.2: Support in principle. The wording in the note needs to be updated to reflect the TCI state selection for each channel/RS.Note: The UE shall apply one or both indicated joint/DL/UL TCI state(s) that is the most recently updated to the DL reception or UL transmission in each slot |
| Panasonic | For proposal 2.1, we think that the first two bullet points are already supported, and the third bullet adds no new information and not needed as well. This leaves us with the two FFS, so we prefer to discuss the proposal in the FL summary in RAN1#112. Basically, we think that there are two methods: merge or overwrite. So, RAN1 needs to pick one or make it configurable. We prefer the merge method or making it configurable. Proposal 2.2: Support |
| Xiaomi | We are fine with proposal 2.1. For the first FFS, we slightly prefer to switch to STRP since if not, gNB can’t switch all channels to STRP transmission at the same time. For the second FFS, since if S-TRP will be assumed when there is TCI state for only one TRP, it is unnecessary to indicate the mapping. Proposal 2.2: Support.  |
| Huawei, HiSilicon | **Proposal 2.1****For the first question**: No. When a subset of indicated TCI states is updated by MAC-CE/DCI, that subset of indicated TCI states replace the currently-used ones. The other part of the indicated TCI states remains unchanged, rather than being dropped. Such principle was adopted since in R17. For example, in sTRP case, when only a DL TCI state is indicated, the indicated DL TCI state is used to replace the currently-used DL TCI state. The UL TCI state remains unchanged and used for subsequent transmissions. **For the second question**: Yes. UE should know each indicated TCI state is for the first TRP or second TRP. Such information should be contained in the MAC-CE. Otherwise, if, for instance, only one joint TCI state is updated in MAC-CE/DCI, UE wouldn’t know it should replace which of the two currently-used joint TCI states. However, how to carry such information in the MAC-CE depends on MAC-CE format design in RAN2. RAN1 can agree on this and suggest such principle to RAN2.**Proposal 2.2**Support without the Note. The Note may be misinterpreted as only the subset of indicated TCI states that are most recently updated in MAC-CE/DCI are used and UE does not retain the currently-used indicated TCI states that are not updated in the last MAC-CE/DCI.  |
| QC | For Proposal 2.1, Q1: Yes, Q2: No. We think DCI based sTRP/mTRP sticky switch is more efficient/faster than MAC-CE based switch, which also needs new MAC-CE designFor Proposal 2.2, support without the Note. No spec change on the application time to our understanding |
| Docomo | For Proposal 2.1, Q1: No, we have same view as Huawei (*When a subset of indicated TCI states is updated by MAC-CE/DCI, that subset of indicated TCI states replace the currently-used ones. The other part of the indicated TCI states remains unchanged, rather than being dropped. Such principle was adopted since in R17.*).Q2: No. MAC CE does not need to indicate {1st, 2nd} of the indicated TCI states. If MAC CE contains two DL TCI state IDs, it means 1st TCI state ID is 1st TCI state and 2nd TCI state ID is 2nd TCI state. It is impossible to update 2nd TCI state ID only. However, if gNB wants to update 2nd TCI state, gNB can indicate both 1st and 2nd TCI state IDs.In Rel.17 MAC CE for unified TCI state, TCI state ID has 7-bit and “D/U” field has 1-bit. If we introduce 1 more bit for indication of {1st, 2nd} field, it increases the number of octet (i.e. MAC CE overhead). Proposal 2.2, Support. But, the note looks not accurate. If [TCI selection field] is configured, one or both TCI states are selected/applied based on the TCI selection field. So, we prefer to use “update” instead of “apply”.* Note: The UE shall update ~~apply~~ one or both indicated joint/DL/UL TCI state(s) that is the most recently updated to the DL reception or UL transmission in each slot
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| Fujitsu | Proposal 2.1: Support.Q1: Yes. And if it is supported, it seems necessary to introduce a mechanism to avoid confusion between STRP/MTRP switching and TCI state updating.Q2: YesProposal 2.2: Support |
| CMCC | Proposal 2.1: Support the first three bullets.Regarding the first FFS: Not support. Based on the previous agreement, it is able to use the existing TCI field in DCI format 1\_1/1\_2 to indicate joint/DL/UL TCI state(s) for one of the two TRPs or both TRPs, the flexibility of dynamic switching between S-TRP and M-TRP has been realized by 2-bit [TCI selection field]. Besides, in most cases, only one TCI state needs to be updated for one of the TRP, and the other TCI state for the other TRP still works well. Then, if the UE receives a TCI codepoint mapped with one single joint/DL/UL TCI state, UE should know whether this is used to update the first or the second TCI state, and the UE shall apply the joint/DL/UL TCI state in the TCI codepoint while keeping the currently applied joint/DL/UL TCI state not in the codepoint, and UE still works in M-TRP transmission scheme.Regarding the first FFS: Not support. 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, then 9-16 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, to consider the overhead of DCI, the 2-bit [TCI selection field] can be further reused to indicate the mapping. For example:* 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 joint TCI states to all PDSCH DMRS port(s) of corresponding PDSCH transmission occasions(s) scheduled/activated by the DCI format 1\_1/1\_2, AND, if only one joint TCI state is mapped to a TCI codepoint of the TCI field, then the indicated joint TCI state corresponds to update the 1st joint TCI state, and keeps the 2nd TCI state for the other TRP.
* 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 joint TCI states to all PDSCH DMRS port(s) of corresponding PDSCH transmission occasions(s) scheduled/activated by the DCI format 1\_1/1\_2, AND, if only one joint TCI state is mapped to a TCI codepoint of the TCI field, then the indicated joint TCI state corresponds to update the 2nd joint TCI state, and keeps the 1st TCI state for the other TRP.
* If the DCI format 1\_1/1\_2 indicates codepoint "10" for the [TCI selection field], the UE shall apply both joint TCI states to all PDSCH DMRS port(s) of corresponding PDSCH transmission occasions(s) scheduled/activated by the DCI format 1\_1/1\_2, AND, if only one joint TCI state is mapped to a TCI codepoint of the TCI field, then the indicated joint TCI state corresponds to update the 1st joint TCI state, and keeps the 2nd TCI state for the other TRP.
* If the DCI format 1\_1/1\_2 indicates codepoint "11" for the [TCI selection field], the UE shall apply both joint TCI states to all PDSCH DMRS port(s) of corresponding PDSCH transmission occasions(s) scheduled/activated by the DCI format 1\_1/1\_2, AND, if only one joint TCI state is mapped to a TCI codepoint of the TCI field, then the indicated joint TCI state corresponds to update the 2nd joint TCI state, and keeps the 1st TCI state for the other TRP.

Proposal 2.2: Support. |
| Apple  | **Proposal 2.1*** Q1: No. The switching between mTRP and sTRP can be operated on a per channel basis and the MAC-CE is used to update a ‘common’ pool for DL or UL or both. More importantly, using a subset of TCI-state combination to update improves the TCI-state update flexibility to certain degree; Otherwise, 3-bit TCI field with up to 8 TCI-states combination is too restrictive in our opinion.
* Q2: Yes. We are open to use MAC-CE or a 1-bit field in DCI to indicate how to update the TCI-state for subset case.

**Proposal 2.2**Support with removing the NOTE as it creates some confusion as HW commented.  |
| Sharp | **Proposal 2.1*** Q1: No. If the UE receives a TCI codepoint mapped with one single joint TCI state for a TRP, the UE should update the indicated joint TCI state for the TRP and keep other indicated joint TCI state for other TRP. Switching between STRP and MTRP operations can be done by new TCI selection scheme (e.g., TCI selection field).
* Q2: Yes.

**Proposal 2.2**Support |
| NEC | **Proposal 2.1:** support in principle.* Q1: No.
* Q2: Yes.

**Proposal 2.2:** Support. |
| LG | **Proposal 2.1:** * Q1: No. Similar view with Huawei and CMCC where the existing TCI field in DCI format 1\_1/1\_2 to indicate joint/DL/UL TCI state(s) for one of TRPs or both TRPs. Regarding the dynamic STRP/MTRP switching on channels, it is based on TCI indication field for PDSCH and SRS set selection field for PUSCH, respectively.

**Proposal 2.2:** Fine with the proposal |
| IDC | **Proposal 2.1:*** Q1: No. (Not indicated TCI state should remain unchanged)
* Q2: Yes. (This is needed so that UE can identify each indicated TCI state is for which TRP)

**Proposal 2.2:** Support, and the ‘Note’ is needed for clear agreement on UE behavior, as we think here the important term is “in each slot”. So, basically, **in each slot (for the DL reception or UL transmission)**, the UE shall apply whatever the most recently updated one(s) (for each TRP perspective). For example, if the UL transmission is scheduled across two (or multiple) consecutive slots, the Note clarifies that the first slot and the second slot may apply different joint/UL TCI state if a beam application time elapsed on the first slot, meaning the beam update happens in the middle of multiple UL transmission occasions, etc. We think Huawei’s concern (whether to retain the not-indicated one) is not the intension of the Note. So, to address Huawei’s concern, the following further clarification may be considered for the Note:**Further clarification on the Note (highlighting “in each slot” and to address Huawei’s question):*** Note: The UE shall apply, to DL reception or UL transmission in each slot, one or both indicated joint/DL/UL TCI state(s) that is/are the most recently updated, where the update can be done either by one TCI field of a DCI or by individual updates via different TCI codepoints indicated by different DCIs.
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| Mod V16 | Proposal 2.1: Remove the note from Proposal 2.2 due to concern from many companies. Add “in each slot” in the main bullet to address the concern from IDC. |
| FGI | **Proposal 2.1:*** Q1: Not support. The switching between sTRP and mTRP can rely on different ways (e.g., another DCI field or by RRC configuration) other than receiving a TCI codepoint mapped with one single TCI since its just only one TCI state needs to be updated upon mTRP operation.
* Q2: Yes. Using MAC CE as one of selection indication might be helpful.

**Proposal 2.2:** Support with FL’s update. |
| Intel | **Proposal 2.1:** In our view, the two FFS points should be settled first before agreeing to Proposal 2.1. We cannot agree with the proposal unless the behavior reflected in the FFS is clarified first. **The first question:** We can support updating of one of the two TCI of the two indicated TCI states when a UE receives a codepoint mapped to single TCI state. However, this implies two things – (1) the UE is signaled somehow that this indicated single TCI state is the first or second TCI, and (2) legacy switching to sTRP which was done using the number of TCI states mapped to a codepoint is not supported. The first issue can be handled by the second question, but we should first settle the issue of switching to sTRP and how is it enabled. If following legacy, the answer to this question is “NO”. We are OK with answering “YES” only if it is clarified how dynamic switching to sTRP works in this case. **The second question:** We are OK with MAC-CE providing the TCI state grouping explicitly i.e., whether the single TCI state is the first or second TCI state. Detailed MAC-CE design is up to RAN2. **Proposal 2.2:**  OK in general but similar comment as Huawei above on the note. It should be clarified that UE applies the “current” indicated joint/DL/UL TCI state(s). Note that the current indicated TCI state could also be a single TCI if dynamic switching to sTRP is supported.  |
| Futurewei | **Proposal 2.1:** Q1: No. We have similar view to other companies that Rel. 17 principle should be reused when just a subset of the indicated TCI states is updated by MAC-CE/DCI. **Proposal 2.2:** Support FL’s updated proposal. |
| Samsung | **Proposal 2.1**: The order of the discussions is backward. We prefer to first address the issue of identifying TRPs in SDCI. If this issue can be addressed: (1) how to identify the first or second when an indicated TCI codepoint comprising a single TCI state, and (2) how to differentiate between STRP and SDCI MTRP operations, can be addressed together. We do not think that agreeing on the first three main bullets of this proposal is more pressing than addressing the above issue.Q1: No. We do not think another layer of DCI based switching is needed.Q2: A simple solution to indicate/differentiate between the “1st” and the “2nd” is to have RRC-level resource (e.g., TCI state) grouping. **Proposal 2.2**: Support.  |
| OPPO | **Proposal 2.1**: we add our answers to Q1 and Q2 in above table. **Proposal 2.1**: okay. |
| Mod Final | * Proposal 2.1: For M-DCI based MTRP, we have the following agreement in RAN1#110b for the supported mapping between TCI codepoint(s) and joint/DL/UL TCI state(s). Thus, it is reasonable at least to me to have a similar one for SDCI based MTRP as well, which could be important for RAN2 design on TCI state activation MAC-CE.

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| **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)
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* Q1 in Issue 2.1: The following is current situation:
* Yes: vivo, Xiaomi, QC, Fujitsu
* No: ZTE, Huawei, HiSilicon, Docomo, CMCC, Apple, Sharp, NEC, LG, IDC, FGI, Futurewei, OPPO, Samsung

Based on the feedback to this question so far, the following conclusion will be proposed in Round 0 summary.**Conclusion 2.1**: On unified TCI framework extension, there is no consensus to support dynamic switching between single-TRP operation and multi-TRP operation for channels/signals based on the existing TCI field in DCI format 1\_1/1\_2* Q2 in Issue 2.1: The following is current situation:
* Yes: ZTE, Huawei, HiSilicon, Fujitsu, Apple, Sharp, NEC, IDC, FGI, OPPO
* No: vivo, Xiaomi, QC, Docomo, CMCC, Samsung

It seems this issue requires more discussion since there are different schemes (e.g., RRC grouping, MAC-CE/DCI indication) proposed by companies. The following updated proposal will be provided in Round 0 summary.**Proposal 2.1:** 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, one or two joint 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)
* For a serving cell configured with separate DL/UL TCI mode, one or two DL TCI states and/or one or two 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)
* The indicated joint/DL/UL TCI state(s) is updated according to the joint/DL/UL TCI state(s) mapped to a TCI codepoint received by the UE
* FFS: Whether and how to indicate/determine the followings
	+ For a serving cell configured with joint DL/UL TCI mode, each activated joint TCI state in TCI state activation command corresponds to the 1st joint TCI state or 2nd joint TCI state.
	+ For a serving cell configured with separate DL/UL TCI mode, each activated DL/UL TCI state in TCI state activation command corresponds the 1st DL TCI state, 1st UL TCI state, 2nd DL TCI state, or 2nd UL TCI state.
* Proposal 2.2: The following proposal w/o further update will be provided in Round 0 summary:

**Proposal 2.2**: 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 |

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

A summary of the TCI selection scheme for each target channel/signal according to current agreements is provided in Table 3-0 as reference, including both S-DCI and M-DCI operations.

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

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| --- |
| **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) |
| 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: whether to use the codepoint “11”) |
| 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 | Down-selection in RAN1#112bis |
| PDSCH scheduled/activated by DCI format 1\_1/1\_2 before threshold (for the UE doesn’t support the capability of two default beams for S-DCI based MTRP in FR2) | No | To be discussed in RAN1#112bis |
| 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: codepoint "10" or “11” for SDM and SFN based PUSCH Tx schemes) |
| PDSCH scheduled/activated by DCI format 1\_0 (including DG and SPS)PUSCH scheduled/activated by DCI format 0\_0 (including DG and Type2 CG) | No | To be discussed in RAN1#112bis |
| Type1 CG-PUSCH | No | To be discussed in RAN1#112bis |
| PUCCH | Yes | RRC configuration per PUCCH resource/resource group |
| AP CSI-RS for CSI/BM | No | To be discussed in RAN1#112bis |
| SRS for CB/NCB/AS and AP SRS for BM | No | To be discussed in RAN1#112bis |
| **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 |
| Type1 CG-PUSCH | No | To be discussed in RAN1#112bis |
| PUCCH | No | Down-selection in RAN1#112bis |
| AP CSI-RS for CSI/BM | No | To be discussed in RAN1#112bis |
| SRS for CB/NCB/AS and AP SRS for BM | No | To be discussed in RAN1#112bis |

Table 3-1 Summary for Issue 3

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| **#** | **Issue** | **Companies’ view and summary** |
| 3.1 | PDSCH/PUSCH scheduled/activated by fallback DCI (DCI format 1\_0/0\_1) in S-DCI based MTRP operation | **Proposal 3.1:** On unified TCI framework extension for S-DCI based MTRP:* The UE shall apply the first indicated joint/DL TCI state to PDSCH reception scheduled/activated by DCI format 1\_0 (including DG and SPS) [if the UE is not configured with PDSCH-SFN and PDSCH-CJT]
* [The UE shall apply both first and second indicated joint/DL TCI states to PDSCH reception scheduled/activated by DCI format 1\_0 (including DG and SPS) if the UE is configured with PDSCH-SFN or PDSCH-CJT]
* The UE shall apply the first indicated joint/UL TCI state to PUSCH transmission scheduled/activated by DCI format 0\_0 (including DG and Type2 CG)

Question 1: For UE configured with and without PDSCH-SFN and PDSCH-CJT, whether to introduce different behaviors for PDSCH reception scheduled/activated by DCI format 1\_0?* Yes: vivo, QC, Docomo, CMCC, Sharp, OPPO
* No: ZTE, Fujitsu
 |
| 3.2 | AP CSI-RS for CSI/BM in S-DCI based MTRP | **FL note: I would suggest making down-selection in RAN1#112bis instead of just listing/ agreeing on the alternatives. Please share your preference on Alt1 and Alt2 in Proposal 3.2.****Proposal 3.2:** On unified TCI framework extension for S-DCI based MTRP, if *QCL-Info* is absent in *CSI-AssociatedReportConfigInfo* of *CSI-AperiodicTriggerState* for an aperiodic CSI-RS resource set configured for CSI/BM, down-select one from the following alternatives:* Alt1: An RRC configuration is provided in *CSI-AssociatedReportConfigInfo* of *CSI-AperiodicTriggerState* for the aperiodic CSI-RS resource set to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the aperiodic CSI-RS resource set
* Alt2: For aperiodic CSI-RS for enhanced group-based beam reporting or NCJT CSI measurement, the indicated joint/DL TCI state applied to the aperiodic CSI-RS is determined based on a fixed rule. Otherwise, an RRC configuration is provided in *CSI-AssociatedReportConfigInfo* of *CSI-AperiodicTriggerState* for the aperiodic CSI-RS resource set to inform that the UE shall apply the first or the second indicated joint/DL TCI state to the aperiodic CSI-RS resource set.

Question 1: Preference on the alternatives in Proposal 3.2* Alt1: ZTE (but not support the condition in main bullet), vivo, QC, Fujitsu, Sharp, Docomo, IDC, OPPO, Samsung, Intel
* Alt2: vivo, Huawei, HiSilicon, CMCC, Apple, LG, FGI, Futurewei
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Table 3-2 Company inputs for Issue 3

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| --- | --- |
| **Company** | **Input** |
| Mod V00 | * Please share your view on the question under Proposal 3.1
* Please share your preference on Alt1 and Alt2 in Proposal 3.2
 |
| ZTE | Proposal 3.1: No support. We have a strong concern on changing the legacy behavior that different TRPs can use DCI format 1\_0 to schedule a PDSCH in FR1 and FR2 with scheduling offset > a threshold. As a fall-back mode, we should guarantee the basic function of per-TRP transmission in S-DCI based MTRP. In short, we think that, “UE shall apply the indicated joint/DL TCI state corresponding to the scheduled PDCCH/CORESET” as a starting point, and then we may consider the first bullet for FR2 and a scheduling offset < a threshold.Proposal 3.2: We support Alt1, but the main bullet seems not to be needed. Why we need to explicit mention that ‘*QCL-Info* is absent in *CSI-AssociatedReportConfigInfo* of *CSI-AperiodicTriggerState* for an aperiodic CSI-RS resource set configured for CSI/BM’. In our views, we only need specify the corresponding new behavior as what we did for CORESET, PDSCH, etc.   |
| vivo | Proposal 3.1: We support the proposal on the first bullet, and we also think PDSCH-CJT shall follow the first bullet.When PDSCH-SFN is configured, we think the behavior should depend on whether UE supports dynamic switching of SFN with STRP or not. If UE supports dynamic switching of SFN with STRP, the UE shall apply the first indicated joint/DL TCI state for PDSCH-CJT reception. Otherwise, the UE shall apply both indicated joint/DL TCI states.Proposal 3.2: We think both Alts have advantages and can be supported. |
| Panasonic | Proposal 3.1: There is legacy behavior change, so we prefer to further discuss. Proposal 3.2: For Alt1, we think RRC configuration should be per CSI-RS resource instead of resource set.  |
| Xiaomi | Proposal 3.1: we can take the legacy mechanism, i.e., apply same TCI state as CORESET if the CORESET follows the unified TCI state as a starting point. And we suggest to separate the discussion on PDSCH and PUSCH. In addition, since PUSCH-SFN has been supported and it is also possible to differentiate the UE behavior with/without configuration of PUSCH-SFN.Proposal 3.2: support Alt 1 at least |
| Huawei, HiSilicon | Proposal 3.1: Further discussion seems to be required. We prefer to keep the legacy behaviour as much as possible for SFN. For CJT reception, the UE behaviour should be similar to that of SFN reception. Question 1: The question is unclear. Proposal 3.2: Support Alt 2. Alt 1 cannot work. For NCJT CSI measurement, one or two resource pairs can be configured by *cmrGroupingAndPairing-r17* in a resource set where each resource pair includes two CSI-RS resources. Since the two CSI-RS resources are used for channel measurement of different TRPs, they should adopt different indicated joint/DL TCI states. In particular, if QCL-Info is not provided for the CSI-RS resources of the resource set, the first and the second indicated joint/DL TCI state should be applied to the first and the second CSI-RS resources in the resource pair, respectively. Therefore, Alt1 which assign the same TCI state to all resources in the same CSI-RS resource set cannot work.  |
| QC | For Proposal 3.1, support. Q1: Yes. Using 1st TCI can be a unified solution for different cases.[Mod] I guess your answer is “no” to Q1 if using a unified solution for different cases is your preference.For Proposal 3.2, prefer Alt1. Alt2 is only for group based or NCJT report, and not clear why the fixed rule is needed. |
| Docomo | Proposal 3.1: Support with adopting texts in [ ]. For SFN, since we have legacy behavior, we should not change it as much as possible. When PDSCH-SFN is configured, 1st TCI or both TCI depend on whether UE supports dynamic switching of SFN with STRP or not. If UE supports dynamic switching of SFN with STRP, the UE shall apply the 1st or both of indicated joint/DL TCI state depending on the number of the scheduling CORESET. Otherwise, the UE shall apply both indicated joint/DL TCI states.Proposal 3.2: Prefer Alt.1 (RRC based). Based on the proposal, the triggering DCI can indicate one of {1st, 2nd} indicated TCI state by CSI request field. There is an issue of buffering.Similar to PDSCH, UE may receive A-CSI-RS before finishing the DCI decoding of the triggering DCI. Hence, default QCL was defined for PDSCH/A-CSI-RS in Rel.17. In Rel.18, if all UEs buffer received signal with both indicated TCIs, it is fine that the triggering DCI selects 1st or 2nd indicated TCI. However, it was agreed that buffering of two indicated TCI states for PDSCH is optional UE capability, and if UE does not support the capability, it is not possible to select {1st, 2nd} indicated TCI by the triggering DCI. Hence, the proposal can be applied when the triggering offset > threshold or when UE supports the capability of buffering two indicated TCI states. If not, we need to discuss separately. |
| Fujitsu | Proposal 3.1: Support. Q1: No. We think it is important to keep the rule simple for PDSCH/PUSCH scheduled/activated by fallback DCI.Proposal 3.2: Alt 1 is preferred, as in our view, RRC configuration per CSI-RS resource set could cover the case of enhanced group-based beam reporting in Alt 2. |
| CMCC | Proposal 3.1: Support. For PDSCH-SFN or PDSCH-CJT, apply both first and second indicated joint/DL TCI states is aligned with the channel of PDSCH and improve channel estimation performance. For other cases, S-TRP transmission can be assumed for PDSCH reception, and whether 1st TRP or 2nd TRP is transmission can be left to gNB implementation depending on the 1st TCI state indication.Proposal 3.2: Support Alt2. Similar as when two SRS resource sets for CB/NCB are configured (for PUSCH STxMP), a pre-define the mapping rule has been agreed in AI 9.1.4.1 in RAN1#111, that the first SRS resource set is associated with coresetPoolIndex value 0 and the other SRS resource set is associated with coresetPoolIndex value 1. For aperiodic CSI-RS for enhanced group-based beam reporting or NCJT CSI measurement, a pre-defined rule can be also considered. |
| Apple  | **Proposal 3.1:** Further discuss. Our preference is to introduce a unified design for all cases without ‘TCI selection field’, which include DCI format 1\_1 and 1\_2 by RRC configuration as well as fallback DCI case. This is clearly advantage in many aspects e.g., standard/implementation/test efforts. On the detailed mechanism, RRC signaling can be used to select one from ‘the first’ or ‘the second’ or both based on the UE capability e.g., whether support two default beams or not.For the 2nd bullet, our preference is to keep the legacy TCI-state determine rule defined for SFN-PDSCH. **Proposal 3.2:** Our preference is Alt.2, which is advantageous in terms of RRC signaling overhead compared to Alt.1 for group-based reporting and NCJT CSI measurement. Note that Alt.2 is NOT a fixed rule, it is sort of combination of ‘Alt.1 + fixed rule’ for different cases.  |
| Sharp | Proposal 3.1: We generally support the proposal. For PUSCH, we are fine with the proposal at least in a case that STxMP is not supported.Proposal 3.2: Support Alt 1 that is simpler than Alt 2. |
| NEC | **Proposal 3.1:** Not support. It is not aligned with the design principle of legacy default assumption and we need further discussions. **Proposal 3.2:** Alt.1 can work and with correct configurations the effect is just the same as what Alt.2 says. |
| LG | Proposal 3.1: Similar view with ZTE to keep the legacy behavior as a fall-back DCI with per-TRP transmission in S-DCI based MTRP.Proposal 3.2: To our understanding on TCI state applicability for CSI-RS, extending per-resource configuration is required at least in case of NCJT CSI since two TRPs use resource pairing within one set. While keeping the principle of Rel-17 unified TCI framework, special handling for NCJT CSI needs to be considered. |
| IDC | **Proposal 3.1:** Needs more discussions considering legacy behavior. **Proposal 3.2:** Alt.1 is preferred which is simpler.  |
| Mod V16 | Proposal 3.2: Based on above comments, it seems Alt1 may not be able to properly support two beams applying to a CSI-RS resource set configured with two Resource Groups for NCJT CSI, which are associated with different TRPs, respectively. Could opponents of Alt2 clarify more how to support NCJT CSI based on Alt1?  |
| FGI | **Proposal 3.1:** We prefer to have a similar solution as the default behavior when TCI selection field is absent.**Proposal 3.2:** Alt 2 is preferred. |
| Intel | **Proposal 3.1:** Can be further discussed. We prefer to keep legacy behaviour. Answer to Q1 is NO**Proposal 3.2:** We prefer RRC based rules for all cases. For the same reason as Docomo pointed out, if a UE does not support buffering on two beams and for cases before a threshold, we need to further discuss. However, the current formulation it is not clear to us i.e., how are the listed alternative addressing the same issue? It seems Alt-1 missed the NCJT CSI and group-based beam reporting case altogether. |
| Futurewei | **Proposal 3.1:** More discussions are needed considering legacy behavior and default behavior when TCI selection field is absent.**Proposal 3.2:** We prefer Alt 2. As pointed out by other companies and FL, Alt 1 does not work for NCJT CSI case where different joint/DL TCI state associated with different TRP should be applied to each CSI-RS resource of a resource pair, respectively, within the same CSI-RS resource set.  |
| Samsung | **Proposal 3.1**: we prefer to have unified behaviors for various transmission options that have similar ingredients. The discussions of fallback DCI were originated from the discussions of when [TCI selection field] is not configured/present – so it would be much simpler from system design perspective to discuss them together and have a common design.**Proposal 3.2**: prefer to have RRC based method in place first.  |
| OPPO | **Proposal 3.1**: regarding Q1, we add our preference in above table. **Proposal 3.2**: fine to down select in this meeting. Regarding Q1, we prefer Alt1. As for Alt.2 it seems the connection between group-based beam reporting and a so-called fixed rule is unclear and unnecessary.  |
| Mod Final | * Proposal 3.1: It seems more discussions are necessary. An updated proposal according to the comments will be provided in Round 0 summary.
* Proposal 3.2: Views on the two alternatives are quite diverse. An updated proposal according to the comments will be provided in Round 0 summary to seek whether there is a common ground.
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# Issue 5 – PDSCH-CJT

Table 5-1 Summary for Issue 5

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| --- | --- | --- |
| **#** | **Issue** | **Companies’ view and Recommended Proposal** |
| 5.1 | Switching between CJT Tx scheme and other S-DCI based PDSCH Tx scheme(s) | Question 1: Whether to support dynamic switching between PDSCH-CJT and S-DCI based PDSCH SDM/FDM/TDM/SFN Tx schemes* Yes: ZTE
* No: Xiaomi, QC, Google, Huawei, HiSilicon, Docomo, Lenovo, vivo, NEC, CATT OPPO, Fraunhofer, Intel, Fujitsu, LG, IDC

**FL note: Based above feedback from RAN1#112 meeting, the following proposal is recommended:****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 other S-DCI based PDSCH Tx schemes is not supported |

Table 5-1 Company inputs for Issue 5

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V00 | * Please check Proposal 5.1
 |
| ZTE | Technically speaking, for a PDSCH reception, we do NOT identify UE complexity increase for dynamic switching between PDSCH-CJT and S-DCI based PDSCH SDM (NCJT)/SFN/TDM (also, we do not identify a clear technical motivation of having FDM and SFN herein).* For CJT and PDSCH SDM (NCJT)/SFN, it seems to be almost spec-transparent. Do we miss anything?
* For CJT and TDM, if having TDM repetition naturally, why we need to preclude TDM herein.
 |
| vivo | Proposal 5.1: Please note that not all S-DCI based PDSCH Tx schemes are RRC configured, e.g., SDM scheme. Thus, we suggest to address the PDSCH-CJT in other way:On unified TCI framework extension for S-DCI based MTRP, PDSCH-CJT Tx scheme is RRC configured. |
| Xiaomi | Support  |
| Huawei, HiSilicon | Support |
| QC | Support |
| Docomo | Support. We don’t have concern on the dynamic switching, but we don’t see it is useful. |
| Fujitsu | Proposal 5.1: If our understanding is correct, it seems transparent to UE whether it is PDSCH-CJT or PDSCH-SFN. We are not sure whether it is appropriate to say it is switching between PDSCH-CJT and PDSCH-SFN.[Mod] To my understanding to current agreements, PDSCH-CJT will be an individual Tx scheme supported in Rel-18, and NW needs to explicitly configure the Tx scheme. |
| CMCC | Proposal 5.1: Support. |
| Apple  | Support  |
| Sharp | Support |
| LG | Support |
| IDC | Support |
| Mod V16 | Proposal 5.1 is updated according to comment from vivo |
| FGI | Support |
| Intel | Support |
| Futurewei | Support |
| OPPO | Support |
| Mod Final | The following proposal w/o further update will be provided in Round 0 summary:**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 other S-DCI based PDSCH Tx schemes is not supported |

# Other issue

Table 5-1 Company inputs for other issue

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| --- | --- |
| **Company** | **Input** |
| Mod V00 | If there is any important issue not captured in the discussion of previous meetings, company can input to this table. |
| 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.

|  |
| --- |
| **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
 |

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
 |
| 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
 |
| 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 2.1We 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#112

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| --- |
| **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. |