**3GPP TSG RAN WG1 #110 R1-2207928**

**Toulouse, France, August 22nd – 26th, 2022**

**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

# Issue 1 – General framework for unified TCI extension

**Proposal 1.A**: On unified TCI framework extension, up to X (X > 1) joint/DL TCI states can be applied simultaneously to CJT-based PDSCH reception, where the UE shall assume that the PDSCH DM-RS port(s) is QCLed with the DL RSs of the joint/DL TCI states

* FFS: Whether this can be supported based on current specification (e.g., PDSCH-SFN) w/o change
* FFS: PDSCH DM-RS port(s) is QCLed with the more than one joint/DL TCI states with what QCL type(s)
* FFS: RAN1 to make decision in RAN1#110bis-e on the value of X
* Note: CJT in Rel-18 targets only FR1

**Updated Proposal 1.B-1:**

On unified TCI framework extension, at least for the target use cases agreed in RAN1#109-e in AI 9.1.1.1, up to 4 TCI states can be indicated in a CC/BWP or a set of CCs/BWPs in a CC list to DL receptions and/or UL transmissions, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation

* FFS: The possible combination(s) of joint/DL/UL TCI states that can be indicated to DL receptions and/or UL transmissions in a BWP/CC/TRP
* Note: This agreement does not imply that there will be ~~3 or 4~~ 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: Whether applying X (X >1) TCI states simultaneously to CJT-based PDSCH reception is supported is discussed independently in this AI~~
* Note: ~~If applying X (X >1) TCI states simultaneously to CJT-based PDSCH reception is supported,~~ The maximum number of TCI states that can be applied simultaneously to CJT-based PDSCH reception ~~indicated in a CC/BWP for CJT~~ and the required type(s) of TCI states (i.e., DL /UL/joint) are independently discussed in this AI

Table 1 Additional inputs for Issue 1

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| --- | --- |
| **Company** | **Input** |
| Mod V00 | **Please share your preference and further input, if any, to above moderator proposals** |
| Fujitsu | For issue 1.1, we think the most important thing is to determine whether more than one TCI state can be applied to CJT-based PDSCH in this meeting. As for the other details, they can be determined in the next meeting. For Proposal 1.B-1, we are fine with it although we think it would be better to list the combinations as in the previous version. |
| vivo | **Proposal 1.B-1**: Support in principle. We think it is better to separately list the supported combinations for S-DCI based MTRP and M-DCI based MTRP. For example, 1 pair of DL and UL TCI states + 1 UL TCI state is a valid combination for S-DCI based MTRP, but may not be appropriate for M-DCI based MTRP. |
| NTT Docomo | For Proposal 1.A-1, we don’t understand consequence if we will fail to agree “*X (X > 1) joint/DL TCI states can be applied simultaneously to CJT-based PDSCH reception*”. Does it mean that 2 joint/DL TCI states are applied to CJT (e.g. 2 TRPs shares the same TCI state)? If so, we could be fine. However, if Rel.15 TCI framework should be used for CJT, we have concern because it makes fragmentation of beam indication mechanism. |
| QC | For 1.A, suggest to change (X>1) to (X>2), don’t see why R17 SFN PDSCH cannot be applied to CJT.  For 1.A-1, we think 1.A with (X>2) is better, since X=2 can be applied to CJT to our understanding |
| Mod V10 | **Updated Proposal 1.B-1 based on today online discussion is provided** |
| Huawei, HiSilicon | **Proposal 1.A:** Support  **Proposal 1.A-1**: Not support. It is clear for us the CJT requires more than 1 TCI states otherwise coherent joint transmission would not be possible. Also, putting a deadline of this meeting seems impractical.  **Updated Proposal 1.B-1**: For the sake of progress, we can agree with this if the note is updated as follows:  Note: This agreement does not imply that there will be 3 or 4 DL or UL or joint TCI states for the target use cases agreed in RAN1#109-e in AI 9.1.1.1 The required type (DL/UL/joint or the combination thereof) and the number of TCI states for CJT is independently discussed in this AI.  [Mod] Added with some modifications, please check |
| InterDigital | **Proposal 1.A-1**: Support.  **Updated Proposal 1.B-1**: Support the update by FL, which is clearly pointing out ‘in AI 9.1.1.1’ that should be sufficient. |
| Mod | **Updated Proposal 1.B-1 based on today online discussion and feedback from companies** |
| Fraunhofer IIS/HHI | **Proposal 1.A and Proposal 1.A-1:**  We believe the current choices of proposals may not be a productive discussion. The second proposal that agrees to  decide the support of CJT within this meeting, needs another proposal to be agreed by Friday, which is either Proposal 1.A or a conclusion to not support CJT. Therefore, we could directly discuss proposal 1.A or a conclusion to not support CJT (the default option when no consensus) as the two choices for discussion instead of the current proposals 1.A and 1.A-1.  **Proposal 1.B-1:** Ok with the updated proposal. Just a minor modification in the last note as follows:  Note: If applying X (X >1) TCI states simultaneously to CJT-based PDSCH reception is supported, the required type(s) of TCI states (i.e., DL/UL/joint) and the maximum number of TCI states indicated in a CC/BWP for CJT are independently discussed in this AI. |
| Spreadtrum | **Proposal 1.B-1:** Support the updated proposal |
| Lenovo | **Proposal 1.B-1:** Support |
| TransHold | **Proposal 1.A and Proposal 1.A-1:** For the CJT-based PDSCH reception, we think more than 1 TCI states is required.  **Proposal 1.B-1:** Support the updated proposal. |
| CEWiT | **Proposal 1.B-1:** Support the updated proposal |
| vivo | **Proposal 1.B-1:** The note is really hard to read and understand. Can we say in a positive way to replace “up to 4 TCI states”?  **Updated Proposal 1.B-1**:  On unified TCI framework extension, at least for the target use cases agreed in RAN1#109-e in AI 9.1.1.1, the number of TCI states can be indicated in a CC/BWP to DL receptions and/or UL transmissions are given as follows, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation   * For S-DCI based MTRP, up to 2 joint TCI states for joint TCI type, or up to 2 DL TCI states + up to 2 UL TCI states for separate TCI type * For M-DCI based MTRP, up to 1 joint TCI state per TRP for joint TCI type, or up to 1 DL TCI states + up to 1 UL TCI states per TRP for separate TCI type * FFS: The possible combination(s) of joint/DL/UL TCI states that can be applied to DL receptions and/or UL transmissions in a BWP/CC/TRP * FFS: whether and how to support mixed TCI types of joint TCI type and separate TCI type * Note: If applying X (X >1) TCI states simultaneously to CJT-based PDSCH reception is supported, the required type(s) of TCI states (i.e., DL/UL/joint) and the maximum number of TCI states for CJT are independently discussed in this AI |
| ZTE | **Proposal 1.B-1:** Support. Again we believe that CJT related discussion, if any, should be decoupled with normal mTRP unified TCI enhancement, unless our intention is to make the whole feature down-scoped. |
| Mod | **Update Proposal 1.A and Proposal 1.B-1**  **On Proposal 1.B-1, PLEASE do not try to add any combination of indicated joint/DL/UL TCI states that can be supported in a BWP/CC/TRP, which will be left to the next level detail. We have some discussion on the possible combinations early of this week, and it seems we don’t have more time to make it.** |
| FGI | **Proposal 1.A-1:** Wealso wondered if the CJT-based PDSCH reception is not supported, is there any impact on the support of the maximum number of TCI states (up to 4 for now)? If the discussion for CJT can be decoupled from the agreed target use cases, it might be helpful to the progress of this agenda.  **Proposal 1.B-1:** Support the latest version. |
| Huawei, HiSilicon | **Proposal 1.B-1:**  First, let us try to explain why we think more than one TCI state is required for CJT and, then, provide our preferred version of the proposal.   * The question is **“can mTRP CJT work only with one TCI state?”** The answer is **“in theory, yes! But it requires UE specific TRS transmission and a prohibitive overhead at the network side”**.   Let’s assume the TRP set for UE1 is TRP1, TRP2, TRP3, and TRP4. In theory, it is possible that only one TRS is configured for the UE1 and TRP1, TRP2, TRP3, and TRP4 send exactly the same TRS to the UE1. These TRSs are mixed over the air and UE will receive the mixed effect, calculates the average propagation delay and doppler and use these average values to receive the CJTed DL channel. The problem is that, there is also a UE2 whose TRP set is, say, TRP2, TR3, TRP4, and TRP5. The question is, can the same TRS that is configured for UE1 also be configured for UE2? Let’s see what happens if we follow such a design: Then TRP 5 also sends the same TRS signal. The problems is that the TRS from TRP5 will also be mixed with those of TR1, TRP2, TRP3, and TRP4. Then, the average delay and doppler that is calculated at UE1 would be the average delay and doppler wrt (TRP1,…, TRP5) instead of the correct set of (TRP1,…, TRP4). Similarly, the average delay and doppler that is calculated at UE2 would be the average delay and doppler wrt (TRP1,…, TRP5) instead of the correct set of (TRP2,…, TRP5): Both calculated pairs of (average delay, average doppler) at UE1 and UE2 will be wrong! Obviously, above is only a toy example and this situation will be exacerbated by increasing the number of TRPs and UEs in the network. **So, what would be the solution if we want to avoid such erroneous (average delay, average doppler) estimations at the UE side while still maintaining one TRS configuration (or one TCI state) per UE**? The only solution would be the transmission of UE-specific TRS. One TRS is configured for UE1 and is jointly transmitted from the corresponding TRP set (TRP1,…,TRP4) and another TRS is configured for UE2 and is jointly transmitted from the corresponding TRP set (TRP2,…,TRP5). The final effect is that TRP2, TRP3, TRP4 now have to transmit two TRSs:  one for UE1 and one for UE2 (therefore, UE-specific TRS!). Again, obviously, above was only a toy example: In general, if TRPx is in the CJT Tx set of n UEs, it would have to transmit n different TRSs each configured for one of the n UEs. This would be a prohibitive overhead at the network side and should be avoided.  So, what is the solution to avoid all above?  The answer is going back to the “good old” cell specific TRS! Each TRP sends one TRS over the whole network and, **ideally, UE is indicated with one TCI state  per each of the TRPs in its CJT TRP set**. Consequently, UE measures the cell-specific TRSs of each of its  CJT TRP set to calculate the correct average delay and doppler of the CJT TRP set. One may argue that to have a reasonable estimate, UE does not have to measure exactly 4 TRSs and measuring two or three out of four would be enough! Well, we are more than happy to discuss this although we believe CJT would encounter performance loss if the number of TRS measurements reduce.  I hope, above, I have clarified why we think X>1 TCI state is required for CJT.  Given above explanation, we think that a reasonable compromise is the following. **Please note that the “note” in our suggested proposal is worded so that it does not prohibit the maximum of 1 TCI state although we don’t believe such a maximum value would work**:  On unified TCI framework extension, at least for the target use cases agreed in RAN1#109-e in AI 9.1.1.1, up to 4 TCI states can be indicated in a CC/BWP or a set of CCs/BWPs in a CC list to DL receptions and/or UL transmissions, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation   * FFS: The possible combination(s) of joint/DL /UL TCI states that can be applied to DL receptions and/or UL transmissions in a BWP/CC/TRP * Note: This agreement does not imply that there will be ~~3 or 4~~ 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: Whether applying X (X >1) TCI states simultaneously to CJT-based PDSCH reception is supported is discussed independently in this AI~~ * Note: ~~If applying X (X >1) TCI states simultaneously to CJT-based PDSCH reception is supported,~~ the required type(s) of TCI states (i.e., DL /UL/joint) and the maximum number of TCI states that can be indicated in a CC/BWP for CJT are independently discussed in this AI |

# Issue 2 – TCI state update and activation

**Proposal 2.A-1:** On unified TCI framework extension for M-DCI based MTRP, RAN1 to make decision on support ~~only Option 1 or support both~~ one of the following options in RAN1#110bis-e:

* Option 1: Use the existing TCI field in a 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) associated with the same *coresetPoolIndex* value
  + The UE shall apply the joint/DL/UL TCI state(s) associated with a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the *coresetPoolIndex* value
* Option 2: Use the existing TCI field in a 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) associated with the same or different *coresetPoolIndex* value
  + The UE shall apply the joint/DL/UL TCI state(s) associated with a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the *coresetPoolIndex* value
  + FFS: Detail of signaling

Table 2 Additional inputs for Issue 2

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| **Company** | **Input** |
| Mod V00 | **Please share your preference and further input, if any, to above moderator proposals** |
| Xiaomi | We prefer to support Option 2 in the case of TRP beam failure. |
| vivo | Prefer Option 1.  For TCI state indication cross different coresetPoolIndex values, it doesn’t work for M-DCI based MTRP with non-ideal backhaul which could have backhauling delay of at most 50ms assumed in Rel-16 EVM for MTRP, as a result one TRP can hardly acquire the instant desired unified TCI state of the other TRP. Secondly, current spec doesn’t support TCI state indication cross different coresetPoolIndex values either. The TCI state indicated in the DCI associated with a coresetPoolIndex is one of the activated TCI states by MAC CE belonging to the same coresetPoolIndex. Besides, for inter-cell multi-TRP, one PCI associated with one or more of activated TCI states for PDSCH/PDCCH is associated with one coresetPoolIndex, another PCI associated with one or more of activated TCI states for PDSCH/PDCCH is associated with another coresetPoolIndex. |
| NTT DOCOMO | Support. Support Opt.1. |
| InterDigital | @vivo, even Opt.2 doesn’t say always cross-TRP-indication. Opt.2 is a superset of Opt.1, as the network has flexibility on how to associate. Supporting both options, e.g., Opt.1 being a default mode, can also be acceptable, in order at least not to have degraded flexibility compared to Rel-16. |
| QC | Support Option 1 |
| Google | We suggest the following revision. Actually, Option 2 includes all functionality supported by Option 1. We don’t see why Option 1 is anyway supported in original down-selection.  **Proposal 2.A-1:** On unified TCI framework extension for M-DCI based MTRP, RAN1 to make decision on support only Option 1, support only Option 2 or support both following options in RAN1#110bis-e:  Regarding vivo’s comments: In fact, M-DCI can also be operated with ideal backhaul. That’s why we have joint HARQ-ACK feedback mode in Rel-16. In addition, since unified TCI is applied for all channels, we should also consider channels other than PDSCH. For PDCCH, cross-TRP beam indication has been supported. In Rel-16, CORESET with CORESETPoolIndex#0 can actually send MAC-CE to update PDCCH beam of any CORESET. Cross-TRP beam indication are also supported for PUCCH and PUSCH in our views. Therefore, unified TCI in Rel-18 should also support features we had in legacy. |
| Huawei, HiSilicon | OK in principle and we support option 1. Also, Option 2 includes Option 1 so it is not required to support both options. Also, we don’t see the reason to put the deadline of RAN1#110bis-e. What if we cannot make the final decision in the next meeting? Does it mean that unified TCI for m-DCI won’t be supported?  We suggest the following change:  **Proposal 2.A-1 (modified):** On unified TCI framework extension for M-DCI based MTRP, RAN1 to make decision on support only Option 1 or only Option 2 ~~support both following options in RAN1#110bis-e~~:   * Option 1: Use the existing TCI field in a 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) associated with the same *coresetPoolIndex* value   + The UE shall apply the joint/DL/UL TCI state(s) associated with a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the *coresetPoolIndex* value * Option 2: Use the existing TCI field in a 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) associated with the same or different *coresetPoolIndex* value   + The UE shall apply the joint/DL/UL TCI state(s) associated with a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the *coresetPoolIndex* value   + FFS: Detail of signaling |
| InterDigital | Agree with Google |
| Mod | **Updated Proposal 2.A-1 based on feedback from companies** |
| Fraunhofer IIS/HHI | OK with the current version of the proposal |
| Spreadtrum | **Proposal 2.A-1** Support the current proposal and support Alt 2. |
| Lenovo | **Proposal 2.A-1**: Support Updated Proposal 2.A-1 and support option 1. |
| TransHold | **Proposal 2.A-1** Support Option 2. For Option 2, it can provide flexibility and robustness of TCI indication in case of TRP beam failure. In addition, as mentioned by InterDigital, Option 1 is a subset of Option 2, i.e., Option 2 can provide the function of option 1. |
| CEWiT | **Proposal 2.A-1:** Prefer Option 1 |
| Samsung | We are fine with the FL’s proposal. |
| vivo | We are fine with the updated proposal and prefer Option 1.  @InterDigital @Google: Thanks for your comment. Please find our reply as follows:   1. Option 1 still allows TCI state activation for the other TRP by MAC CE when only one TCI state is activated by MAC CE per TRP, maintaining such flexibility as Rel-16. Even if more than one TCI state is activated per TRP, Option 1 is able to activate TCI states and indicate TCI states associate with either coresetPoolIndex value. 2. Cross-TRP TCI state indication by DCI causes redundant signaling because different DCIs associated with two coresetPoolIndex values are doing exactly the same thing. 3. For TRP-specific BFR in Rel-17, after receiving BFRR, beam reset to the new beam is done by the UE itself. There is no need for cross-TRP beam indication. |
| ZTE | **Support 2.A-1:** Our first preference is to support inter-TRP beam indication for MDCI. |
| FGI | Support the updated proposal 2.A-1. |

# Issue 3 – How to associate the indicated TCI state(s) with each target channel/signal

**Proposal 3.B:** On unified TCI framework extension for S-DCI based MTRP, to inform the association with joint/DL TCI state(s) indicated by DCI/MAC-CE and enable dynamic switching between STRP and MTRP operations for PDSCH reception, down-selection at least one alternative from the followings:

* Alt1: Use an indicator field other than the existing TCI field (could be reusing an existing DCI field or introducing a new DCI field) in a DCI format 1\_1/1\_2 with DL assignment to inform which indicated joint/DL TCI state(s) the UE shall apply to PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2
  + ~~[FFS: Detail of the application time]~~
  + FFS: PDSCH reception scheduled/activated by DCI format 1\_0
* Alt2: Use an indicator field other than the existing TCI field (could be reusing an existing DCI field or introducing a new DCI field) in a DCI format 1\_1/1\_2 with and without assignment to inform which indicated joint/DL TCI state(s) the UE shall apply to all PDSCH receptions ~~after an application time~~
  + ~~FFS: Detail of the application time~~
* Alt3: Reuse the existing TCI field in a DCI format 1\_1/1\_2, i.e., the UE shall apply the joint/DL TCI state(s) mapped to the TCI codepoint indicated by the DCI format 1\_1/1\_2 to PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2 if the PDSCH reception is scheduled/activated after the beam application time as defined in Rel-17
* Alt4: Use RRC parameter(s) in a PDSCH configuration in a DL BWP to inform which indicated joint/DL TCI state(s) the UE shall apply to PDSCH reception in the DL BWP
  + Note: One way to enable dynamic switching between STRP and MTRP operations ~~can be achieved~~ is by indication of all the same or different joint/DL TCI states to the indicated joint/DL TCI states if multiple indicated joint/DL TCI states are applied to PDSCH reception in the DL BWP according to the RRC parameter(s)
* Alt5: 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. When a scheduling/activation DCI with DL assignment is received in a CORESET group, the indicated joint/DL TCI state(s) associated with the CORESET group is applied to PDSCH reception scheduled/activated by the scheduling/activation DCI.

**Proposal 3.C:** 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: PUSCH transmission scheduled/activated by a DCI format 0\_0 and Type-1 CG-PUSCH

**Proposal 3.D:** 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

Table 3 Additional inputs for Issue 3

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| **Company** | **Input** |
| Mod V00 | **Please share your preference and further input, if any, to above moderator proposals** |
| Xiaomi | For proposal 3B:  First, for Alt 1, it is limited to DCI format with DL assignment. We suggest to consider both DCI format with and without DL assignment. And the alt 1 can be revised as below:   * Alt1: Use an indicator field other than the existing TCI field (could be reusing an existing DCI field or introducing a new DCI field) in a DCI format 1\_1/1\_2 with/without DL assignment to inform which indicated joint/DL TCI state(s) the UE shall apply to PDSCH reception scheduled/activated by the same or different DCI format 1\_1/1\_2   + FFS: PDSCH reception scheduled/activated by DCI format 1\_0   Second, for alt 2 and alt 3, it can’t support M-TRP PDCCH + S-TRP PDSCH. For Alt 4, there will be some latency introduced by SS for each corresponding CORESET. It means that if gNB want to schedule M-TRP PDSCH, it needs to wait the search space of CORESET group associated with two TCI states. |
| Fujitsu | Proposal 3.B: Suggest to down select at least one alternative.  **Proposal 3.B:** On unified TCI framework extension for S-DCI based MTRP, to inform the association with joint/DL TCI state(s) indicated by DCI/MAC-CE and enable dynamic switching between STRP and MTRP operations for PDSCH reception, down-selection at least one alternative from the followings:  In our view, Alt2 can be a basic method to support sTRP with unified TCI. In this case, one TCI state is applied and lasts for a relatively long time, e.g., for a case where TRP 1 is preferred for a certain time period. On top of it, Alt1 could be also considered. In this case, DL DCI indicates which one TCI state is applied for each sTRP PDSCH scheduling, e.g., for a case where dynamic switching between TRP 1 and TRP 2 is preferred. |
| vivo | Proposal 3.B: Prefer Alt 1.  Proposal 3.C: Prefer Alt 1.  On Proposal 3.D, we prefer to add a new Alt to apply the indicated TCI states dependent on the whether the PUCCH is scheduled by DCI, i.e.,   * For a PUCCH is scheduled by a DCI, apply the indicated TCI state of the scheduling PDCCH, which is corresponding to the coresetPoolIndex associated with the CORESET; * For a PUCCH configured by RRC, apply the indicated TCI state corresponding to a default coresetPoolIndex, e.g. coresetPoolIndex 0, or the TCI state corresponding to a coresetPoolIndex configured by RRC.   [Mod] This proposal is provided for S-DCI |
| QC | For 3.B, support Alt1  For 3.C, support Alt1  For 3.D, support Alt1 |
| Google | We are fine with Proposal 3.C and 3.D for down-selection.  For Proposal 3.B. We are not sure why Alt1 and Alt2 in revised proposal by FL are separately listed. Considering adding an indicator field, what’s the impact from whether it’s with DL assignment or not? |
| Huawei, HiSilicon | **Proposal 3.B:** OK in principle although the FFSs of alt1 and Alt2 should be similar:  **Proposal 3.B (updated):** On unified TCI framework extension for S-DCI based MTRP, to inform the association with joint/DL TCI state(s) indicated by DCI/MAC-CE and enable dynamic switching between STRP and MTRP operations for PDSCH reception, down-selection at least one alternative from the followings:   * Alt1: Use an indicator field other than the existing TCI field (could be reusing an existing DCI field or introducing a new DCI field) in a DCI format 1\_1/1\_2 with DL assignment to inform which indicated joint/DL TCI state(s) the UE shall apply to PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2   + FFS: Detail of the application time ~~that the UE can apply the indicated joint/DL TCI state(s) informed by the indicator field~~   + FFS: PDSCH reception scheduled/activated by DCI format 1\_0 * Alt2: Use an indicator field other than the existing TCI field (could be reusing an existing DCI field or introducing a new DCI field) in a DCI format 1\_1/1\_2 with and without assignment to inform which indicated joint/DL TCI state(s) the UE shall apply to PDSCH receptions after an application time   + FFS: Detail of the application time   + FFS: PDSCH reception scheduled/activated by DCI format 1\_0 * Alt3: Reuse the existing TCI field in a DCI format 1\_1/1\_2, i.e., the UE shall apply the joint/DL TCI state(s) mapped to the TCI codepoint indicated by the DCI format 1\_1/1\_2 to PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2 if the PDSCH reception is scheduled/activated after the beam application time as defined in Rel-17 * Alt4: Use RRC parameter(s) in a PDSCH configuration in a DL BWP to inform which indicated joint/DL TCI state(s) the UE shall apply to PDSCH reception in the DL BWP   + Note: Dynamic switching between STRP and MTRP operations can be achieved by indication of all the same or different joint/DL TCI states to the indicated joint/DL TCI states if multiple indicated joint/DL TCI states are applied to PDSCH reception in the DL BWP according to the RRC parameter(s) * Alt5: 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. When a scheduling/activation DCI is received in a CORESET group, the indicated joint/DL TCI state(s) associated with the CORESET group is applied to PDSCH reception scheduled/activated by the scheduling/activation DCI.   **Proposal 3.C:** Support  **Proposal 3.D:** Support |
| Xiaomi | Support the updated proposal 3B and prefer Alt 2. |
| Mod | **Updated Proposal 3.B based on feedback from companies** |
| Fraunhofer IIS/HHI | **Proposal 3.B:** Ok. For Alt-5, it could be further clarified with a note that a CORESET group may be associated with one or more joint or DL TCI states to enable dynamic switching. It’s not immediately clear in the current version on how dynamic switching is achieved with this alternative.  **Proposals 3.C and 3.D:** Support |
| Spreadtrum | **Proposal 3.C** Support and prefer Alt 2.  Fine with **Proposal 3.D** and **Proposal 3.B** for down-selection. |
| Lenovo | **Proposal 3B: For Alt 1, it has stated that to u**se an indicator field to inform which indicated joint/DL TCI state(s) the UE shall apply to PDSCH reception scheduled/activated by the DCI format 1\_1/1\_2, we are confused that why application time is needed for this alternative. We support Alt1 without the 1st FFS on application time.  **Proposal 3C:** Support Alt1  **Proposal 3D:** Support Alt1 |
| TransHold | For 3.C, support Alt1, the existing SRS resource set indicator is sufficient.  For 3.D, support Alt1. |
| CEWiT | **Proposal 3B:** Support  **Proposal 3C:** Support and prefer Alt1  **Proposal 3D:** We are fine with proposal for down-selection |
| Samsung | We are in principle fine with Proposals 3.B, 3.C and 3.D provided by the FL. For 3.C, we propose to add one alternative (similar to PDSCH reception in Proposal 3.B)  **Proposal 3.C:** 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 at least 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 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: PUSCH transmission scheduled/activated by a DCI format 0\_0 and Type-1 CG-PUSCH |
| vivo | Sorry for the mistake.  **Updated Proposal 3.B**: Share similar view as Lenovo, i.e., the scheduled/activated PDSCH shall apply the TCI state(s) according to the indicator field in the scheduling DCI.  **Proposal 3.D**: Prefer Alt1. |
| ZTE | **Proposal 3.B/C/D: Support.** |
| Mod | **Updated 3.B and 3.C** |
| FGI | **Proposal 3.B:** It is a little bit unclear for the FFS part in Alt.1: Detail of the application time as we don’t even mention the application time in Alt1’s main bullet. Also, why we mentioned the application time in Alt.2 but not in Alt.1 might need some clarification. Moreover, the wording in Alt.3 is the beam application time instead of the application time, do we need to align the wording to each alternative (or is it a different application time?)?  **Proposal 3.C:** Support Alt.1.  **Proposal 3.D:** Support of down-selection and prefer Alt.1 and Alt.2. |
| Huawei, HiSilicon | **Proposal 3.B:** We are not sure why “FFS: PDSCH reception scheduled/activated by DCI format 1\_0” is included in Alt.1 but not Alt. 2.  **Proposal 3.C:** OK. Support Alt. 2.  **Proposal 3.D:** Generally OK but we would like to ask proponents to explain the difference between Alt.1 and Alt. 2. |

# Issue 4 – UL power Control for UL MTRP

**Proposal 4.A:** On unified TCI framework extension, if one or both of indicated joint/UL TCI states applying to PUSCH/PUCCH transmission occasions in an UL BWP at least for S-DCI based PUSCH/PUCCH repetition with TDM is/are not associated with UL PC parameter setting (including P0, alpha for PUSCH, and closed loop index) for PUCCH/PUSCH, down-selection one alternative from the followings:

* Alt1: Support two default UL PC parameter settings configured in *BWP-UplinkDedicated*, and the UE should apply the one or two default UL PC parameter settings configured in the corresponding UL BWP
  + FFS: 1-to-1 association between an indicated joint/UL TCI state and a default UL PC parameter setting
* Alt2: No change from Rel-17 unified TCI framework, i.e., the UE should apply the one single default UL PC parameter setting configured in the corresponding UL BWP regardless the UL PC parameter setting is absent from one or both of indicated joint/UL TCI states
* Alt3: A joint/UL TCI state for PUCCH/PUSCH transmission is always associated with a UL PC parameter setting for PUCCH/PUSCH

**Support/fine: CATT, vivo, TransHold, Intel, FGI, Lenovo, Fujitsu, CMCC, ZTE, Sharp, NTT DOCOMO, QC, Huawei, HiSilicon**

**Not support: Ericsson**

Table 4 Additional inputs for Issue 4

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod V00 | **Please share your preference and further input, if any, to above moderator proposals** |
| vivo | Prefer Alt1. |
| NTT Docomo | We support this proposal, and we support Alt.1  Default power control parameter is supported in Rel-17 unified TCI. It should also be supported for Rel-18 unified TCI. Thus, we do not prefer Alt.3.  Per TRP default power control parameter is supported in Rel-17 M-TRP PUSCH/PUCCH. It should also be supported for M-TRP with Rel-18 unified TCI. Thus, we do not support Alt.2. |
| QC | Support Alt1. 2 PC parameter sets are already supported in R17 |
| Xiaomi | Support and prefer Alt 1 |
| Spreadtrum | Perfer Alt 1 |
| Lenovo | Prefer Alt 3. |
| TransHold | We prefer Alt1 as it is a straightforward extension of Rel-17 default UL PC parameter settings. |
| FGI | Prefer Alt.1 and Alt.3. |

# Issue 5 – Beam reporting and beam failure recovery

Open issues on beam reporting and BFR enhancements and company views are summarized below.

Table 5-1 Summary for Issue 5-1

|  |  |  |  |
| --- | --- | --- | --- |
| **#** | **Issue** | **Companies’ views** | **Moderator notes/observation** |
| 3.1 | Enhance/extend group-based reporting to support simultaneous UL transmission | Support QC, Docomo, ZTE, vivo, Nokia  Concern: OPPO, Huawei/HiSilicon | This issue can be discussed once any Rel-18 MTRP scheme for STxMP is agreed |
| 3.2 | Enhance/extend Rel-17 UE capability index reporting to support simultaneous UL transmission | Support: QC, OPPO, Docomo, NEC, ZTE, IDC, LG, Nokia  Concern: Huawei/HiSilicon | This issue can be discussed once any Rel-18 MTRP scheme for STxMP is agreed |
| 3.3 | Enhancement to TRP-specific BFR under unified TCI framework | Support: QC, OPPO, Huawei/HiSilicon, Docomo, NEC, ZTE, IDC, vivo, Nokia  Concern: |  |

Table 5-2 Additional inputs for Issue 5

|  |  |
| --- | --- |
| **Company** | **Input** |
| QC | Support 3.1 and 3.2, but fine to wait till STxMP decision is clear  Support 3.3. We think the same principle agreed for sTRP is also beneficial for mTRP |
| OPPO | For Issue 3.1, we understand the group-based beam reporting was for DL MTRP operation, while the STxMP is for UL only. It seems unnecessary to combine these two features.  Support Issue 3.2 and 3.3. It seems reasonable to discuss Issue 3.2 when STxMP is agreeable. |
| Huawei, HiSi | **3.1 and 3.2:** We agree with the moderator and prefer to wait the progress of 9.1.4.1.  **3.3:** We support such enhancement. |
| Docomo | Our views added in the table.  For 3.1 and 3.2, we support the enhancements on beam reporting to support STxMP, and fine to wait for progress in 9.1.4.1.  For 3.3, we support to study it. |
| NEC | We support to have enhancements as said in 3.2 and 3.3 |
| ZTE | Our views are provided in the table. BTW, for group based reporting, we think that, for STxMP, the UE capability report should be based on group based report rather than non-group. |
| InterDigital | Our views are updated in the table. |
| Futurewei | For Issues 3.1 and 3.2, we agree with moderator that the discussions should wait for decisions in agenda item 9.1.4.1. |
| Samsung | We prefer to complete STxMP discussion before go into details for 3.1 or 3.2. And we prefer 3.1 as staring point, if STxMP is supported.  Support 3.3. |
| Xiaomi | Support 3.1 and 3.2, ok to discuss the details till STxMP is agreed.  Support 3.3 for mTRP case. |
| CATT | Support 3.1 and 3.2.  For Issue 3.3, detailed issues to be discussed need to be clarified. |
| vivo | Agree with Moderates’ notes. |
| TransHold | Support 3.1 and 3.2, fine to discuss the details till STxMP is agreed.  For 3.3, we support to study it. |
| Nokia | 3.1 and 3.2: Enhancement to beam reporting is needed to provide network information about feasibility of STxMP but this can discussed when STxMP schemes are more clear.  3.3: enhancements needed to BFR operation should be studied to cover the unified TCI extension to mTRP BFR specified in R17. |
| Ericsson | Issue 3.1: This has nothing to do with the unified TCI framework: it’s a reporting enhancement.  Issue 3.2: Nothing to do with the unified TCI framework. Having said that, we have concerns on (some) extensions of the capability index reporting.  Issue 3.3: Low prio. Editorial updates can be considered. |
| CMCC | For 3.1 and 3.2, we think they are important issues to facilitate STxMP, but we are not sure whether they should be discussed in unified TCI framework.  For 3.3, agree with Ericsson. Editorial updates can be considered. |
| TransHold | Support 3.1 and 3.2, fine to discuss the details till STxMP is agreed.  For 3.3, we support to study it. |

# Other potential issues

Table 6 Inputs for other potential issues

|  |  |
| --- | --- |
| **Company** | **Input** |
| Huawei, Hisilicon | Considering enhancements for common TCI state update for mTRP where sTRP and mTRP CCs can be configured in the same CC list. |

# Appendix A: Agreements before/in RAN1#110

|  |
| --- |
| **RAN1#109e** |
| **Agreement**  On unified TCI framework extension, consider all the intra and inter-cell MTRP schemes specified in Rel-16 and Rel-17   * Consider, if STxMP is supported, Rel-18 MTRP scheme(s) with STxMP   **Agreement**  On unified TCI framework extension at least for single-DCI based MTRP, the existing TCI field in DCI format 1\_1/1\_2 (with or without DL assignment) can indicate multiple joint/DL/UL TCI states in a CC/BWP or a set of CCs/BWPs in a CC list   * FFS: Detail of mapping joint/DL/UL TCI state ID(s) to a TCI codepoint, e.g., possible combinations of joint, DL, and/or UL TCI state IDs that can be mapped to a TCI codepoint * FFS: Whether to increase the max number of MAC CE activated TCI codepoints, i.e., more than 8 codepoints * FFS: Whether to increase the max number of TCI field bits, i.e., more than 3 bits * Note: This doesn't imply that support of one additional TCI field or a field associating the TCI field to the TRP(s) is precluded   Note: The term TRP is used only for the purposes of discussions in RAN1 and whether/how to capture this is FFS  **Agreement**  On unified TCI framework extension for M-DCI based MTRP, consider the following alternatives for TCI state update:   * Alt1: Reuse the same TCI state update scheme for S-DCI based MTRP * Atl2: Use the existing TCI field in the DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *CORESETPoolIndex* values to indicate the joint/DL/UL TCI state(s) corresponding to the same *CORESETPoolIndex* value * Alt3: Use the existing TCI field in any DCI format 1\_1/1\_2 (with or without DL assignment) to indicate all joint/DL/UL TCI states corresponding to both *CORESETPoolIndex* values   + Study the association between the indicated joint/DL/UL TCI state(s) and a *CORESETPoolIndex* value * Alt4: Use the existing TCI field in the DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *CORESETPoolIndex* values to indicate joint/DL/UL TCI state(s) corresponding to the same or different *CORESETPoolIndex* value.   + Study whether the indicated joint/DL/UL TCI state(s) applies to the channels/signals associated with the same *CORESETPoolIndex* value or different *CORESETPoolIndex* value is indicated by DCI   **Agreement**  On unified TCI framework extension for S-DCI based MTRP, consider at least the following alternatives to map/associate a joint/DL TCI state to PDCCH reception(s)   * Atl1: Use RRC configuration to inform the mapping/association between a configured or indicated joint/DL TCI state and a CORESET or a CORESET group * Alt2: Use RRC configuration to inform the mapping/association between a configured or indicated joint/DL TCI state and a search space set * Alt3: Use MAC-CE to inform the mapping/association between an activated or indicated joint/DL TCI state and a CORESET or a CORESET group * Alt4: Use DCI to inform the mapping/association between an indicated joint/DL TCI state and a CORESET or a CORESET group * Alt5: Based on a fixed mapping/association rule, e.g., the first indicated joint/DL TCI state always applies to PDCCH receptions   Consider above alternatives for PDCCH repetition, PDCCH-SFN, PDCCH w/o repetition/SFN, and potential support of dynamic switching between S-TRP and M-TRP for PDCCH. It is not precluded to adopt one single alternative or multiple alternatives to support these cases.  **Agreement**  On unified TCI framework extension, if an indicated joint or UL TCI state applies to a PUSCH/PUCCH transmission occasion at least for S-DCI based PUSCH/PUCCH repetition with TDM and the indicated joint or UL TCI state is associated with an UL PC parameter setting for PUSCH /PUCCH (including P0, alpha for PUSCH, and closed loop index) and a PL-RS, the UE should apply the UL PC parameter setting and the PL-RS for the PUSCH /PUCCH transmission occasion.   * FFS: How to extend to other Rel-18 MTRP scheme(s) with STxMP, if supported * FFS: UL PC enhancement for CB and non-CB SRS in above case   FFS: The applied UL PC parameter setting if one or both indicated joint or UL TCI state(s) is not associated with an UL PC parameter setting (including P0, alpha for PUSCH, and closed loop index) for PUCCH/PUSCH  **Agreement**  On UE power limitation for STxMP for FR2, send LS to RAN4 to check the followings:   * Whether it is feasible to assume power limitation per panel for STxMP (Assumption 1) * Whether it is feasible to assume a total power limitation per UE over all UE panels used for STxMP (Assumption 2) * In either of Assumption1 or Assumption 2, whether the total power limitation per UE over all UE panels used for STxMP or the sum of per-panel power limitation for STxMP can be different from (greater than) the existing power limitation for a given power class? * If both Assumption 1 and Assumption 2 are feasible, whether both assumptions can be applied to a same UE, and what is the relationship between the per-panel power limitation and total power limitation if both are applied (e.g., the sum of per-panel power limitation can be larger than the total power limitation per UE, or should be always the same)?   FFS: Detail of exact LS if agreed  Note: Scenarios of above include at least single carrier scenario for FR2  Note: Above power limitation includes both total radiated power and EIRP  LS to RAN4 is endorsed in R1-2205639. |
| **RAN1#110** |
| **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 |

# Appendix B: Proposal Pool

**Proposal 1.B**: On unified TCI framework extension, up to 4 TCI states can be applied to DL receptions and/or UL transmissions in a CC/BWP, where these TCI states are indicated/updated by MAC-CE/DCI with the necessary MAC-CE based TCI state activation

* One of the following combinations can be applied to DL receptions and/or UL transmissions in a CC/BWP for MTRP operation:
  + 2 joint TCI states for joint DL/UL TCI update in the CC/BWP
  + 2 pairs of DL and UL TCI states for separate DL/UL TCI update in the CC/BWP
  + 1 pair of DL and UL TCI states + 1 DL TCI state for separate DL/UL TCI update in the CC/BWP
  + 1 pair of DL and UL TCI states + 1 UL TCI state for separate DL/UL TCI update in the CC/BWP
* In addition to the above combinations, study whether to support the following combinations:
  + 3 joint TCI states for joint DL/UL TCI update in the CC/BWP
  + 4 joint TCI states for joint DL/UL TCI update in the CC/BWP
  + 1 joint TCI state for joint DL/UL TCI update in the CC/BWP + 1 pair of DL and UL TCI states for separate DL/UL TCI update in the same CC/BWP
  + 1 joint TCI state for joint DL/UL TCI update in the CC/BWP + 1 DL TCI state for separate DL/UL TCI update in the same CC/BWP
  + 1 joint TCI state for joint DL/UL TCI update in the CC/BWP + 1 UL TCI state for separate DL/UL TCI update in the same CC/BWP
* Note: 1 joint TCI state is already supported by Rel-17 unified TCI framework
* Note: 1 pair of DL and UL TCI states is already supported by Rel-17 unified TCI framework
* Note: As in Rel-17, a joint TCI state in any above combination is applied for UL transmission only if applicable
* FFS: The possible combination(s) of joint/DL/UL TCI states that can be applied per TRP

**Proposal 2.A:** On unified TCI framework extension for M-DCI based MTRP, use the existing TCI field in a DCI format 1\_1/1\_2 (with or without DL assignment) associated with one of *coresetPoolIndex* values to indicate **at least** the joint/DL/UL TCI state(s) associated with the same *coresetPoolIndex* value

* The UE shall apply the joint/DL/UL TCI state(s) associated with a *coresetPoolIndex* value to channel(s)/signal(s) that have explicit or implicit association with the *coresetPoolIndex* value
* FFS: Whether and how to indicate the joint/DL/UL TCI state(s) associated with another *coresetPoolIndex* value, e.g., reusing the same TCI state update scheme for S-DCI based MTRP or the DCI format 1\_1/1\_2 can inform the indicated joint/DL/UL TCI state(s) is associated with which *coresetPoolIndex* value

**Support (21): Qualcomm, OPPO, Huawei/HiSilicon, Docomo, NEC, Spreadtrum, Fraunhofer, Futurewei, Lenovo, Apple, LG, CATT, vivo, Nokia, Intel, Panasonic, FGI, Fujitsu, CMCC, ZTE, CEWiT**

**Not support (6): Google, InterDigital, Xiaomi, TransHold, Samsung, Ericsson**