**3GPP TSG RAN WG1 #103-e R1-2009574**

**e-Meeting, October 26th – November 13th, 2020**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary#3 for multi-beam enhancement

**Document for:** Discussion and Decision

1. Introduction

Picking up from where the group left off in the 1st moderator summary R1-2009499, the 1st GTW session, and the 1st check-point, below are the summaries and moderator proposals.

1. Summary

We will focus on some of the moderator proposals not included in the agreements from the first check-point as well as a few additional matters.

* 1. Issue 1 (unified TCI framework)

CA support

**(Initial) Proposal 1.A**: On Rel.17 unified TCI framework, support common TCI state ID update and activation to provide common QCL information and/or common UL TX spatial filter(s) across a set of configured CCs:

* The above applies to intra-band CA
* The above applies to joint DL/UL and separate DL/UL beam indications
* FFS: Just as Rel.16, the UE will find the corresponding TCI state in the corresponding CC and apply the corresponding TypeA and TypeD QCL assumption from the TCI state ID
* FFS: The above also applies to inter-band CA
* FFS: sharing a single RRC TCI state pool for the set of configured CCs

There were two main unresolved points during the discussion:

1. TCI state vs TCI state ID:
   1. Huawei: “Similar in R16, it is more appropriate to say ‘common TCI state ID’, with which the UE will find the corresponding TCI state in the corresponding CC and apply the corresponding TypeA and TypeD QCL assumption. If it is about ‘common TCI state’, we don’t know how UE can obtain TypeA QCL assumption from another CC. As the proposal here is mainly for ‘data’ channels (e.g., PDCCH/PDSCH), it seems natural to go with ‘common TCI state ID’, which may refer to CSI-RS for tracking on each CC, for both TypeA and TypeD QCL.”
   2. Futurewei: “As we have not progress on TCI state and pool details, it is too early to talk about TCI state ID. Furthermore, what does it mean to have “common TCI state ID” if different CCs have different state pool? At this point, we suggest to remove “ID”.”
2. Suggestion from ZTE to make the 3rd bullet point as FFS in relation to the 5th bullet point:
   1. The newly added part "Note: Just as Rel.16, the UE will find the corresponding TCI state in the corresponding CC and apply the corresponding TypeA and TypeD QCL assumption from the TCI state ID" should be FFS. It may be relevant to sharing single RRC TCI state pool for the set of configured CCs or configuring TCI state pools per CC, i.e., the last FFS bullet.

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| Action: Interested companies are encouraged to provide their inputs on the above two points.  Goal: Arrive at an agreeable formulation of proposal 1.A after resolving the two points. |

Observation:

* The use of TCI state ID (using Rel.15/16 design with an ID pointing to both QCL-TypeA and TypeD RSs) represents the majority view. The main argument for this is that a TCI state ID allows a common TypeD RS across all CCs while (with the same ID) different TypeA RSs can be used across CCs.
* It was pointed out that in Rel.15/16, UL (analogous to separate UL TCI in unified TCI framework) does not employ TCI state ID. This is not a problem for joint TCI since UL TX spatial filter follows DL Rx staila filter by default. For separate UL TCI based on Rel.17 unified TCI framework, the same design ID-based can be extended as well.

Taking into account the above (as well as other inputs), Proposal 1.A can be revised as follows:

**(Revised) Proposal 1.A**: On Rel.17 unified TCI framework, support common TCI state ID update and activation to provide common QCL information and/or common UL TX spatial filter(s) across a set of configured CCs:

* The above applies to intra-band CA
* The above applies to joint DL/UL and separate DL/UL beam indications
* Just as Rel.16, the RS in the TCI state that provides QCL-TypeA shall be in the same CC as the target RS
* The common TCI state ID implies that the indicated TCI states should be configured with the same RS to provide QCL Type-D indication and the same RS to determine UL TX spatial filter across the set of configured CCs
* FFS: The above also applies to inter-band CA
* FFS: TCI state pool for CA
  + Opt-1: sharing a single RRC TCI state pool for the set of configured CCs, e.g., cell-group TCI state pool, or reuse TCI state pool for PDSCH in a source cell;
    - FFS: Whether it is possible that a single TCI state in the pool includes all source RSs from different CCs
  + Opt-2: configuring RRC TCI state pool per individual CC
* FFS: Whether the R17 common beam update across multiple CCs can also apply to beam indication for single channel (e.g. PDSCH only, single CORESET) or a subset of channels

Table 1 Additional inputs for round-3 discussion: two unresolved points of proposal 1.A

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| **Company** | **Input** |
| Qualcomm | For TCI state vs TCI state ID, we prefer to keep ID. Otherwise, it may imply all CCs will use a common TCI with a common TypeA RS, which may not be compatible with current spec/implementation  For TCI pool, slightly prefer to reuse per-CC based pool as in R15/16. Because single TCI pool across CCs may require gNB to configure same TypeA and TypeD RS IDs for a given TCI ID across all CCs, and the rule for MAC-CE activating TCI per individual CC may also need to be changed accordingly. |
| CATT | First FFS point: Support this option, which is aligned with Rel.16 design.  Second FFS point: Support this option. For UE not supporting this feature, UE capability signaling can be introduced.  Third FFS: Slightly prefer per-CC based TCI pool as in Rel.15/16, for the sake of flexibility and inter-band CA scenario. |
| Apple | First discussion point: Support TCI instead of TCI ID. In Rel-16, UL is based on TCI, and DL is based on TCI ID.  Second discussion point: Support the FFS. This is a good study point. RRC overhead becomes more and more important from UE memory perspective. |
| ZTE | For TCI state vs TCI state ID, we share the same views with QC that TCI state ID is preferred to be kept. For the signaling perspective, we anyway need to indicate an ID for updating TCI state.  For TCI pool, we need to discuss whether or which QCL information can be applied across different CCs, then we can further discuss “Opt-1 sharing a same RRC pool for a configured CC set” or “Opt-2 per-CC RRC pool”.   * In our views, we prefer to keep Rel-16 rule: QCL TypeA shall be in the same CC as the target RS, but QCL-TypeD can be applied across CC. * Regarding QC comments, if going with a single RRC pool, we think that there is no need for changing a rule for MAC-CE activating TCI per individual CC. In short, a UE may determine the separate RS resources with a same QCL type-A RS ID in a common TCI state per individual CC, rather than separate TCI state with a common TCI state ID per individual CC.   Then, we have the following proposed update:  **Proposal 1.A**: On Rel.17 unified TCI framework, support common TCI state ID update and activation to provide common QCL information and/or common UL TX spatial filter(s) across a set of configured CCs:   * The above applies to intra-band CA * The above applies to joint DL/UL and separate DL/UL beam indications * ~~FFS: Just as Rel.16, the UE will find the corresponding TCI state in the corresponding CC and apply the corresponding TypeA and TypeD QCL assumption from the TCI state ID~~ * Note: Just as Rel.16, the RS in the TCI state that provides QCL TypeA shall be in the same CC as the target RS, whereas the RS in the TCI state that provides QCL TypeD can be in the same CC or in a different CC as the target RS * FFS: The above also applies to inter-band CA * FFS: TCI state pool in CA   + Opt-1: sharing a single RRC TCI state pool for the set of configured CCs, e.g., cell-group TCI state pool;   + Opt-2: configuring RRC TCI state pool per individual CC |
| OPPO | In our view, the motivation for this design is to use a single signaling to provide the same DL Tx beam and same Rx beam for a set of CCs. Thus in the framework of unified TCI state, the functionality is we use DCI to indicate the TCI switch and same QCL-TypeD for DL and same UL Tx spatial filter are applied to those CCs.  **Proposal 1.A**: On Rel.17 unified TCI framework, support to use a single signaling of TCI update ~~common TCI state ID update and activation~~ to provide common QCL-typeD information and/or common UL TX spatial filter(s) across a set of configured CCs:   * The above applies to intra-band CA * The above applies to joint DL/UL and separate DL/UL beam indications * FFS: Just as Rel.16, the UE will find the corresponding TCI state in the corresponding CC and apply the corresponding TypeA and TypeD QCL assumption from the TCI state ID * FFS: The above also applies to inter-band CA * FFS: sharing a single RRC TCI state pool for the set of configured CCs |
| NTT Docomo | We agree with the “TCI state ID”. If we remove “ID”, it looks to imply even the Type A RS can be common across CCs, which is different from Rel.15/16.  Third FFS: We prefer per-CC based TCI pool as in Rel.15/16. The similar mechanism of “the simultaneous beam update across CCs in Rel.16” can be reused for common TCI framework. |
| LG | Regarding to TCI state vs. TCI state ID, prefer TCI state ID as Rel-16. We may consider further enhancement to update QCL-TypeD RS later. |
| Xiaomi | For TCI state vs TCI state ID, we share the same views with QC and ZTE that TCI state ID is preferred to be kept.  While for RRC TCI state pool, we slightly prefer per-CC based TCI state pool. |
| MediaTek | First discussion point: we think use TCI state instead of TCI ID is fine, even QCL TypeA shall be in the same CC as the target channel/RS. This is because in each QCL-Info of a TCI state, the serving cell index associated with target RS is optional. If the serving cell index is absent, we can further define that the RS is located on the serving cell in which the common QCL information is applied. Of course this will cause some spec impacts, but we think it is not a big problem and can be clarified in the Note of the discussion point.  Second discussion point: we slightly change the wording from TS38.213 as follows:   * ~~FFS: Just as Rel.16, the UE will find the corresponding TCI state in the corresponding CC and apply the corresponding TypeA and TypeD QCL assumption from the TCI state ID~~ * Note: If the RS in QCL-Info of the TCI state is not associated with a serving cell index, the RS is located on a serving cell in which the common QCL information is applied. The RS in QCL-Info of the TCI state can be located on a serving cell other than the serving cell in which the common QCL information is applied only if the qcl-Type is configured as typeC or typed.   Third discussion point: we support a single TCI pool across a set of CCs. |
| Spreadtrum | For TCI state vs TCI state ID, since we need to achieve common beam across CCs, it’s not clear to us why we should allow a TCI state ID being associated to different beams in different CCs. Therefore, it should be common TCI state update.  Regarding the second discussion point, we support sharing a single RRC TCI state pool for the set of configured CCs. |
| Nokia, NSB | For the 1st issue, we are O.K. with ‘ID’. It means Rel-16 link simultaneous activation of TCI states across multiple CCs. For the 2nd highlighted issue, we support to capture 3rd bullet without FFS, since we don’t see other usecase where QCL-TypeA RS is transmitted on the CC where the target signal is transmitted |
| Huawei, HiSilicon | As commented before, we slightly prefer to keep the same design principle as in R16, as the impacts of moving TCI states outside of serving cell configuration is unclear to us at this moment. |
| Ericsson | First discussion point: Support to keep TCI state ID, since the QCLTypeA properties cannot be shared across CCs.  Second discussion point: This is signaling design, and can be left to RAN2. If RAN1 needs to decide, we prefer to keep the (DL) TCI states in the PDSCH configuration. |
| Samsung | There is a one-to-one mapping between TCI State and TCI State ID, the TCI state ID is included in the TCI state, indication is by the TCI state ID. Therefore, we prefer to use TCI State ID. The TCI Sate ID can point to a TCI state with different QCL-TypeA RS for each CC, and a same QCL-TypeD RS for a subset of CCs. |
| Convida Wireless | We also prefer to keep TCI state ID and per CC TCI state pool |
| After revision | |
| FUTUREWEI | For the 1st discussion point, as can be seen from the above inputs from the companies, choosing between “common TCI state ID” and “common TCI state” have quite different implication on designs such as TCI pool (per-CC or common), applicable QCL Types (only TypeD or as TypeA), only same carrier QCL RS or can be cross-carrier, etc. If we are going to select now, it is better to spell out designs implied by such a decision clearly. To use “common TCI state ID”, we are reusing R16 mechanism and hence having per-CC TCI state pool at least for QCL-TypeA. If this is clear to everyone with the FFS points clarified, we are ok with “TCI state ID”.  [FL ans] The revised version may clarify this issue, at least partially (to make it clear that a common ID wil always infer a common QCL Type-D even if it can infer different QCL Type-A across CCs). The pool issue can be FFS and perhaps more related to RAN2 (as pointed out by several companies). |
| Intel | We are ok with the updated Proposal 1.A  For the last FFS, Option 1, we would like to understand the benefits of a shared TCI state pool. In our understanding, each BWP has its own configured TRS and therefore for QCL Type A reference, we would still need the same number of TCI state IDs for shared or per CC TCI state pool. In this case, what would be the advantage of shared pool over separate pool?  [FL ans] This pool problem can be discussed in the next meeting, |
| InterDigital | We are generally fine with the principle, but the wording of the proposal may be a bit confusing. In that regard, we propose following updates:  On Rel.17 unified TCI framework, support common TCI state update and activation based on the indication of TCI state ID (analogous to Rel-15/16) to provide common QCL information and/or common UL TX spatial filter(s) across a set of configured CCs:  [FL ans] Thanks, this has been addressed in the revised version (fourth bullet) per Apple’s offline comment. |
| Qualcomm | Suggest to add the following FFS in updated Proposal 1.A. Slightly prefer Opt-2   * FFS: Whether the R17 common beam update across multiple CCs can also apply to beam indication for single channel (e.g. PDSCH only, single CORESET) or a subset of channels |
| vivo | Clarification on the understanding of single TCI state pool (opt-1): is it correct understanding that a single TCI state in the pool includes all source RS from different CCs? Hope to FFS such possibility. |
| Lenovo/MoM | We prefer to use TCI state ID because the ID is what is used for TCI indication. This also allows the case when the state TCI state ID indicates different RS for QCL-Type A are used in different CC.  Regarding the last FFS, we think configurating TCI state pool for a group of CC (Opt-1) does not exclude configuring TCI state per CC (Opt-2). The TCI state pool for a CC depends on whether it is part of a CC-group (Opt-1) or not (Opt-2). Both should be allowed. |
| Apple2 | We have concern to use TCI state ID. We should try to avoid the simultaneous Tx/Rx issue at the starting point.  We suggest at least we use TCI state for UL side, which is to be aligned with Rel-16 design.  [FL ans] Per offline discussion, the revised version will clarify this issue, at least partially (to make it clear that a common ID wil always infer a common QCL Type-D even if it can infer different QCL Type-A across CCs). |
| ZTE2 | Some other companies also prefer to reuse the PDSCH TCI state pool in opt-1 which seems to be a good solution with minimizing spec impact.  @Intel, in our views, “the advantage of shared pool over separate pool” is to avoid the duplicated TCI state pools to be configured per CC. As you see, there are same QCL/beam candidates for each of configured CC, and gNB has to copy the pool for each of CC. The RRC overhead is huge (~100kB). For QCL-Type A RS, we think that, from spec perspective, a CC ID for QCL-Type A RS is absent in TCI, and its CC ID is determined according to each of the target CC(s), respectively. In practice, a UE can automatically copy this single TCI state pool for each of CC(s), and QCL Type A RS is separately selected from the target CC according to the RS ID in the TCI state pool.  @vivo, to be honest, we do NOT think that including all source RS from different CCs is needed. If so, the overhead is still there as Opt-2.  Please check the following updated version for the last FFS part:   * FFS: TCI state pool in CA   + Opt-1: sharing a single RRC TCI state pool for the set of configured CCs, e.g., cell-group TCI state pool, or reuse TCI state pool for PDSCH in a source cell;   + Opt-2: configuring RRC TCI state pool per individual CC |
| MediaTek2 | Even we still prefer use TCI state instead of TCI state ID, we can go with majority to support using TCI state ID.  Meanwhile, Option 2 is a more reasonable choice if TCI state ID is adopted. |
| OPPO2 | spatial Tx filter is applied to all the CCs. Whether using “common TCI state update” or “common TCI state ID” can be the next level discussion.  Therefore, we suggest the following change to the main bullet of the proposal.  **Proposal 1.A**: On Rel.17 unified TCI framework, support common TCI ~~state ID~~ update and activation to provide ~~common~~ same QCL-TypeD information and/or ~~common~~ same UL TX spatial filter(s) ~~across~~ for a set of configured CCs:  [FL ans] the revised version will clarify this issue, at least partially (to make it clear that a common ID wil always infer a common QCL Type-D even if it can infer different QCL Type-A across CCs). |
| Sony | For TCI state vs. TCI state ID, like many others, we prefer to keep the ID as “TCI state ID”.  As for TCI state pool configuration, we are fine with Opt.2, i.e. TCI state pool per individual CC, since each CC may need to be configured with CC-dependent source RS for QCL-TypeA. At current stage we are open to further discuss Opt.1 and Opt.2. |
| AT&T | Ok with revised proposal 1A, and configuring RRC TCI state pool per individual CC |

TCI state pool

The following was agreed in RAN1#102-e:

* For Rel.17 NR FeMIMO, on the unified TCI framework
  + Support joint TCI for DL and UL based on and analogous to Rel.15/16 DL TCI framework
    - …
    - FFS: When used for the purpose of joint beam indication for UL and DL, whether a joint TCI pool for DL and UL dedicated for the purpose is used, or the same TCI pool as that used for the purpose of separate DL/UL beam indication is used
    - …

The following was agreed in RAN1#103-e:

On Rel.17 unified TCI framework, to accommodate the case of separate beam indication for UL and DL:

* Utilize two separate TCI states, one for DL and one for UL
* FFS: Whether the UL TCI state is taken from a common/same or separate TCI state pool from DL TCI state

With the understanding that TCI state pool refers to a set of TCI states configured via higher-layer signaling, the following alternatives are available:

* Alt1. A joint DL/UL TCI state pool is used for joint DL/UL TCI, and the same joint DL/UL TCI state pool is used for separate DL/UL TCI
* Alt2. A joint DL/UL TCI state pool is used for joint DL/UL TCI, and separate DL/UL TCI state pools are used for separate DL/UL TCI
* Alt3. Separate DL/UL TCI state pools are used for joint DL/UL TCI, and the same separate DL/UL TCI state pools are used for separate DL/UL TCI
* Alt4. Separate DL/UL TCI state pools are used for joint DL/UL TCI, and a joint DL/UL TCI state pool is used for separate DL/UL TCI

Among the above four alternatives, Alt4 is less motivated for an apparent reason (if joint TCI uses separate pools for DL and UL, using a joint pool for separate DL/UL TCI is difficult to justify). Therefore, Alt4 can be precluded.

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| Action: Interested companies are encouraged to provide their preferences among Alt1, Alt2, and Alt3 (and their reasoning)  Goal: Select one of the three alternatives and, after that, formulate a proposal for endorsement |

**Observation**:

* Alt1 represents the majority view while the use of joint DL/UL TCI state pool for joint DL/UL TCI is almost unanimous.
* Regarding the TCI state pool for separate DL/UL TCI, most companies prefer the use of joint DL/UL TCI state pool mainly for simplicity, while some prefer using separate DL/UL TCI state pool for more flexibility/modularity. However, there is still some concern primarily since the use of SRS (UL RS) for DL QCL Type D source is not yet finalized. Therefore, the pool design for separate DL/UL TCI may need to be decided concurrently or after the said SRS issue is resolved.

Taking into account the above (as well as other inputs), Proposal 1.B can be revised as follows:

**Proposal 1.B**: On Rel.17 unified TCI framework:

* A joint DL/UL TCI state pool is used for joint DL/UL TCI state update (beam indication).
* FFS: Whether the same joint DL/UL TCI state pool or two separate DL/UL TCI state pools will be used for separate DL/UL TCI state update (beam indication)
* Note: Here, TCI state pool refers to a pool configured via higher-layer (RRC) signaling

Table 2 Additional inputs for round-3 discussion: TCI state pool

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| **Company** | **Input** |
| Qualcomm | Prefer Alt.1. Otherwise, DCI for beam update may have to indicate the TCI ID is from the DL, UL, or joint pool, in addition to the TCI ID. |
| CATT | Prefer Alt-1. |
| Apple | Maybe after we see more details for UL TCI design, we can finish this issue.  Before that, we would like to clarify the meaning of “joint DL/UL TCI indication” and “separate DL/UL TCI indication”. Is it correct understanding that “joint DL/UL TCI indication” means gNB indicate 1 TCI which is used for both UL and DL, and “separate DL/UL TCI indication” means gNB indicates two TCIs – one for UL and the other for DL?  [FL ans: Correct] |
| ZTE | Prefer Alt.1, if above candidate is from the perspectives of RRC level.   * Because of always including QCL-Type D information in TCI state, the motivation of further introducing “UL spatial relation” is unclear. Considering backward compatibility, we can consider to use a RRC-level function of mapping UL parameters (e.g., SRS, or pathloss RS) with a TCI state, rather than modifying the existing RRC TCI state directly. * Regarding Apple’s comment, it is “yes” in our views.   For MAC level, we can live with separate pool in the case of using for separate DL and UL indication, if majority companies think there may be different candidate activated TCI pools for DL and UL, respectively. |
| OPPO | Alt-1 is preferred for unified design. |
| NTT Docomo | Prefer Alt. 1. |
| LG | Alt1 is slightly preferred. |
| Xiaomi | We prefer Alt 1 |
| MediaTek | Same question as ZTE, is higher-layer signaling is the same as RRC signaling? If yes, we can support Alt.1.  [FL ans] Yes, it is RRC |
| Spreadtrum | We support common TCI configuration structure for joint and separate UL/DL TCI. Alt-1 is preferred. |
| Nokia, NSB | Since different reception and transmission capabilities are typically assumed (e.g. 3 RX panels and 1 TX panel at a time) for the UE as well as due to e.g. MPE mitigation the MAC filtered/activated TCI states may need to be different for DL and UL at a time. Thus, we consider the **Alt2 and Alt3 are the feasible options** to make the final selection. As QCL-TypeD RS can act as a QCL source for DL and spatial relation for UL, **Alt2 could be simpler**. |
| APT | We are not clear if there is any relationship between joint TCI state pool and separate TCI state pool in Alt2. Specifically, is the joint TCI state pool the same as the DL TCI state pool from separate TCI state pools?  [FL ans] Correct. Separate UL is viewed as a special (rarer) case when MPE event occurs. Therefore, unless MPE event occurs, joint TCI is the default operational mode. |
| Huawei, HiSilicon | We found it difficult to understand the alternatives listed above. With the current formulation, it seems ‘joint DL/UL TCI’ does not mean ‘joint beam indication for DL and UL’. Instead, ‘joint DL/UL TCI’ may refer to ‘joint indication of a DL TCI state and a UL TCI state’. Is this the correct understanding?  [FL ans] Joint DL/UL TCI is a single TCI used for DL and UL (RAN1#102-e agreement).  Assuming this is the case, we prefer Alt3, as such separate pooling is easier for NW configuration, and the identification of the corresponding pool can be performed by MAC-CE level instead of DCI level. |
| Ericsson | We think this is confusing. “Separate pools” would seem to indicate that the TCI states in the pools are of different kind. With this understanding, Alt3 cannot work for joint DL/UL TCI: a joint DL/UL TCI state would have to come from one pool.  In our understanding, Alt1 is the previous Alt2-1 and Alt2 is the previous Alt2-2. We suggest to sticking to those alternatives.  [FL ans] New Alt1 corresponds to Alt2-1 for separate DL/UL + joint DL/UL TCI pool for joint TCI  Comment to Qualcomm: for all 3 alternatives, two beam indications must be provided to the UE. |
| Samsung | Prefer Alt-1. For a unified TCI framework it seems reasonable to have a common TCI pool for joint and separate TCI states. |
| Convida Wireless | Also prefer Alt 1. |
| After revision | |
| FUTUREWEI | We prefer Alt. 3. UL TCI state may comprise UL-related parameters which is not needed in DL TCI state. Separate DL/UL TCI state pools could result in a cleaner TCI state pool design with less impact on the existing DL TCI state pool design. |
| Intel | We are ok with the updated Proposal 1.B.  The wording can be updated by replacing DL/UL TCI with DL/UL beam indication. Maybe simpler wording can also be used i.e., A single TCI state pool is used for joint DL/UL beam indication, and for separate DL/UL beam indication  In our understanding, all aim of all four alternatives is to enable joint and separate beam indication. Assuming the following revised wording represents accurate understanding of the other alternatives from the initial discussion, we have some questions for clarification   * Alt2. Three TCI state pools are used, one for joint DL/UL beam indication, and two separate DL and UL TCI state pools separate DL/UL beam indication * Alt3. Two separate DL and UL TCI state pools are used for joint DL/UL beam indication, as well as for separate DL/UL beam indication * Alt4. Three TCI state pools are used, two separate DL and UL TCI state pools are used for joint DL/UL beam indication, and single TCI state pool is used for separate DL/UL beam indication   For Alt.2, we would like to clarify that if we agree to use 3 different TCI state pools, then associated enhancement of MAC-CE might be necessary. There can be 3 sets of TCI codepoints or there needs to be some signaling to indicate which codepoint maps to which TCI state pool?  [FL ans] For Alt2, two pools would suffice. The pool used for joint TCI would be the same as the one used for separate DL TCI.  For Alt.3, is the understanding that the separate TCI state pools behave similar to Rel-16 default beam framework i.e., for example when UL TCI pool is not available, the DL TCI pool can be used to indicate UL beam?  [FL ans] As commented by Ericsson, Alt3 seems peculiar. |
| Fraunhofer | Prefer Alt-2 or Alt-3. Support separate TCI state pools at least in the case of separate beam indication. |
| InterDigital | We are fine with Moderator’s proposal |
| Qualcomm | Support FL’s Proposal 1.B |
| vivo | Support FL proposal. |
| Lenovo/MoM | Support proposal 1.B |
| Apple2 | By same pool, is it correct understanding that some TCI cannot be configured for DL, since the source RS is SRS? |
| Huawei, HiSilicon | We still have concerns on Proposal 1.B, especially the 2nd sub-bullet. As the content of DL QCL indication and UL beam indication are quite different (the former can consist of two RS(s), while the latter involves only one RS), we still don’t see it as a good idea to mix them into one TCI state definition or one TCI state pool. By discussing such pooling concepts, it seems we are now touching RAN2 territory. In our view, similar as in R15, it would be more straightforward for RAN1 to discuss the supported combinations of source RS(s) for joint DL/UL, DL-only, and UL-only QCL/beam indication, and leave the signaling structure to RAN2. |
| ZTE2 | Support FL’s Proposal 1.B.   * If possible, we can highlight this proposal is just for RRC level. It may be related to Huawei’s comment, and we only need a global RRC TCI state ID for joint DL/UL, DL-only, and UL-only QCL/beam indication |
| MediaTek2 | Support FL’s Proposal 1.B, with adding “RRC”.  Proposal 1.B: On Rel.17 unified TCI framework:   * A joint DL/UL RRC TCI state pool is used for joint DL/UL TCI. * The same joint DL/UL RRC TCI state pool is used for separate DL/UL TCI |
| Xiaomi2 | First we want to clarify two points.  Point 1: Here we assume that all UEs can support beam correspondence? [FL ans: Yes]  Point 2: There is only one source RS in each TCI state for each TRP for beam indication? [FL ans: Not agreed yet ☺ but that’s one possibility]  If my understanding is correct, TCI with DL source RS can be configured for UL and TCI with UL source RS can be configured for DL. Thus if there is a UL beam with MPE, gNB can indicate another TCI with different source RS to indicate another UL beam. So we think it is reasonable to support a same TCI state pool, i.e. Alt 1.  [FL ans: Your understanding is correct. But we haven’t finalized the support for SRS for DL QCL Type D source. So while we can decide the pool issue for joint TCI, we cannot do so for separate TCI]  If my understanding is not correct, if some UE cannot support beam correspondence or if there are two source RSs in some TCI states, it is better to configure three different TCI state pools for joint DL/UL TCI, separate DL TCI and separate UL TCI respectively, i.e., the updated Alt 2 by Intel. |
| Sony | In terms of flexibility, we prefer Alt.2. In addition, we share the same concern as mentioned by Apple2 that if SRS configured as source RS in one TCI state in joint TCI state pool, then it seems that this TCI cannot be applied to indicate DL Rx for UE, given the current progress in RAN1. So a separately configured DL TCI state pool may provide such flexibility. |
| AT&T | Need clarification on what same TCI state pool mean for separate indication.  [FL ans] It is now under FFS. Basically it implies that the same TCI state pool will be used for separate UL TCI state update (MPE) as that for joint TCI and separate DL TCI state update |

* 1. Issue 2 (L1/L2-centric inter-cell mobility)

**(Initial) Proposal 2.A**: On Rel.17 enhancements to enable L1/L2-centric inter-cell mobility:

* ...
* The following enhancement scope is assumed:
  + No RRC reconfiguration signaling is needed during and after handover when a TCI associated with non-serving cell RS is indicated
    - A non-serving cell RS is an RS that is or has an SSB of a non-serving cell as direct or indirect QCL source
    - This implies no C-RNTI update during inter-cell mobility during and after handover
  + ...

One unresolved point was related to whether the blue highlighted text should be made a Working Assumption. Those arguing as such (e.g. Nokia, OPPO) seem to be primarily concerned on making a premature agreement without checking with RAN2 (note: sending an LS to RAN2/4 is too premature at this point since there is no TU allocation for Rel.17 FeMIMO in RAN2/4 yet – the FL is compiling a list of potential issues for a planned LS later in 2021). Those arguing against making the blue highlighted text a Working Assumption (e.g. Ericsson) fails to see the relevance of a Working Assumption in a scope.

|  |
| --- |
| Action: Interested companies are encouraged to provide their inputs on the above point  Goal: Arrive at an agreeable formulation of the blue highlighted text of proposal 2.A after resolving the point |

Observation: Based on the inputs, it seems the majority prefer to leave this as FFS for now. This, however, should be discussed in the near future preferably with some involvement from RAN2. A clarity on this issue would help defining the enhancement scope clearer.The revised wording from Nokia seems appropriate with WA changed to FFS (for now):

(Revised) **Proposal 2.A**: On Rel.17 enhancements to enable L1/L2-centric inter-cell mobility:

* ...
* FFS: The following enhancement scope is assumed by RAN1:
  + Whether RRC reconfiguration signaling is needed or not when a TCI associated with non-serving cell RS is indicated
    - A non-serving cell RS is an RS that is or has an SSB of a non-serving cell as direct or indirect QCL source
    - This implies no C-RNTI update when UE receives DL channel RS associated to non-serving cell RS as QCL source.
  + Whether some RRC parameters need to be updated without additional RRC signaling, e.g. some RRC parameters are pre-configured, which are associated with TCI states with neighbor cell RS as QCL source
  + The above assumption to be verified by RAN2
* ...

Table 3 Additional inputs for round-3 discussion: RRC point of proposal 2.A

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | Prefer to leave those issues open for now, i.e. no WA or agreement on those bullets. Light RRC reconfig may be beneficial if gNB cannot ensure identical configurations across different cells.  For potential LS to RAN2/4, we suggest to check with RAN4 for the feasibility to accomplish the feature of one-shot TA update in R17. Because this feature is our assumption for the TA part to work when the cell is changed. It would be good to check with RAN4 on their plan. |
| Apple | We think this issue is an important clarification for inter-cell mobility. If RRC reconfiguration signaling is still required, the bottleneck should still be the RRC latency. Then we failed to see the necessity for this enhancement. |
| ZTE | We prefer to FFS those issues firstly. It seems to be too strong of precluding any RRC reconfiguration signaling at this early stage. Or, we can use a more general description, like “Striving to minimizing/precluding RRC reconfiguration signaling …” |
| OPPO | After studying more on this issue, we think it is too risk to make an working assumption or agreement on this. As defined in RAN2 spec, the handover starts from the Handover request msg sent to the target cell and ends with the UE sending response to the handover command. Even assuming there is no RRC parameter configuration change between the source gNB and target gNB, there still exist some higher layer change. For example, a UE handover from cell-A to cell-B. Before handover, the cell-A is serving cell while cell-B is non-serving. After handover, cell-B becomes serving cell while cell-A becomes non-serving cell. As a result, all the RS resources configured in RRC layers would experience the same transform. A non-serving cell RS becomes a serving cell RS while a serving cell RS becomes a non-serving cell RS, which happens during and after handover. Regarding the assumption of C-RNTI is not changed, we shall discuss with RAN2 if C-RNTI can be moved from one cell to the target cell without any change. Another confusion part is the system information. Which system information (serving cell or target cell) is the UE going to use and when is the UE going to start to use for the configuration of PRACH, paging, group-common PDCCH and PUCCH? All those questions need input from the RAN2.  There we would suggest to put the proposal to FFS so that we can study more on that to get clear understanding on this issue much more related with RAN2.   * FFS: if the following can be assumed: * FFS: If there is No RRC reconfiguration signaling is needed during and after handover when a TCI associated with non-serving cell RS is indicated * FFS: if there is no C-RNTI update during inter-cell mobility during and after handover |
| NTT Docomo | We also prefer to keep open for now (i.e. no WA/agreement). This is related to the discussion on MTRP inter-cell mobility. We should further study it, and it is too early to conclude no RRC reconfiguration signaling is needed. |
| LG | We are supportive on the Proposal2.A and confirming by RAN2 seems not be needed since the proposal would not cause any impact on RAN2’s work to our understanding. We are fine with checking with RAN4 for the feature of one-shot TA as suggested by Qualcomm. |
| Xiaomi | We prefer to leave this issue to FFS |
| Nokia/NSB | We are not negative to indication of non-serving cell RS as QCL source via TCI state, which mean enable UE to receive PDCCH/PDSCH/RS from non-serving cell without reconfiguration of RRC. But we do not think such operation needs to define new hand over operation. We also believe hand over process needs to be discussed and confirmed via multiple working groups. So we suggest to clarify L1 operation here and to have further discussion whether new handover operation will be clarified. Please see our modification below:   * [Working assumption] The following enhancement scope is assumed by RAN1:   + No RRC reconfiguration signaling is needed ~~during and after handover~~ when a TCI associated with non-serving cell RS is indicated     - A non-serving cell RS is an RS that is or has an SSB of a non-serving cell as direct or indirect QCL source     - This implies no C-RNTI update when UE receives DL channel RS associated to non-serving cell RS as QCL source. ~~During inter-cell mobility during and after handover~~ * The above assumption to be verified by RAN2 |
| APT | While we prefer no RRC reconfiguration, it is too early to make the decision now. |
| Huawei, HiSilicon | Our understanding is the WID already precluded RRC reconfiguration during L1/L2-centric inter-cell mobility. It is also our understanding that such L1/L2-centric inter-cell mobility naturally involves moving from one cell to another cell, i.e., handover. If RAN1 cannot agree on keeping several important configurations unchanged, such as C-RNTI and integrity/ciphering, we are not sure how we can design L1/L2-centric inter-cell mobility without incurring RRC reconfigurations. We are fine to make Proposal 2.A above as working assumption to be checked by RAN2. |
| Ericsson | We are generally fine with proposal 2A. However, we think Nokia has a good point: we should avoid using the term “handover”.  We suggest the following combination of proposal 2A and Nokia’s proposal:   * The following enhancement scope is assumed by RAN1:   + No RRC reconfiguration signaling is needed ~~during and after handover~~ when a TCI associated with non-serving cell RS is indicated     - A non-serving cell RS is an RS that is or has an SSB of a non-serving cell as direct or indirect QCL source     - This implies no C-RNTI update when UE receives DL channel RS associated to non-serving cell RS as QCL source. ~~During inter-cell mobility during and after handover~~   This formulation is quite precise, and it would not seem likely that RAN2 would have any comment on the TCI state indication.  For companies who prefer to allow small RRC reconfigurations, note that this is not precluded – it is only stated that it is not needed. But that would be up to RAN2. |
| Samsung | Some of the design aspects of this proposal fall under RAN2, for example not updating the C-RNTI as UE moves from one cell to the next. When the UE moves from cell A to cell B does the UE derive its system information (e.g. RACH and paging) from cell B or continue to use that of cell A. We prefer to keep this part FFS. |
| After revision | |
| FUTUREWEI | We prefer FFS for this issue and suggest RAN1 getting inputs on this topic from RAN2. |
| Intel | We would like to understand the proposals from Ericsson and Nokia in a little more detail. Based on the wording, it would imply that the serving cell ID does not change, and the UE simply switches to the other TRP when TCI associated with non-serving cell is indicated. How is this different from inter-cell multi-TRP operation? Additionally, what are the assumptions for UL channels/RSs?  [FL ans: This can be done in the next meeting by the proponents since this is the farthest we can go in RAN1#103-e] |
| InterDigital | We are fine with the updated proposal from Nokia. |
| Qualcomm | Support FL’s Proposals 2.A. Should we explicitly say to send LS to RAN2 for verification? |
| Vivo | Support FL proposal 2.A. We would also prefer to send LS to RAN2. It seems that although there is no explicit TU in RAN2 but LS could still be handled. |
| Lenovo/MoM | If we accept Proposal 2.A, does it mean there will be no RRC configuration even if all TCI states are associated with non-serving cell RS? We think this is a very different scenario when only one or part of the TCI states are associated with no-serving cell. This assumption needs confirmation from RAN2. |
| Apple2 | We are ok to study this assumption.  In our view, we should study two points:   * Whether RRC reconfiguration signal is needed * Whether some RRC parameters need to be updated without additional RRC signaling, e.g. some RRC parameters are pre-configured, which are associated with TCI states with neighbor cell RS as QCL source.   We suggest we add the second bullet above as a study point. |
| Huawei, HiSilicon | Regarding Proposal 2.A, we have similar questions as Intel and prefer to see some explanations.  [FL ans: This can be done in the next meeting by the proponents since this is the farthest we can go in RAN1#103-e] |
| ZTE2 | Support FL’s Proposal 2.A. |
| OPPO2 | Regarding the revised Proposal 2.A, we think the “during and after handover” shall be included because the issue here is L1/L2-centric inter-cell mobility  [FL ans: Good point, but the latest version per Apple’s comment shifts the question to whether ... or. So “during and after HO” can be discussed together later] |
| Sony | At current stage, we prefer to keep “FFS”. As we have not completed the design for TCI states (containing non-serving cell information), it would be too early to exclude all RRC signaling for inter-cell mobility. |

* 1. Issue 3 (beam indication signaling medium)

“for joint beam indication” text

**Proposal 3.A**: (Yellow 3.1 of issue 3 agreement) “for joint beam indication” text can be addressed as follows:

* The existing DCI formats 1\_1 and 1\_2 are reused for joint DL/UL beam indication
  + ~~FFS: If additional DCI format(s) are supported, e.g. existing DCI formats 0\_0, 0\_1, 0\_2, 1\_0 as well as new DCI format(s) dedicated for beam indication~~
  + FFS: support of DCI format 1\_0 for joint DL/UL or separate DL/UL beam indication
  + FFS: support new DCI format(s) dedicated for beam indication for joint or separate DL/UL beam indication
  + FFS: support for reusing the existing UL-related DCI format(s) (e.g. 0\_0, 0\_1, 0\_2) for joint or separate DL/UL beam indication
  + FFS: support for reusing DCI format 1\_1, and 1\_2 for separate DL/UL beam indication

The part of the agreed text was “(for) beam indication” (“joint” was in red since it was suggested and discussed but without conclusion). During the discussion several versions were proposed:

1. V1. “for joint and separate DL/UL beam indication”: This is equivalent to “for joint beam indication” since the unified TCI framework comprises joint and separate DL/UL.
   1. At least Intel raised some concern on this version
2. V2. “for joint DL/UL beam indication”: This keeps the separate DL/UL mode open. The rationale is that DCI 1\_1/1\_2 only includes DL assignment (but not UL grant). In this case, UL-only beam indication (used when, e.g. MPE event occurs) can only be done when DL assignment is available thereby resulting in poor latency performance.
   1. At least Huawei raised some concern on this version
3. V3. (reworded) “for joint DL/UL beam indication, as well as DL-only beam indication when configured with separate DL/UL beam indication”: This keeps only the UL part for separate DL/UL mode open. The rationale is the same as V2 and there is no reason not to use DCI 1\_1/1\_2 for DL-only beam indication.

The list of FFS doesn’t seem controversial. It only needs to be consistent with the main statement (either V1, V2, or V3).

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| --- |
| Action: Interested companies are encouraged to provide their inputs on selecting among versions V1, V2, and V3 (or in general if/how to revise “for beam indication”)  Goal: Arrive at an agreeable (potential) revision of “for beam indication” and its corresponding list of FFS in Proposal 3.A |

Table 4 Additional inputs for round-3 discussion: Joint beam indication proposal 3.A

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | Slightly prefer V3. It seems reasonable for DL DCI to also indicate DL common beam. |
| CATT | Both V2 and V3 seem feasible, while V3 may be slightly preferable. |
| Apple | Prefer V1. In our understanding, for separate DL/UL beam indication should also lead to the same action time for the new TCI with regard to single-beam tracking loop UE.  Some clarification from Intel would be necessary   * why V1 has problems? * what the alternative should be? * what is the benefit for the alternative compared to V1? * How to make sure the alternative can work for single-beam tracking loop UE |
| ZTE | We support V3.  For each candidates, it seems that we are all on the same page this this DCI format 1\_1/1\_2 can be applied to joint DL/UL beam indication. For separate beam indication, consideration that the time point(s) of separate DL and UL beam indication may be different with high probability should be taken when discussing this issue, and so we prefer to introduce a DCI format 0\_1/0\_2 for separate UL beam indication, while we can reuse this DCI format 1\_1/1\_2 for separate DL beam indication. |
| OPPO | We prefer V1.  We do not see there is any issue of re-using DCI 1\_1 and 1\_2 for both joint and separate DL/UL beam indication. We do not see the feasibility of using 0\_1/0\_2 to provide separate UL beam indication. There is no TCI state field in these two DCI formats. If DCI format 0\_1/0\_2 is used, that would mean we introduce new DCI formats. |
| NTT Docomo | Prefer V1 or V3. It is straightforward to reuse DCI format 1\_1/1\_2 to indicate both the joint DL/UL beam indication and DL TCI of the separate DL/UL beam indication. |
| LG | Prefer to support V1 for simplicity. |
| Xiaomi | We share same view as Qualcomm. We slightly prefer V3. It is reasonable for DL DCI to also indicate DL common beam. |
| MediaTek | V3. It seems it is still very controversial that how to implement UL-only beam indication for separate DL/UL mode. Let’s keep it open. And there is no reason not to use DCI 1\_1/1\_2 for DL-only beam indication. |
| Spreadtrum | Prefer V1. In our views, using DL DCI to indicate UL common beam can be supported. Introducing UL DCI will only increase the beam indication opportunity, and the spec work is not cost-effective. |
| Nokia/NSB | We wonder whether current discussion is aligned with original issue 3, but can accept current text. In general, we think that common DL and UL TCI state indication (both joint and separate DL/UL) should be possible independent of the DL or UL grant. That is because it should be possible for instance to update TCI state for PDCCH monitoring without DL grant and also TCI state for UL resources to transmit periodic CSI report without UL grant. Given that, **V1** seems to be enabling that. |
| APT | Prefer V3. |
| Huawei, HiSilicon | Support V1 only (as part of the compromise). For V2/V3, it is unclear to us how the scheduled PUSCH is to be transmitted, with the previous UL Tx beam or the newly indicated UL Tx beam. If it is the pervious UL Tx beam, why would NW schedule such transmission given the MPE event? If it is the indicated UL Tx beam, how would the NW know if the UE received the DCI or not, given that there is no ACK for UL DCI? |
| Ericsson | Support V1. We want to operate this with only DCI format 1\_1 and 1\_2, and we see the need to do this both for joint and separate DL/UL beam indication. |
| Samsung | PreferV3.  DCI format 1\_1 and 1\_2 include a TCI field when tci-PresentInDCI is enabled. In unified TCI framework it would seem reasonable to indicate the joint DL/UL TCI for a joint DL/UL beam or the DL TCI for the DL beam in case of separate DL/UL beams by the existing TCI field. |
| After revision | |
| FUTUREWEI | We prefer V3. It is reasonable to use DCI formats 1\_1 and 1\_2 for DL common beam indication in the case of separate DL/UL beam indication. |
| Intel | First, we want to note that we have not raised a concern to the specific text in this proposal. We had proposed to include “separate DL/UL beam indication” in the highlighted part when the FFS text was different. Therefore, based on our previous comment **we are OK with V1**. Our comment was related to UL beam indication with different DCI formats which has been added to the FFS of current version.  Additionally, for UL related DCI formats, the term “re-using” is not accurate since there is no TCI in DCI field in those formats. Therefore, the wording should be changed to “using” as follows:   * + FFS: support for ~~re~~using ~~the existing~~ UL-related DCI format(s) (e.g. 0\_0, 0\_1, 0\_2) for joint or separate DL/UL beam indication |
| Fraunhofer | Support V1 or V3. |
| InterDigital | We prefer V3. We think that utilizing UL DCIs for UL scheduling seems reasonable choice. |
| Vivo | Fine with V1. |
| Lenovo/MoM | We support V3. If DCI format 1\_1 and 1\_2 can support joint DL/UL TCI, it should be able to support individual DL TCI. |
| Sony | Prefer V3, with respect to the fields of current DCI format 1\_1 and 1\_2. But in our view, if new DCI format can be designed, than we are open to discuss other Versions. |
| AT&T | V3 is ok with the understanding that this does not mean that V1 is no longer an option for later agreement on UL beam indication |

{Will summarize later – still thinking, for GTW}

UE capability for latency

**Proposal 3.B**: On Rel.17 DCI-based beam indication:

* Regarding application time of the beam indication: if beam indication is received, down-select from the following:
  + Alt1: the first slot that is at least X ms or Y symbols after the DCI with the joint or separate DL/UL beam indication
  + Alt2: the first slot that is at least X ms or Y symbols after the acknowledgment of the joint or separate DL/UL beam indication
  + FFS: whether any existing timing defined for DCI based TCI/spatial relation update can be used for X/Y
* FFS: When and how to apply the minimum beam indication delay
* Support a UE capability for the minimum value of X or Y
  + FFS: the beam application time X or Y is configured by the gNB via higher-layer (RRC) signaling based the UE capability
  + FFS: the exact minimum values of X (e.g., 0.5ms, 2ms, 3ms) or Y supported by UE
  + FFS: Whether to support more than one values of X/Y and UE capabilities for the minimum values of X/Y
  + FFS: whether existing UE capability (e.g. beamSwitchTime) can be reused as this UE capability.
* The latency of the DCI design (with or without specification impact) should be significantly improved with respect to the utilization of MAC CE

Only the blue highlighted text was still in flux during the discussion.

|  |
| --- |
| Action: Interested companies are encouraged to provide their inputs on the blue highlighted text.  Goal: Arrive at an agreeable formulation of the blue highlighted text of Proposal 3.B |

Table 5 Additional inputs for round-3 discussion: UE capability of proposal 3.A

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | Suggest to remove 1st FFS or merge it into 3rd FFS, since 1st FFS seems similar to the 3rd FFS  Suggest to remove 2nd FFS, since UE capability may not make too much sense if there is only a single candidate value. In this case, the spec may simply define a fixed value |
| Apple | Support |
| ZTE | Firstly, we may need to consider using DCI signaling of indicating the applicable time offset, e.g., as for PDSCH reception. Then, besides *beamSwitchTime*, *timeDurationForQCL* that is applied for PDSCH beam switching in R15/R16 should be considered. Please find our update in red.  **Proposal 3.B**: On Rel.17 DCI-based beam indication:   * Regarding application time of the beam indication: if beam indication is received, down-select from the following:   + Alt1: the first slot that is at least X ms or Y symbols after the DCI with the joint or separate DL/UL beam indication   + Alt2: the first slot that is at least X ms or Y symbols after the acknowledgment of the joint or separate DL/UL beam indication   + FFS: whether any existing timing defined for DCI based TCI/spatial relation update can be used for X/Y * FFS: When and how to apply the minimum beam indication delay * Support a UE capability for the minimum value of X or Y   + FFS: the beam application time X or Y is configured by the gNB via higher-layer (RRC) signaling or DCI command based the UE capability   + FFS: the exact minimum values of X (e.g., 0.5ms, 2ms, 3ms) or Y supported by UE   + FFS: Whether to support more than one values of X/Y and UE capabilities for the minimum values of X/Y   + FFS: whether existing UE capability (e.g. beamSwitchTime, timeDurationForQCL) can be reused as this UE capability. * The latency of the DCI design (with or without specification impact) should be significantly improved with respect to the utilization of MAC CE |
| OPPO | Re the 1st FFS:  The existing timing defined for DCI-based PDSCH/AP CSI-RS beam indication is to consider the DCI decoding latency and then determine the default TCI state. A big difference in the new DCI-based TCI indication is a ACK for the DCI would be defined. And the action of applying the new TCI state is after that ACK. So a new timing line will be needed. Thus, the first FFS sub-bullet is not needed.   * + ~~FFS: whether any existing timing defined for DCI based TCI/spatial relation update can be used for X/Y~~   Re the 2nd and 3rd FFS: we support to FFS.  We do not support the “or DCI command” added by ZTE.  Re the last bullet:  the latency of one beam switch would be impacted by multiple factors, including how fast the UE can track the beam, whether the indicated TCI state is known or known and the control signaling used for beam indication. We would have to improve from all those aspects to minimize the latency. Using DCI is one step to reduce the latency of beam operation from the perspective of control signaling. Evaluations have shown that DCI-based beam indication has advantage over MAC CE based method in terms of both latency and signaling overhead. That is one of the reason for the agreement we made for issue 3 previously. And the UE capability of beam update latency will be discussed and specified anyway for this new feature. Thus the added text seems not necessary. |
| NTT Docomo | Support FL proposal. |
| LG | Support FL’s proposal in general while we are still on the fence to agree something for UE capability for latency, which is unclear as we mentioned in e-mail reflector last week. |
| Xiaomi | Support FL proposal |
| MediaTek | Support current proposal.  @Qualcomm, on 2nd FFS, we agree that the number of candidate values supported by UE should be more than one. However, the exact X/Y value should be decided and configured by gNB, and there might be one value for both DL/UL beam indications, or two values, one for DL and one for UL. Thus, we think current wording is fine.  @ZTE, we don’t support the “or DCI command” added by ZTE due to no clear motivation. The value of X/Y shall be decided and semi-statically configured to Ues based on UE capability reports.  @OPPO, since the application time is not decided, it may be Alt 1 (the first slot that is at least X ms or Y symbols after the DCI with the joint or separate DL/UL beam indication). If so, some companies think existing timing can be reused. |
| Spreadtrum | Support to keep these FFSs before making further decisions. |
| Nokia/NSN | Regarding   * + FFS: whether any existing timing defined for DCI based TCI/spatial relation update can be used for X/Y   to recover from the error case that either PDCCH or HARQ-ACK is lost, there should be UE provided minimum beam switching latency from the HARQ-Ack but also network configured and provided overall beam switching latency that is equal to or greater than UE’s provided value.  Regarding   * + FFS: Whether to support more than one values of X/Y and UE capabilities for the minimum values of X/Y   The better procedure here is to agree first what are the possible values of X/Y, the capability definition would follow from that. The current proposal seems to suggest first that there would be multiple values defined, and only then RAN1 will discuss the possible values, and that is reverting the logic of the process.  Regarding   * The latency of the DCI design (with or without specification impact) should be significantly improved with respect to the utilization of MAC CE   we support the requirement since otherwise the feature would be useless.  We have the following proposal   * FFS: When and how to apply the minimum beam indication delay * FFS: Support a UE capability for the minimum value of X or Y   + FFS: the beam application time X or Y is configured by the gNB via higher-layer (RRC) signaling based the UE capability   + FFS: the exact minimum values of X (e.g., 0.5ms, 2ms, 3ms) or Y supported by UE   + FFS: Whether to support more than one values of X/Y and UE capabilities for the minimum values of X/Y   + FFS: whether existing UE capability (e.g. beamSwitchTime) can be reused as this UE capability. |
| APT | We support FL proposal. |
| Huawei, HiSilicon | Regarding Alt1: Given that we agreed to reuse ACK for scheduled PDSCH as that for DCI, we don’t understand the intention of listing Alt1 here, which may leave the PDCCH beam indication unprotected.  Regarding the last bullet: We are not sure about the exactly meaning of ‘significantly improved’ and prefer to avoid such vague statement. As captured in previous bullets, the application timing and UE capability will be discussed anyway. |
| Ericsson | We have strong concerns of   * + FFS: the beam application time X or Y is configured by the gNB via higher-layer (RRC) signaling based the UE capability   The beam application time must be determined by the gNB. This cannot be FFS.  The first FFS seems superfluous –Alt1 and Alt2 seems to span the possibilities  The second FFS is unclear: a UE capability is associated with a set of candidate values – as always. What does the second FFS add to that??  It is unclear what the latest highlighted paragraph means: it sounds like a relevant design target, but what do we really agree to? Do we agree on that the minimum UE capability must be smaller than 0.5ms?  Comment to Huawei: for Alt1, the corresponding application time need to be extended to give time for the ACK. |
| Samsung | Support FL proposal with following updates  The first FFS: Out understanding is that DCI is only used for TCI not spatial relation in R15/R16. We suggest that we can reword as:   * + FFS: whether any existing UE capability ~~timing~~ defined for time of DCI based TCI/~~spatial relation~~ update can be used/updated for X/Y   For second FFS “FFS: Whether to support more than one value …” Is this for the same UE or across Ues. If it is for the same UE what is the rationale for that? If it is for different Ues, then it is natural to have more than one capability to distinguish Ues. In either case, this FFS can be removed  Is there a difference between the last FFS of the first bullet and the last FFS of the third bullet? We think that these two can be merged.  The last bullet is a design target rather than a proposal for DCI design. Maybe we can reword to a note along the lines of …  Note: It is expected that the latency of a DCI-based TCI state update is significantly improved with respect to the latency of a MAC CE-based TCI state update. |
| After revision | |
| FUTUREWEI | It is better to discuss UE capability later after designs are clearer. |
| Fraunhofer | Support FL proposal |
| InterDigital | We are fine with Moderator’s proposal |
| vivo | Supportive of the first FFS |
| Lenovo/MoM | We suggest to remove the first FFS so we can down select between Alt1 and Alt 2.  Regarding the 2nd and 3rd FFS, we think it can be discussed in UE capability. |
| Sony | Support the FL proposal in principle.  Regarding the last bullet (listed as below), would it be better to say “RAN1 strives to reduce the latency of DCI design with respect to the utilization of MAC CE”?   * The latency of the DCI design (with or without specification impact) should be significantly improved with respect to the utilization of MAC CE   Moreover, it seems vague to measure whether the latency performance can be “significant” improved. |

{Will summarize later – still thinking, for GTW}

* 1. Issue 4 (MP-UE)

[X]

* 1. Issue 5 (MPE mitigation)

**(Initial) Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17, investigate and, if needed, specify the following:

* ...
* ...
* Any additional reporting: down-select from the following in RAN1#104-e
  + Alt0: no additional reporting content
  + Alt1: P-MPR + L1-RSRP
  + Alt2: virtual PHR + L1-RSRP
  + Alt3: L1-RSRP/SINR with and without MPE effect
  + Alt4: virtual PHR
  + Alt5: P-MPR or virtual PHR + CRI/SSBRI
  + Other options are not precluded
  + Note that PHR including PH and Pcmax is calculated based on P-MPR and the L1-RSRP

Intel inquired and argued: “... we wanted to clarify if the additional reporting *applies to the current MPE impacted beam or the new candidate beam* which is targeted to be used. In our understanding this should be further clarified... *explicit alternatives* are listed under bullet 3 for down-selection in RAN1#104-e. In this case, it is not clear to us how we are supposed to down-select without knowing *which options apply to which use case*.” (emphasis added)

Intel proposed a more compact alternative text:

* Any additional reporting: down-select from the following in RAN1#104-e
  + Alt0: no additional reporting content
  + Alt1: Additional reporting is supported (for example P-MPR + L1-RSRP, virtual PHR + L1-RSRP, L1-RSRP/SINR with and without MPE effect, virtual PHR, P-MPR or virtual PHR + CRI/SSBRI)
    - Note: Other options are not precluded

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| Action: Interested companies are encouraged to provide their inputs on which of the two versions (blue vs. red) they prefer (or perhaps another)  Goal: Arrive at an agreeable formulation of the text for ‘Any additional reporting’ of Proposal 5.A |

**Observation**: In general, Intel’s more compact version is agreeable to all. Some mentioned that we can remove the examples if other options are not precluded. But this is perhaps not necessary. A minor change to Intel’s version (changing “is supported” to “is included” is done to avoid misunderstanding about support while this issue is still under investigation).

**(Revised) Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17, investigate and, if needed, specify the following:

* ...
* ...
* Any additional reporting content: down-select from the following in RAN1#104-e
  + Alt0: no additional reporting content
  + Alt1: Additional reporting content is included (for example P-MPR + L1-RSRP, virtual PHR + L1-RSRP, L1-RSRP/SINR with and without MPE effect, virtual PHR, P-MPR or virtual PHR + CRI/SSBRI, estimated max UL RSRP)
    - Note: Other options are not precluded
    - FFS: For each option, whether the report is triggered by UE or configured by NW

Table 6 Additional inputs for round-3 discussion: ‘other reporting’ of proposal 5.A

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | We prefer Intel’s compact proposal at this stage. It can have other report metric combinations.  Suggest to add in Alt.1 one more metric “estimated max UL RSRP”, which is equal to max allowed UL Tx power minus path loss   * + Alt1: Additional reporting is supported (for example P-MPR + L1-RSRP, virtual PHR + L1-RSRP, L1-RSRP/SINR with and without MPE effect, virtual PHR, P-MPR or virtual PHR + CRI/SSBRI, estimated max UL RSRP) |
| Apple | OK with either Intel/Qualcomm’s version or proposal 5.A. |
| ZTE | We do not have strong preference to go with original or Intel’s version. But, we think that we need to further discuss these additional reporting based on R16 MPE/PHR reporting. So we suggest to add the following bullet.   * R16 P-MPR/PHR reporting for FR2 MPE mitigation should be considered as starting point for discussing additional reporting content.   [FL ans]: This is already included in the first bullet (not copied above) |
| OPPO | We suggest we to make the following re-wording:   * Any additional reporting, further consider the following:   + Alt0: no additional reporting content   + Alt1: P-MPR + L1-RSRP   + Alt2: virtual PHR + L1-RSRP   + Alt3: L1-RSRP/SINR with and without MPE effect   + Alt4: virtual PHR   + Alt5: P-MPR or virtual PHR + CRI/SSBRI   + Other options are not precluded   + Note that PHR can include a PHR and/or Pcmax, where Pcmax is calculated based on P-MPR and PHR is calculated based on the Pcmax and the L1-RSRP measured from the corresponding CRI/SSBRI. |
| NTT Docomo | We prefer Intel’s version.  We suggest to add a FFS regarding whether the report is triggered by UE or configured by NW, which will lead to different solutions.  With report configured by NW, UE can report feasible panels/beams for UL Tx, so that NW can configure appropriate panel/beam for UL Tx to prevent MPE from happening.  With report triggered by UE, UE can report new panel/beam when MPE happens.  Thus, in our view, whether the report is triggered by UE or configured by NW need to be considered and clarified for further study.   * Any additional reporting: down-select from the following in RAN1#104-e   + Alt0: no additional reporting content   + Alt1: Additional reporting is supported (for example P-MPR + L1-RSRP, virtual PHR + L1-RSRP, L1-RSRP/SINR with and without MPE effect, virtual PHR, P-MPR or virtual PHR + CRI/SSBRI)     - Note: Other options are not precluded     - FFS: for each option, whether the report is triggered by UE or configured by NW |
| LG | Compact proposal from Intel seems reasonable. |
| Xiaomi | OK with either Intel’s version or proposal 5.A. |
| MediaTek | Fine with either Intel/Qualcomm’s version or proposal 5.A.  But we would like to clarify one thing. In last week, the following two reports were agreed to be investigate:   |  | | --- | | **Agreement RAN1#103e**  On UE reporting for MPE mitigation for Rel.17, investigate and, if needed, specify the following:   * Reporting of P-MPR report based on Rel.16 framework.   + FFS: Whether panel/beam level based P-MPR report is supported   + FFS: Maximum reported number of panels, e.g. single or multiple * Reporting SSBRI(s)/CRI(s) and/or indication of panel selection for the purpose of indicating:   + Alt1: alternative UE panel(s) or TX beam(s) for UL transmission   + Alt2: feasible UE panel(s) or TX beam(s) for UL transmission taking the MPE effect into account   + FFS: indication of panel selection details (e.g. explicit/implicit) |   Then, the additional reporting we discussed in yellow part is additional report content(s) along with two reports, or they are different reports  [FL ans] It is additional to the above two |
| Nokia/NSB | A combined version would make sense where alternatives in blue are further studied and additional reporting alternatives could apply both the impacted beams currently activated/in use and the new candidate beams. |
| Huawei, HiSilicon | As commented by MTK, it is unclear whether the examples of additional reporting are in addition to the 1st or 2nd approach agreed to investigate in the last week. The feasibility of some examples are also unclear, such as ‘L1-RSRP/SINR without MPE effect’. It is also unclear these additional reporting are per panel or per beam at UE. In general, we suggest removing all the examples, or adding reference contributions to each of the example.  [FL ans] They are just examples ☺ |
| Ericsson | We prefer Intel’s version – in fact, the examples are unnecessary and can be removed. Since no options are precluded, why do we need a list of examples?  [FL ans] They are just examples ☺ |
| Samsung | Maybe we need to start with what we already support in R15/R16 and what can be additional. Some of the options are not clear. In options 1,2,3 L1-RSRP is already there and we add a second report (P-MPR, virtual PHR, or L1-RSRP with MPE effect). Option 4 seems to be like option 2 but missing some details, Option 5 seems to be a super set of 1,2 and 4.  We slightly prefer going with Intel’s proposal. This is more high-level; first decide if we need to have additional reporting or not. If additional reporting is needed i.e. Alt1 discuss the options in more detail in RAN1#104-e and down select in RAN1#104bis-e |
| Convida Wireless | OK with Intel’s version. |
| After revision | |
| Intel | We are ok with Proposal 5.A |
| InterDigital | We support the updated proposal 5.A. |
| Qualcomm | Can we add one more metric to the examples?   * + Alt1: Additional reporting is supported (for example P-MPR + L1-RSRP, virtual PHR + L1-RSRP, L1-RSRP/SINR with and without MPE effect, virtual PHR, P-MPR or virtual PHR + CRI/SSBRI, estimated max UL RSRP) |
| vivo | We don’t have to support these new alternatives. The original agreement is general enough and does not preclude any possibility. |
| Lenovo/MoM | We support revised proposal 5.A |
| MediaTek | We support revised proposal 5.A, with adding “content”:  **(Revised) Proposal 5.A**: On UE reporting for MPE mitigation for Rel.17, investigate and, if needed, specify the following:   * ... * ... * Any additional reporting content: down-select from the following in RAN1#104-e   + Alt0: no additional reporting content   + Alt1: Additional reporting content is included (for example P-MPR + L1-RSRP, virtual PHR + L1-RSRP, L1-RSRP/SINR with and without MPE effect, virtual PHR, P-MPR or virtual PHR + CRI/SSBRI)     - Note: Other options are not precluded |
| Sony | We are fine with the compact version of proposal 5.A. |

* 1. Issue 6 (beam refinement/tracking)

**(Initial) Proposal 6.A**: Investigate and, if needed, specify *at least* the following enhancements for beam refinement/tracking in Rel.17:

* Beam measurement and reporting enhancement via RACH during initial access (e.g. RO for measurement and MSG3 for reporting)
* Improving efficiency (latency and/or overhead) of beam refinement assuming the unified TCI framework (issue 1):
  + Enabling joint DL TX and RX beam refinement/tracking (P2+P3)
  + Additional UE report to aid P1/P2/P3 related measurement/report configuration (triggering frequency or periodicity)
* Beam management with reduced DL signaling assuming the unified TCI framework (issue 1):
  + Dynamic beam update based on beam report (without beam indication)
  + Dynamic beam measurement and report triggered by beam indication (without CSI-RS/CSI triggering)
  + Configuring/indicating to UE multiple SSBs for beam tracking
  + Semi-static/pre-planned (RRC based) beam transition (for, e.g. isolated HST deployment)
  + Reducing activation delay of TCI states (e.g. via storing QCL properties of a subset of source RSs for a time period)

Several companies (Convida, Huawei, vivo, ZTE) propose to deprioritize the work for this issue. In particular, Huawei raised some concern on agreeing to Proposal 6.A because of the perceived scope. Note that this is a proposal to “investigate and, if needed, specify”.

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| Action: Interested companies are encouraged to provide their inputs on how to modify Proposal 6.A to make it more acceptable to the concerned companies – such as adding a statement on priority relative to the other five issues.  Goal: Arrive at an agreeable formulation of Proposal 6.A |

**Observation**: While a number of companies are supportive of Proposal 6.A, a few companies raise some legitimate concern on work scope and priority. In terms of work scope, more detailed comments such as those from OPPO can be used as a good starting point for narrowing down candidates when the investigative work starts. Also note that the overlap with Coverage Enhancement on RACH-based beam management will need to be addressed in RAN. In terms of priorities, assigning a lower priority relative to the other items is reasonable especially since almost all the proposed schemes are especially relevant for high mobility and large number of configured TCI states (where the Rel.17 unified TCI framework is expected to be used).

**(Revised) Proposal 6.A**: Investigate and, if needed, specify *at least* the following enhancements for beam refinement/tracking in Rel.17 (with lower priority than the other five issues and later starting point during the WI phase):

* Group 1: Beam measurement and reporting enhancement via RACH (e.g. RO for measurement and MSG3 for reporting)
* Group 2: Improving efficiency (latency and/or overhead) of beam refinement assuming the unified TCI framework (issue 1):
  + Enabling joint DL TX and RX beam refinement/tracking (P2+P3)
  + Additional UE report to aid P1/P2/P3 related measurement/report configuration (triggering frequency or periodicity)
* Group 3: Beam management with reduced DL signaling assuming the unified TCI framework (issue 1):
  + Dynamic beam update based on beam report (without beam indication)
  + Dynamic beam measurement and report triggered by beam indication (without CSI-RS/CSI triggering)
  + Configuring/indicating to UE multiple SSBs for beam tracking
  + Semi-static/pre-planned (RRC based) beam transition (for, e.g. isolated HST deployment)
  + Reducing activation delay of TCI states (e.g. via storing QCL properties of a subset of source RSs for a time period)

Reduce the scope of investigation (including down selecting or combining) within and/or across the three groups in RAN1#104-e. Considering the dependence on issue 1 and 3, the work on issue 6 should be preceded by sufficient maturity of issue 1 and 3.

Table 7 Additional inputs for round-3 discussion: proposal 6.A

|  |  |
| --- | --- |
| **Company** | **Input** |
| Qualcomm | We are fine to keep item 6 with lower priority than issue 1 and issue 3 but same priority as the other 3 issues, whose direction is also not very clear so far. |
| Apple | We think this iteam should be with high priority. Our understanding is that issue 1 and 3 handles the overhead issue – gNB does not need to send multiple MAC Ces to change the beam, but issue 1 and 3 cannot handle the fundamental beam tracking latency issue. |
| ZTE | We think that the item-6 has lower priority over item 1~5 firstly.  Then for progress, we need to identify which issues in this item-6 should be considered firstly, and it is hard for us to imagine that all above 8 candidates are discussed simultaneously. From our perspective, the last issue – “Reducing activation delay of TCI states (e.g. via storing QCL properties of a subset of source RSs for a time period)” should be prioritized when discussing this item. |
| OPPO | In our view.  High priority issues are:   * + Enabling joint DL TX and RX beam refinement/tracking (P2+P3)   + Additional UE report to aid P1/P2/P3 related measurement/report configuration (triggering frequency or periodicity)   + Dynamic beam measurement and report triggered by beam indication (without CSI-RS/CSI triggering)   The others are low priority issues:   * Beam measurement and reporting enhancement via RACH during initial access (e.g. RO for measurement and MSG3 for reporting):   Comment: we do not see the motivation to improve beam operation during initial access. The beam used during initial access is the best SSB selected by the UE.     * + Dynamic beam update based on beam report (without beam indication)   Comments: Do not support that. We have concern of reliability of beam update based on beam report. We suggest to consider more on the UE initiated beam switch.   * + Configuring/indicating to UE multiple SSBs for beam tracking   Comment: the proposal is not clear   * + Semi-static/pre-planned (RRC based) beam transition (for, e.g. isolated HST deployment)   Comment: do not support that. Beam indication is only about the UE side Rx beam change. The NW can not use RRC to pre-configure the UE Rx beam switch without latest beam reporting. For the scenario, it would be better to support UE-initiated beam switch.   * + Reducing activation delay of TCI states (e.g. via storing QCL properties of a subset of source RSs for a time period)   Comment: Do not support this. The only way to reduce activation delay of TCI state is to support faster and more efficient beam tracking. That can be done by the 2nd bullet. |
| NTT Docomo | We are fine with FL proposal. |
| LG | Prefer to discuss this proposal in later meetings since those have dependency on other issues, e.g. unified TCI framework and contents. |
| Spreadtrum | Prefer to keep it low priority. The enhancements in proposal 6.A are quite diverging and some of them can be discussed after finishing unified TCI framework design. |
| Huawei, HiSilicon | Similar view as ZTE/LG/Spreadtrum. |
| Ericsson | Support. |
| Samsung | We are fine with proposal 6. In terms of priority this ranks after issue 3 and issue 1. |
| Convida Wireless | Similar view as ZTE/LG/Spreadtrum/Huawei/HiSilicon |
| After revision | |
| FUTUREWEI | We are ok with Proposal 6.A. Some of the enhancements such as “Dynamic beam update based on beam report (without beam indication)” can be considered after Issue 1 and 3. Note that the beam training and tracking latency is a critical issue. We think some efforts are needed there in addition to DCI-based TCI update and beam indication. Otherwise, the end performance may still not be up to what we needed. |
| Intel | We believe some of the issues in this proposal should be high priority in order to design a beam indication framework with meaningful improvements over legacy framework. To this end, this issue should not be deprioritized.  From our perspective, the following are the **high priority issues** which can significantly improve latency of beam indication/tracking/acquisition:   * Improving efficiency (latency and/or overhead) of beam refinement assuming the unified TCI framework (issue 1):   + Enabling joint DL TX and RX beam refinement/tracking (P2+P3) * Beam management with reduced DL signaling assuming the unified TCI framework (issue 1):   + Dynamic beam update based on beam report (without beam indication)   + Dynamic beam measurement and report triggered by beam indication (without CSI-RS/CSI triggering) |
| Qualcomm | Didn’t see why cannot investigate Issue 6 in parallel with Issue 2, 4, and 5. We can discuss items not depending on other topics first. |
| Vivo | Supportive of FL proposal. |
| Lenovo/MoM | Because the first and second bullets require much work, we agree these are of lower priority than the others. The last bullet (Beam management with reduced DL signaling assuming the unified TCI framework) is much easier to discuss and identify the benefit and required spec change, we think it should be treated with higher priority than the others. |
| Apple2 | We do not think these issues should be with low priority.  We understand we have limited TU but lots of issues to handle, we suggest we pick up 2 issues for further study: one from “improve efficiency” and the other one from “Beam management with reduced DL signaling assuming the unified TCI framework”. |
| Huawei, HiSilicon | We are still reluctant to agree on Proposal 6.A, which may open a “can of worms” and dilute the efforts on Issue 1~5. If one issue is to be picked, we suggest picking the last bullet (reducing activation delay of TCI states). |
| OPPO2 | We think the issues of “Improving efficiency (latency and/or overhead) of beam refinement assuming the unified TCI framework” shall be with high priority because the latency of beam tracking/refinement has critical impact on the latency of multi-beam operation.    And all other issues can be low priority. |
| Sony | Agree with FL’s observation. We could pick up 1 or 2 items to enhance with lower priority when compared with Issue 1 to Issue 5. |
| AT&T | We agree with QC. This issue can be discussed in parallel with issue 2, 4 and 5. Proposals in this section are important to bring BM enhancements over Rel. 15/16. |

# References

1. R1-2009499 Moderator summary#2 for multi-beam enhancement Moderator (Samsung)
2. R1-2008147 Moderator summary#1 for multi-beam enhancement Moderator (Samsung)