**3GPP TSG RAN WG1 #103-e R1-2009749**

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

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary#5 for multi-beam enhancement

**Document for:** Discussion and Decision

1. Introduction

Picking up from where the group left off in the moderator summaries R1-2009499 and R1-2009574, the 1st GTW session, the 1st and 2nd check-points, 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 and second check-points and the UL parameters.

* 1. Issue 1 (unified TCI framework)

The discussion of UL parameters was not concluded due to lack of inputs. This time, we aim at reaching some conclusion.

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| Action: Interested companies are encouraged to provide their preferences in below and, if any, their reasoning in  Goal: Select one of the three alternatives and, after that, formulate a proposal for endorsement |

Table 1 Additional inputs: for round-4 discussion: UL parameters

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| --- | --- |
| **Issue** | **Companies’ views** |
| Additional parameters included in or concurrent with (but not included in) unified TCI   * **Alt1**. Include as a part of unified TCI framework (as a part of the UL spatial reference in TCI state definition) * **Alt2**. Outside of but linked to unified TCI framework (linked by RRC configuration) * **Alt3**. Outside of and not lined to unified TCI framework * **Alt4**. Include concurrently with but outside unified TCI framework (independently signaled without pre-configured linkage between TCI and PC parameters) | **UL PC parameters (P0/alpha, CL index)**   * **Alt1 (5)**: LG, Fraunhofer, Interdigital, Intel, Qualcomm (2nd preference) * **Alt2 (12)**: Apple, OPPO, ZTE, MTK (associated MAC-CE), Sony, NTT Docomo, CATT, Nokia/NSB, Samsung, Lenovo/MoM * **Alt3 (4)**: vivo, Ericsson, Huawei, HiSilicon * **Alt4 (2)**: Qualcomm (1st preference), Futurewei   **PL RS**   * **Alt1 (9)**: OPPO, LG, Ericsson, Fraunhofer (first preference), Interdigital, Intel, Samsung, Qualcomm (2nd preference), Futurewei * **Alt2 (11)**: ZTE (first priority), MTK (associated MAC-CE), Sony, NTT Docomo, Fraunhofer (linked by RRC or MAC-CE), CATT, Nokia/NSB, Futurewei, Lenovo/MoM * **Alt3 (6)**: Apple, ZTE (second priority, reusing periodic QCL-TypeD RS), MTK, vivo, Huawei, HiSilicon * **Alt4 (2):** Qualcomm (1st preference), Futurewei |

Note that these alternatives can be further elaborated as follows:

* Alt1 incorporates UL parameter setting into TCI state definition. For joint DL/UL TCI, the UL parameter setting is included in each of the joint TCI states. For separate DL/UL TCI, the UL parameter setting is included only in each of the UL-only TCI states – but not necessarily in DL-only TCI states. For unified TCI framework:
  + Alt1 facilitates TCI-state-specific UL parameter setting (e.g. “beam-specific” UL PC)
  + Alt1 implies that the same (common) UL parameter setting applies to the channels and signals where the common TCI applies (thus far, at least dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources in a CC)
  + If multiple TCI states are mapped to a single/common DL QCL (or UL spatial filter) setting but multiple UL parameter settings, TCI state update allows more dynamic linkage between UL parameter setting and the DL QCL (or UL spatial filter) setting.
* Alt2 defines UL parameter setting outside the TCI state definition but allows semi-static (RRC-based) linkage between the UL parameter setting and each of the TCI states (joint DL/UL or UL-only for separate DL/UL). For unified TCI framework:
  + Alt2 also facilitates TCI-state-specific UL parameter setting (e.g. “beam-specific” UL PC)
  + Alt2 also implies that the same (common) UL parameter setting applies to the channels and signals where the common TCI applies (thus far, at least dynamic-grant/configured-grant based PUSCH, all or subset of dedicated PUCCH resources in a CC)
* Alt3 does not associate UL parameter setting with each of the TCI states, i.e. the UL parameter setting is independent of TCI state. Naturally, the UL parameter setting is outside the TCI state definition.
  + Alt3 does not facilitates TCI-state-specific UL parameter setting (e.g. “beam-specific” UL PC)
  + Alt2 also implies that different UL parameter settings can apply to different UL channels/signals

**FL observation**:

* It is important to finalize this issue in this meeting to facilitate better progress on UL TCI design, e.g. pools, UL TCI state update for separate DL/UL.
* The main difference between Alt1 and Alt2 is the ability to dynamically change the UL parameter setting in Alt1 (whereas the UL parameter setting is configured semi-statically in Alt2).
* The main advantage of Alt1/Alt2 includes facilitating beam-specific UL parameter setting. However, it is restrictive since different UL channels/signals will have share the same UL parameter setting.
* The main advantage of Alt3 includes facilitating channel/signal-specific UL parameter setting.

**Proposal 1.A**: A PL-RS can be associated with or configured in a TCI state in a Rel-17 unified TCI framework

* The UE uses the PL-RS at least for the UL channels/RSs configured to be included in Rel-17 unified TCI framework
* [Down-select one of the following options
  + Alt1: Explicit manner for determining the PL-RS, e.g., including PL-RS in TCI state, pre-configured linkage (e.g., RRC signaling) between TCI state and PL-RS, or dynamic linkage (e.g. MAC CE signaling, separate fields in DCI/MAC CE) between TCI state and PL-RS
  + Alt2: Implicit manner for determining the PL-RS, e.g. if a [periodic] DL RS is provided to indicate the spatial relation in the TCI state, that DL RS is used as PL-RS;
  + FFS: For Alt1, whether PL-RS is mandatory or optional. If optional, combining Alt1 with Alt2 can be further considered
  + FFS: Application time of PL-RS associated with a TCI indicated by a DCI]
* [FFS: Association/configuration of PL RS with a TCI state e.g., implicit or explicit]
* [Consider the following ways for configuring PL-RS:
  + PL-RS is separately configured: The method for associating PL-RS with a TCI state can be, e.g., including PL RS in TCI state, pre-configured linkage (e.g. RRC signaling) between TCI state and PL-RS, or dynamic linkage (e.g. MAC CE signaling, separate fields in DCI/MAC CE) between TCI state and PL-RS
  + PL-RS is not separately configured. if a periodic downlink reference signal is provided to indicate the spatial relation in the TCI State, that downlink reference signal is used as PL-RS
  + FFS: Application time of PL RS associated with a TCI indicated by a DCI]

**Proposal 1.B:**

[ZTE, OPPO, MediaTek, ...]

Separate UL PC parameter settings (P0/alpha, CL index) can be provided for different UL channels/RSs in a Rel-17 unified TCI framework

* FFS: How to provide UL PC parameter settings (P0/alpha, CL index) at least for the UL channels/RSs supported in Rel-17 unified TCI framework
* FFS: Whether and how to associate UL PC parameter settings (P0/alpha, CL index) with a TCI state

[Samsung, Nokia/NSB]

* On Rel-17 unified TCI framework, down select at least one from:
  + Alt1: UL PC parameter settings (P0/alpha, CL index) are provided per UL channel/RS
  + Alt2: UL PC parameter settings (P0/alpha, CL index) are provided per TCI state
  + Alt3: UL PC parameter settings (P0/alpha, CL index) are provided per UL channel/RS per TCI state
* FFS: How to provide UL PC parameter settings (P0/alpha, CL index) at least for the UL channels/RSs supported in Rel-17 unified TCI framework

Table 2 Additional inputs (if any) for round-4 discussion: UL parameters

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| **Company** | **Input** |
| Apple | Our views are provided in the table.  We think the DL RS for beam indication can be used as PL-RS, this can help to reduce the possibility of mismatch between UL Tx beam and DL Rx beam for PL measurement. |
| OPPO | Our views for each aspect are provided in the table. |
| LG | For additional parameters, UL timing parameter should be considered that each UE panel can be associated to same or different TRP. Especially for the different TRP, large difference of propagation delay to each TRP is quite critical. Not only for mTRP cases, inter-panel delay should also be taken into account that the timing difference between panels can be increased depending on the geometry of the panels and implementation error/calibration for panel. |
| ZTE | Regarding PL RS, considering that semi-persistent or aperiodic RS can be configured as QCL Type D RS in TCI state, Alt2 (explicitly mapping) should be supported as baseline. But, we may live with the solution of reusing QCL Type D RS for PL RS if the QCL Type D RS is periodic as in Rel-16 default UL beam. |
| MediaTek | For PL RS, both Alt2 and Alt3 can be supported, similar to Rel-16. |
| Sony | Our views are given for UL parameters in the table. Simple solution in our view is to allow all UL PC parameters concurrently along with unified TCI state. |
| NTT Docomo | **Alt.1 vs Alt.2**  Since “A pool of joint DL/UL TCI state” is already agreed, the TCI state is used for DL as well. If the TCI state is used for DL, the signaling of UL PC parameters/PL-RS are useless. Hence, we don’t prefer to include UL PC parameters/PL-RS to a TCI state. Instead, we can configure the association between UL PC/PL-RS parameters and the unified TCI configuration.  **Alt.2 vs Alt.3**  Since it is beneficial to align the UL beam and PL-RS (as supported in Rel.16), we believe it is good to update UL PC parameters/PL-RS when the indicated TCI is updated.  In short, we support Alt.2 for both UL PC parameters/PL-RS. |
| vivo | SRI in DCI field can still be used for P0/alpha and CL index related indication.  If the RS used for beam indication is not used for PL RS, then SRI could also be reused for indication of pathloss RS. |
| Ericsson | The power control parameters may be different for different channels, so it would make sense to have it outside the unified TCI framework.  The pathloss RS is tightly coupled with the UE Tx beam, so it would belong with the UL TCI. When SRS is used to determine the UL Tx filter, a separate DL RS need to be provided. |
| Fraunhofer | Inclusion of the PL RS and the UL PC parameters in the TCI state would be our first preference. At least in the case of PL RS, the alignment with the spatial relation RS can be performed with the indication of a single TCI state. |
| Huawei, HiSilicon | In R15/R16, the power control parameters for PUCCH, PUSCH, and SRS are separately configured, for the reason that they are transmitted in different form/format(s) and targeted for different SNR regions. With this in mind, we prefer to keep power control parameters separated from TCI state in R17.  Similar as in R16, in the case where the PL-RS is not configured, the indicated source RS inside the joint DL/UL TCI state, if it is a periodic DL RS, can be used as PL-RS, and hopefully not being restricted to QCL-TypeD RS, which is not applicable to FR1.  In addition, the formulation of Alt-2 is a bit strange. In our understanding, in R16, the linkage between UL beam indication (i.e., SRI) and PL-RS, can be updated via MAC-CE, with which RRC involvement is not always required. So if we go with Alt-2, the design may be worse than R16. |
| CATT | Our views are provided in the table. |
| InterDigital | Our views are provided in the table. Especially, for PL-RS, we prefer to have it as an independent configuration for better flexibility. |
| Intel | Views are updated in the table.  One clarification: when we say unified TCI, does it include both joint DL/UL TCI and the separate UL-only TCI state?  [FL: correct]  We also prefer to include this in the UL-only TCI state for separate beam indication. It would be beneficial to probably finalize the design of UL-only TCI first and then use it as a reference for DL/UL joint TCI |
| Nokia/NSB | Alt 2. As baseline.  During Rel-15/16, it has been well discussed that the pathloss and uplink MAI depends on beam of each UE, but similarities can be found among multiple beams or multiple combination of UEs, in case of MAI. Based on such observation and also based on the practical issue that UE has limited capability on tracking multiple RS for pathloss measurement, Rel-15/16 defined power control parameters to be separately configured, but to be associated to SRI, the uplink spatial filter indicator. No reason we would have to change those approaches.  We consider Alt 1 as optimized solution to reduce RRC overhead, and we think it could work in some limited cases.  We think Alt 3 will bring mostly new design or it would bring severe restriction on flexibility of adaptive power control such as changing of PL-RS according to UL beam, which is already well supported from Rel-15. |
| Samsung | Our views are provided in the table above. |
| FUTUREWEI | For Alt1, the parameters could be included in the TCI states, which lacks flexibility but may be fine for rather static parameters such as P0/alpha. The inclusion may be done via indexes / references to parameters defined elsewhere, or done via direct inclusion of the parameters themselves (not preferred by us).  For Alt2, the wording “Include with” and “but outside” seem contradictory. We suggest removing “Include” here. Also the link by only RRC is restrictive and MAC should be allowed.  For Alt3, it is unclear what “Not include” implies. Does it mean for different TCI states, a common default is used? Please clarify.  Note that PL RS needs not to be the source RS for QCL-TypeD and the PC parameters can be different for different uplink channels and SRSs.  Some further clarifications / discussions are needed. |
| Qualcomm | Added Alt4, which is our 1st preference. The TCI and PC parameters should be updated simultaneously but without any pre-configure linkage between them to provide fastest and most flexible mapping. Otherwise, the fast beam update will be delayed by the PC parameter update, which may become the bottleneck. Also, the number of active beams and PL RSs supported by UE can be different, so they cannot be always 1-to-1 mapped.   * **Alt4**. Include concurrently with but outside unified TCI framework (independently signaled without pre-configured linkage between TCI and PC parameters)   We are also fine for Alt1, which gives less flexibility than Alt4 due to RRC pre-configured mapping between beam and PC parameters. But we think Alt1 may be allowed at least for some TCI states, since spatial relation in R15 for PUCCH is RRC pre-configured with both UL beam indication and PC parameters. |
| MediaTek | There is difference between Alt1 and Alt2 if the linkage between a TCI state and power control setting is provided by MAC-CE. |
| ZTE | Regarding UL power control design, in Rel-15/16, the UL power control parameter including P0/alpha, CL index and PL RS is all beam specific. For instance, besides beam specific PL RS, we also have up to 16 P0/alpha and up to 2 CL that facilitate this beam specific PC framework. Straightforwardly we reuse this principle herein. The unified TCI framework is to provide common beam for all UL channel/RSs, but the UL PC parameters (P0/alpha, CL index) seems to be per UL channel/RSs per TCI state considering that there may be different target receive power for different channels. Also as FL mentioned, there is no significant difference between Alt1 and Alt2 that seems to be signaling design issue. Consequently, we have the following proposal, and hopefully it can harmonize views from different sides.    Possible proposal  For unified TCI framework, UL PC parameters (P0/alpha, CL index) and PL RS can be associated with TCI state   * UL PC parameters (P0/alpha, CL index) is provided per UL channel/RS per TCI state * PL RS is provided per TCI state * Note that the unique UL PC parameters (P0/alpha, CL index) and PL RS are provided for SRS resource set as in Rel.15/16 * FFS: UL PC parameters (P0/alpha, CL index) and PL RS are included in or concurrent with (but not included in) TCI state * FFS: Explicit or implicit manner for determining PL RS. |
| OPPO | Regarding the PC parameters in rel-15/16, the UL PC parameters are not all beam specific. In SRS: UL beam is configured per SRS resource but PC parameters are configured per set. Actually, only the pathloss RS can be highly associated with the UL beam. But all the other PC parameter (P0, alpha, CL index) are only related with channel, but not associated with the beam applied on that channel. Please note, in rel16, we introduce MAC CE based path loss RS update for SRS and PUSCH considering the beam update but we do not update other PC parameters. Thus, for rel17, we propose to associate the PC parameters except pathloss RS with per channel (not per TCI state), i.e., same to rel16 and PL RS is included or associated with each UL TCI state.  Here is the proposed change on top of the proposal text suggested by ZTE:  For unified TCI framework, UL PC parameters (P0/alpha, CL index) and PL RS ~~can be associated with TCI state~~are configured as follows:  -    UL PC parameters (P0/alpha, CL index) is provided per UL channel/RS ~~per TCI state~~  -    PL RS is provided per TCI state |
| MediaTek | We share similar view with ZTE that power control settings for PUCCH and PUSCH in Rel-15/16 is per spatial relation. However, the number of different power control settings doesn’t have to be proportional to the number of beams. That is why we prefer not to directly put those parameters in TCI state. Instead, associating a small number of power control settings and PL RSs with TCI states either by RRC parameter or by MAC-CE is a good choice.  Regarding SRS, since it is agreed that SRS for CSI (CB, NBC, AntSwitch) can optionally apply the Rel-17 unified TCI, at least in that case it is still beneficial to provide UL PC parameters and PL RS for SRS per TCI state. |
| Futurewei2 | We are ok with Qualcomm’s proposed Alt.4 for both UL PC parameters and PL RS. Note that Alt.1 or Alt.2 may also work for PL RS.  General guidance that existing power control framework should be generally reused without significant change   * Separate power control settings (including PL LS, alpha/Po, and CL index) for different uplink channels/RSs * Power control setting of a uplink channel/RS can vary with uplink TX beam * A UE supports limited numbers of power control parameter sets (alpha/Po), PL RSs, and CLs which are then linked/associated with the UE’s uplink channels/Rs and TX beams. |
| MediaTek | According to the comments from companies, most companies share a similar view that PL RS is tightly coupled with the UE Tx beam, thus providing PL RS per TCI state is quite reasonable. We see PL RS could be good starting point since it is less controversial, and corresponding signaling issue (e.g., including PL RS in TCI state or additional linkage between TCI state and PL RS) can be further discussed in the next meeting. Regarding UL power control parameters, most companies also have the same views that UL PC setting should be provided per channel/RS provided. However, whether to associate UL power control parameters with TCI state (i.e., provide UL PC setting per TCI state) is still questionable. Thus, we suggest to discuss it later as well. |
| Lenovo/MoM | Our views are inserted in the table above. We support Alt 2 for both PL RS and UL PC parameters. This enables fast beam switching for UL while allowing re-configuration of PL RS and PC parameters. |
| Intel | From our perspective, we want to ensure that the unified TCI framework with both joint TCI and UL-only TCI can provide at least the same functionality as the current uplink spatial relation framework, including for cases when MAC-CE only activates single uplink TCI state etc.  From this perspective, it can be seen that current *PUCCH-SpatialRelationInfo* IE currently includes pucch-PathlossReferenceRS-Id, p0-PUCCH-Id and closedLoopIndex. Therefore, at least for PUCCH, the UL-related TCI should optionally include such configuration. Additional cases for PUSCH and SRS can be further discussed, since the new framework would not require configuration of SRS for determining the PUSCH spatial filter. |
| Samsung | I agree with Claes to go back to the original proposal from Darcy and Bo, as this fits nicely with the structure from the FL, focusing on   1. PC Parameters, i.e. P0/alpha and CL index 2. PL RS   For the first possible proposal, which deals with PL RS, it seems natural that the PL RS is related to the TCI state, as the TCI state changes, the PL RS can change accordingly. Ideally, we could have taken the PL RS to be the QCL TypeD RS, however this might not be always possible if the QCL TypeD RS is aperiodic or semi-persistent RS. We agree with the FFS in proposal 1 to further study the manner of determining the PL RS for a TCI state.  For the second proposal, it suggests providing the power control parameters per channel/RS. This deviates and is less flexible from the R15/R16 framework, where the power control parameters are linked to the SRI through RRC configuration  SRI-PUSCH-PowerControl ::=          SEQUENCE {      sri-PUSCH-PowerControlId            SRI-PUSCH-PowerControlId,      sri-PUSCH-PathlossReferenceRS-Id    PUSCH-PathlossReferenceRS-Id,      sri-P0-PUSCH-AlphaSetId             P0-PUSCH-AlphaSetId,      sri-PUSCH-ClosedLoopIndex           ENUMERATED { i0, i1 }  }  There could be merit in having the PC parameters tied to the TCI state, as this provides a greater level of flexibility. Therefore, let’s consider first the three options for signaling the UL PC parameters, i.e. PC parameters are provided per cell, or PC parameter are provided per TCI state or PC parameters are provide per channel per TCI state. During the email discussions its seems that more (18 vs 8) want the PC parameter to be in the TCI state or linked to the TCI state than being provided separately.  Therefore, we suggest to update the second proposal as follows:  **Updated possible proposal 2:**   * On Rel-17 unified TCI framework, down select from:   + Alt1: UL PC parameters (P0/alpha, CL index) are provided per UL channel/RS   + Alt2: UL PC parameters (P0/alpha, CL index) are provided per TCI state   + Alt3: UL PC parameters (P0/alpha, CL index) are provided per UL channel/RS per TCI state * FFS: How to provide UL PC parameters (P0/alpha, CL index) at least for the UL channels/RSs supported in Rel-17 unified TCI framework |
| MediaTek | It is not easy to have a converged view at the stage. However, it seems most companies have common understanding on the following points. At least we can try to agree on the non-controversial parts, and leave potential issues FFS.   1. Separate power control parameters for different uplink channels/RSs are needed 2. PL RS used for a uplink channel/RS can vary with TCI state   Regarding PL RS, we are fine with the last version provided by Yan. However, we don't intend to discuss which UL channel/RS should be supported in Rel-17 unified TCI framework. Thus, it would be better to remove the details and using a general description instead. On Youngwoo’s comment, we don't see the wording “can be associated” precludes any possible solution including “configured with a TCI state”. It is still FFS, right?  Regarding UL PC parameters, at least Bo’s original proposal doesn't intend to preclude the association with TCI state, which can be further discussed. Anyway, at least we can try agree on the common understanding first ,and we suggest some wording changes.  The revision of the possible proposal are suggested here:  On Rel-17 unified TCI framework,   * At least a PL RS can be associated ~~[or configured]~~ with a TCI state   + ~~The UE uses the PL RS at least for dynamic-grant/configured-grant based PUSCH transmissions, all or subset of dedicated PUCCH resources in a CC~~     - ~~Optionally, the UE uses the PL RS for all SRS resources in resource set(s) configured for [beam management]/antenna switching/codebook-based/non-codebook-based UL transmissions~~   + The UE uses the PL RS at least for the UL channels/RSs supported in Rel-17 unified TCI framework   + FFS: ~~[~~Association with a TCI state,~~]~~ Explicit manner for determining the PL RS, e.g., including PL RS in TCI state, pre-configured linkage (e.g., RRC signaling) between TCI state and PL RS, or dynamic linkage (e.g. MAC-CE signaling, separate fields in DCI/MAC CE) between TCI state and PL RS   + FFS: Whether and how to support an implicit manner for determining PL RS * Separate UL PC parameters (P0/alpha, CL index) are provided ~~at least per~~ for different UL channel/RS   + FFS: How to provide UL PC parameters (P0/alpha, CL index) at least for the UL channels/RSs supported in Rel-17 unified TCI framework   + FFS: Whether and how to associate UL PC parameters (P0/alpha, CL index) with a TCI state   ~~FFS: Whether UL PC parameters (P0/alpha, CL index) can be provided per UL channel/RS~~  ~~FFS: Mapping between UL PC parameters (P0/alpha, CL index) and TCI~~ |
| Docomo | We agree to separate the discussion of power control parameters and PL-RS. Considering the different channel/RS would have different power control parameters, we agree with UL PC parameters per channel/RS. Hence, we support the latest proposal (above) from MediaTek. |
| ZTE | There are at least three candidate proposals, and some of them were crossed. For the sake of discussion, I try to merge them together. This version is almost up to Mediatek version but further handles comments from Apple.  **Possible proposal 1:**  On Rel-17 unified TCI framework, a PL RS can be associated with a TCI state   * The UE uses the PL RS at least for the UL channels/RSs supported in Rel-17 unified TCI framework * FFS: Association with a TCI state   + Option-1: Explicit manner for determining the PL RS, e.g., including PL RS in TCI state, pre-configured linkage (e.g., RRC signaling) between TCI state and PL RS, or dynamic linkage (e.g. ,MAC-CE signaling, separate fields in DCI/MAC-CE) between TCI state and PL RS   + Option-2: Implicit manner for determining PL RS, e.g., if a downlink reference signal is provided to indicate the spatial relation in the TCI State, that downlink reference signal is used as PL-RS.   **Possible proposal 2:**  On Rel-17 unified TCI framework, separate UL PC parameters (P0/alpha, CL index) can be provided at least per UL channel/RS   * FFS: How to provide UL PC parameters (P0/alpha, CL index) at least for the UL channels/RSs supported in Rel-17 unified TCI framework * FFS: Whether and how to associate UL PC parameters (P0/alpha, CL index) with a TCI state |
| LG | For Proposal 1A, it seems that the above suggestions are applicable for single panel UE. In case of MP-UE, the channel condition can be significantly different for each panel especially on FR2 and RF/antenna configuration may be non-homogeneous. Therefore, we suggest to add a note that further investigation is needed for MP-UE, which may depend on the discussion outcome of panel identifier and panel switching mechanism. |
| Qualcomm | Fine with the 1st proposal with the following changes.   * At least a PL RS can be associated [or configured] with a TCI state   + The UE uses the PL RS at least for dynamic-grant/configured-grant based PUSCH transmissions, all or subset of dedicated PUCCH resources in a CC     - Optionally, the UE uses the PL RS for all SRS resources in resource set(s) configured for [beam management]/antenna switching/codebook-based/non-codebook-based UL transmissions   + FFS: [Association with a TCI state,] Explicit manner for determining the PL RS, e.g., including PL RS in TCI state, pre-configured linkage (e.g., RRC signaling) between TCI state and PL RS, or dynamic linkage (e.g. MAC-CE signaling, separate fields in DCI/MAC CE) between TCI state and PL RS   + FFS: Whether and how to support an implicit manner for determining PL RS   + FFS: Application of PL RS explicitly/implicitly indicated in DCI * Separate UL PC parameters (P0/alpha, CL index) can be ~~are~~ provided ~~at least per UL channel/RS~~ for different UL channels/RS   + FFS: How to provide UL PC parameters (P0/alpha, CL index) at least for the UL channels/RSs supported in Rel-17 unified TCI framework   + FFS: Whether and how to associate UL PC parameters (P0/alpha, CL index) with a TCI state |
| InterDigital | To MediaTek: If “can be associated” does not preclude anything, as you said, then let’s put “or configured” to make companies which supports PL RS configuration per TCI state comfortable. If you said correctly, the proposal is exactly same thing and there’s no harm to companies which support association. In that sense, we propose to remove brackets as follows:   * At least a PL RS can be associated or configured with a TCI state   + The UE uses the PL RS at least for dynamic-grant/configured-grant based PUSCH transmissions, all or subset of dedicated PUCCH resources in a CC     - Optionally, the UE uses the PL RS for all SRS resources in resource set(s) configured for [beam management]/antenna switching/codebook-based/non-codebook-based UL transmissions   + FFS: Association with a TCI state, Explicit manner for determining the PL RS, e.g., including PL RS in TCI state, pre-configured linkage (e.g., RRC signaling) between TCI state and PL RS, or dynamic linkage (e.g. MAC-CE signaling, separate fields in DCI/MAC CE) between TCI state and PL RS   + FFS: Whether and how to support an implicit manner for determining PL RS   + FFS: Application time of PL RS associated with a TCI indicated by a DCI * Separate UL PC parameters (P0/alpha, CL index) can be ~~are~~ provided ~~at least per UL channel/RS~~ for different UL channels/RS   + FFS: How to provide UL PC parameters (P0/alpha, CL index) at least for the UL channels/RSs supported in Rel-17 unified TCI framework   + FFS: Whether and how to associate UL PC parameters (P0/alpha, CL index) with a TCI state |
| Huawei/HiSi | Proposal 1:   * Main bullet: To avoid the mis-interpretation that PL-RS is part of the TCI framework, we suggest removing ‘On Rel-17 unified TCI framework’ and add ‘in R17 unified TCI framework’ after ‘a TCI state’. * 1st sub-bullet: Given that the TCI state in R17 is optionally applied to SRS for CB/NCB/AS, we suggest changing ‘supported’ to ‘configured to be included’. * Option 2: Similar as in R16, we suggest adding being ‘periodic’ as one condition for the RS in UL TCI to be applied as PL-RS.   Proposal 2:   * Main bullet: To avoid the mis-interpretation that UL PC parameters are part of the TCI framework, we suggest removing ‘On Rel-17 unified TCI framework’ * 1st sub-bullet: Given that the TCI state in R17 is optionally applied to SRS for CB/NCB/AS, we suggest changing ‘supported’ to ‘configured to be included’. |
| OPPO | We think the direction of listing "two options" is good. However, we do not think Option 1 and Option 2 are really exclusive to each other and they are two different Option/Alts for us to down-select.  The So called "Option-1: PL-RS is mandatorily configured..." is actually the case when the PL RS is separately configured.. while the "Option-2: PL-RS is optionally configured" is the case that we do not configure PL RS separately but to re-use the DL PRS configured for UL spatial Tx filter.  We shall reword the proposal to clarify that. Furthermore, We suggest to add "or configured" back, the same view as Youngwoo.  Here is the suggested updated proposal 1:  **Possible Proposal 1**  On Rel-17 unified TCI framework, a PL RS can be associated with or configured in a TCI state  -       The UE uses the PL RS at least for the UL channels/RSs supported in Rel-17 unified TCI framework  -       ~~Down-select one of the following options~~Consider the following ways for configuring PL RS:  n  ~~Option-1:~~PL-RS is ~~mandatorily~~ separately configured. ~~Explicit manner for determining the PL RS~~The method for associating PL-RS with a TCI state can be, e.g., including PL RS in TCI state, pre-configured linkage (e.g., RRC signaling) between TCI state and PL RS, or dynamic linkage (e.g. ,MAC-CE signaling, separate fields in DCI/MAC-CE) between TCI state and PL RS  n  ~~Option-2:~~PL-RS is ~~optionally~~ not separately configured. if a periodic downlink reference signal is provided to indicate the spatial relation in the TCI State, that downlink reference signal is used as PL-RS; ~~Otherwise, UE expects a PL RS is associated with the TCI State with explicit configuration as the examples in option 1~~  FFS: Application time of PL RS associated with a TCI indicated by a DCI |
| Samsung | * We are fine to associate PLRS with TCI State * For UL PC parameters, in R15/R16, different channels had different spatial relations, so it was fine to have different power control parameters for each channel. I think we need to reconsider this in release 17 in light of the unified TCI framework. Therefore, we suggest listing possible alternatives, with target down selection in the next meeting. Alternatives can include PC parameters per channel/RS, PC parameters per TCI state, PC parameters per channel/RS per TCI state |
| Nokia/NSB | We still prefer 2nd proposal the most, but can be flexible to select any of the proposal as baseline. But we have clear preference to reuse Rel15/16 power control as much as possible, and to provide at least same level of flexibility.  For the 1st proposal, let me clarify that PC parameters can be configured/associated per channel and per SRI in Rel-15/16. So configuration of PC parameters per channel is actually reduced flexibility than Rel-15/16. We supports following modifications on main bullets.   * ~~At least a~~ PL RS can be associated [or configured] with a TCI state * UL PC parameters (P0/alpha, CL index) are provided ~~at least~~ per UL channel/RS and per TCI sate   For the 2nd proposal, we are O.K. with  For 3rd proposal, we still wonder how much gain it can provide compared with option 1, while it needs additional bit in DCI.  For last proposal from Samsung, we disagree to down select ‘only one’. And we also want to add more description about PL RS. So we can support this proposal with following modification:   * PL RS can be associated [or configured] with a TCI state * On Rel-17 unified TCI framework, down select at least one from:   + Alt1: UL PC parameters (P0/alpha, CL index) are provided per UL channel/RS   + Alt2: UL PC parameters (P0/alpha, CL index) are provided per TCI state   + Alt3: UL PC parameters (P0/alpha, CL index) are provided per UL channel/RS per TCI state * FFS: How to provide UL PC parameters (P0/alpha, CL index) at least for the UL channels/RSs supported in Rel-17 unified TCI framework |

* 1. Issue 3 (beam indication signaling medium)

UE capability for latency

**Proposal 3.A**: On Rel.17 DCI-based beam indication, the beam application time X or Y is to be down-selected from the following:

* Alt1: The beam application time X or Y can be configured by the gNB via higher-layer (RRC) signaling based the UE capability
  + Support a UE capability for the minimum value of X or Y
  + FFS: the exact minimum values of X (e.g., 0.5ms, 2ms, 3ms) or Y supported by UE
  + FFS: whether existing UE capability (e.g. beamSwitchTime, TimeDurationQCL) can be reused as this UE capability.
* Alt2: The beam application time X or Y is fixed value(s) defined in specification
  + FFS: Whether to support more than one values of X/Y

**Proposal 3.B**: On Rel.17 DCI-based beam indication, the following criterion is used for selecting application time of the beam indication:

* AltA wording [The latency of the DCI design (with or without specification impact) should be significantly improved with respect to the utilization of MAC CE]
* AltB wording [RAN1 strives to reduce the latency of DCI design with respect to the utilization of MAC CE]
* AltC wording [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]

Company’s view:

* Support: Nokia/NSB (AltA)
* Remove: Ericsson, Intel, Huawei/HiSi, LG
* AltB was suggested by Sony
* AltC was suggested by Samsung

Table 4 Additional inputs for round-4 discussion: UE capability of proposal 3.B

|  |  |
| --- | --- |
| **Company** | **Input** |
| Apple | We do not quite understand why some companies have concern for the UE capability. There are 3 options to define the action delay:   * Option 1: a predefined value * Option 2: a UE capability * Option 3: unspecified – up to UE implementation   Option 1 often leads to the worst case and prohibits UE to have an opportunity to do a better job. We are also ok for option 3. But option 2 is our typical way. |
| OPPO | We do not support to put UE capability with FFS. Naturally, the minimum time shall be a UE capability. If no UE capability is defined and we specify a predefined value in the spec, then we will have to choose a very large value to accommodate the worst scenario, which would be even worse for this feature. |
| LG | We suggest to add the following FFS back.   * + FFS: whether any existing timing defined for DCI based TCI/spatial relation update can be used for X/Y   As commented in email, DCI to PDSCH timing and PDSCH to HARQ-ACK timing is already well defined in Rel-15/16, so we cannot agree on the first bullet without having the FFS above.  [FL: Although the FL thinks this is fine, at least 3 companies raised some concern on this and at least 2 companies suggested that this is essentially the same as the 4th bullet] |
| ZTE | In our views, we support gNB configuration/indication for action delay due to the fact that this delay is not only related to UE capability but also relevant to handle DCI retransmission from gNB perspective. It seems that we may have two candidates for gNB configuration, e.g., by RRC or by DCI (e.g., reuse the existing field for PDSCH reception). At the first stage, we prefer to keep this door open, and let’s make decision at the next meeting.  BTW, timeDurationForQCL is UE capability parameter and should be typed together. Please check my minor update:   * [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 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 existing UE capability (e.g. beamSwitchTime, timeDurationForQCL ~~TimeDuration for QCL~~) can be reused as this UE capability   [FL: Although the FL is fine with this, at least 2 companies raised some concern on adding “DCI command”] |
| MediaTek | We see either Alt1 or Alt2 will requires UE capability. If there is UE capability, application time has to be controlled by NW. Thus, we prefer to remove the FFSs for the following two bullets:   * ~~[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   Again, we don’t support the “or DCI command” added by ZTE due to no clear motivation, even in FFS. |
| Sony2 | We support the UE capability on beam indication delay. Either defining new UE capabilities or reusing existing ones, i.e. BeamSwitchTiming or QCLTimeDuration can be decided later. |
| NTT Docomo2 | Support FL proposal. We agree with Apple. Either “a predefined value” or “a UE capability” would be needed for the action delay.  If we agree on Alt2 of the proposal 3B, we believe 0ms action delay is possible. |
| Vivo2 | We are supportive of reusing current UE capability for TimeDuration for QCL. |
| Ericsson | The use of FFS in brackets is a little confusing. We propose the following modifications:   * Support a UE capability for the minimum value of X or Y   + the beam application time X or Y is configured by the gNB via higher-layer (RRC) signaling based the UE capability   The remaining FFSs are OK, but some would seem superfluous:   * FFS: When and how to apply the minimum beam indication delay   “when” is described in the first bullet with Alt1 and Alt2. “How” is quite unclear.   * FFS: whether existing UE capability (e.g. beamSwitchTime, TimeDuration for QCL) can be reused as this UE capability   This would seem extremely unlikely, and the benefits are unclear.  For the final bullet:   * Criterion for selecting application time of the beam indication:   We are not sure why this is needed. If we have a UE capability, the value advertised by the UE will determine the application time, in combination with the NW configuration. If the intention of the statement is to rule out the UE capability or the NW configuration, we do not support any such statement. |
| Fraunhofer | The support of the UE capability can be confirmed and not be added as FFS (i.e., remove the FFS in front of ‘Support a UE capability…’). |
| Huawei, HiSilicon | Regarding Alt-1 under the 1st bullet, if our understanding is correct, we suggest adding a note: This alternative implies the ACK is transmitted with the indicated beam and DCI carrying beam indication is hence not protected by ACK.  [FL: The FL doesn’t share the same understanding. Alt1 still requires ACK transmission. It enables the NW to assume the UE receives the DCI before receiving the ACK. If the NW needs to signal a new beam indication before receiving the ACK, the NW will anyway do so. If the NW later doesn’t receive an ACK after the expected ACK latency is reached, the NW will send a new beam indication regardless whether a new beam indication is deemed necessary (if the optimum beam changes) or not (if the optimum beam stays the same)].  Regarding the last bullet, it is unclear to us whether DCI will be used for indicate switching cell during L1/L2 inter-cell mobility or switching to a UE panel which was in inactive status. With these in mind, we don’t think it is a good idea to agree on such vague statement and suggest removing them. |
| Intel | For the last bullet, (1st and 3rd sub-bullets) it is still unclear to us what “significant improvement” means. We would like to clarify what will be the actual criterion of determining this “improvement”. Will this be based on SLS results with the agreed evaluation assumptions?  For the second sub-bullet, since we already agreed to support TCI based beam indication, we do not see the value of this statement in the agreement. The overall delay depends on Alt1 or Alt2 compared to MAC-CE update. |
| Nokia/NSB | We need to repeat ourselves; we are not OK to agree on a UE capability before we see that this implies, values, improved latency, etc. Hence the proposal:   * 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 |
| Samsung2 | Support the update proposal, with the following comments:   * First FFS can be removed (when and how to apply the minimum beam indication delay), this seems to be redundant with the first bullet (including Alt1 and Alt2) |
| AT&T | We support this proposal in principle. We agree with Ericsson and Nokia that the FFS on the gNB configuration can be removed. It would also be good to quantify what “significant improvement” means for the criterion for selection. |
| FUTUREWEI | As in our previous comments, it is better to discuss UE capability later after designs are clearer. At this point, we suggest to first discuss the timeline of TCI update (beam indication) via DCI which should target for much short latency than that of MAC CE. |
| Qualcomm | We prefer to make the UE capability as FFS. A single fixed value may be beneficial to simplify the signaling. Because the values supported by different UEs may not be significantly different. The spec already has fixed value of 28 symbols for beam reset latency in case of BFR, which is common for all UEs. In addition, MAC-CE based activation also has a common fixed value of 3ms.   * FFS: Whether to Support a UE capability or a common fixed value for the minimum value of X or Y. If UE capability is supported,   + 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 |
| MediaTek | Define a fixed value of X or Y is also acceptable, but as Apple mentioned above, a fixed value often leads to the worst case. We can down-select one of the alternatives in the next meeting as follows:  **(Initial) 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 * The beam application time X or Y, down-select from the following:   + Alt1: The beam application time X or Y is configured by the gNB via higher-layer (RRC) signaling based the UE capability     - Support a UE capability for the minimum value of X or Y     - 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.   + Alt2: The beam application time X or Y is fixed value(s) defined in specification     - FFS: Whether to support more than one values of X/Y * ~~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 |
| Interdigital | On the revised proposal 3.B, we strongly propose to add following FFS bullet.  **FFS: When and how to apply the minimum beam indication delay**  We don’t think that “when” is described in the first bullet. As DCI format 1\_1 and 1\_2 are DCI formats for PDSCH scheduling, the DCIs do not always indicate a new beam for the operation. In that sense, if a newly indicated beam is same with a previously indicated beam, then UE may not need to apply the minimum beam indication delay. Based on the understanding, the first bullet just indicates how to apply the beam indication delay when the UE needs to apply. In that sense, we propose following update.  FFS: When to apply the minimum indication delay (e.g., when the newly indicated beam is different with the previously indicated beam) |
| LG | On revised proposal 3.B, could anyone explain the concern on adding the following FFS? As discussed before, this was our compromise to accept the first bullet since we are not convinced that new timing is really needed. This does not belong to the UE capability since some of existing timing use fixed values(i.e. number of symbols), which are not dependent on UE capability.   * + FFS: whether any existing timing defined for DCI based TCI/spatial relation update can be used for X/Y |
| Lenovo/MoM | We support the UE capability on beam indication delay. We prefer to reuse existing UE capability if applicable, such as, BeamSwitchTiming or QCLTimeDuration |
| LG | On proposal 3B, it seems not quite essential to add the criterion for selecting application time of the beam indication. Slightly prefer not to have that sentence. |
| Qualcomm | Support Proposal 3.A |
| InterDigital | We are fine with proposal 3.A. and Alt C of proposal 3.B. |

# References

1. R1-2009715 Moderator summary#4 for multi-beam enhancement Moderator (Samsung)
2. R1-2009574 Moderator summary#3 for multi-beam enhancement Moderator (Samsung)
3. R1-2009499 Moderator summary#2 for multi-beam enhancement Moderator (Samsung)
4. R1-2008147 Moderator summary#1 for multi-beam enhancement Moderator (Samsung)