**3GPP TSG RAN WG1 #104-e R1-2101913**

**e-Meeting, January 25th – February 5th, 2021**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator summary#3 for multi-beam enhancement: Round 2

**Document for:** Discussion and Decision

## Introduction

In this summary, the term “item 1” refers to the first item in the Rel.17 NR FeMIMO WID, i.e. multi-beam enhancement:

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| * Enhancement on multi-beam operation, mainly targeting FR2 while also applicable to FR1:   + Identify and specify features to facilitate more efficient (lower latency and overhead) DL/UL beam management to support higher intra- and L1/L2-centric inter-cell mobility and/or a larger number of configured TCI states:     1. Common beam for data and control transmission/reception for DL and UL, especially for intra-band CA     2. Unified TCI framework for DL and UL beam indication     3. Enhancement on signaling mechanisms for the above features to improve latency and efficiency with more usage of dynamic control signaling (as opposed to RRC)   + Identify and specify features to facilitate UL beam selection for UEs equipped with multiple panels, considering UL coverage loss mitigation due to MPE, based on UL beam indication with the unified TCI framework for UL fast panel selection |

## Summary and proposals

The summary and proposals are based on the content of the previous FL summaries R1-2101185 (preparation) and R1-2101856 (round 1).

### Issue 1 (Rel.17 unified TCI framework)

Table 1 Summary: issue 1

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| **#** | **Issue** | **Companies’ views** | **Moderator notes** |
| 1.6 | PL-RS in relation to UL TCI state and channels | Alternatives:   * **PL-RS included in UL TCI state:** IDC, Ericsson (optional for DL RS), Apple (only valid when SRS is configured for beam indication), vivo (in case of DL RS in TCI state), MTK (for no PL-RS configured, and DL CSI-RS or SSB), Intel, AT&T, OPPO (separate RS), Fraunhofer IIS/HHI (separate RS), Qualcomm, Lenovo/MoM, Xiaomi, NTT Docomo, OPPO, Nokia/NSB (QCL-TypeD RS if periodic and no PL-RS configured /associated), LG * **PL-RS associated with UL TCI state:** Futurewei, Spreadtrum, Nokia/NSB, Huawei/HiSi, MTK, Sony, Qualcomm (separate field in the same DCI), CATT, NTT Docomo, ZTE, CMCC * **PL-RS not associated with UL TCI state:** Ericsson (in case of UL RS in TCI state) * **Use Rel-16 PL-RS framework:** vivo (for UL RS in TCI state)   MAC CE configures association between activated TCI states and PL-RS/PC: CATT, MTK(PL-RS only), Sony(only PL-RS) | |

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| **Proposal 1.4**: On Rel.17 unified TCI framework:   * When a PL-RS is not explicitly associated or included in the UL or, if applicable, joint TCI state, a periodic DL RS used as a source RS for determining spatial TX filter ~~is~~ in the UL or, if applicable, joint TCI state, ~~the periodic DL RS~~ is the PL-RS * ~~When a periodic DL RS used as a source RS for determining spatial TX filter is not configured in the UL or, if applicable, joint TCI state~~Otherwise, select one of the following alternatives by RAN1#104bis-e:   + Alt1. PL-RS is always included in UL TCI state or (if applicable) joint TCI state   + Alt2. PL-RS can be associated with (but not included in) UL TCI state or (if applicable) joint TCI state   + Alt3. Reuse Rel.16 procedure (MAC CE+DCI based) to indicate PL-RS for UL transmission without enhancement   + Alt4. UE calculates path-loss based on periodic DL RS configured as the QCL/spatialRelationInfo source of the RS in UL TCI state or (if applicable) joint TCI state |

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| Action: Interested companies are encouraged to provide their inputs on the proposal  Goal: Finalize the proposal to be ready for endorsement |

Table 2 Inputs: issue 1

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| **Company** | **Input** |
| Moderator | 1.1: Starting from the last version before it was removed from Wed checkpoint list (Dr. Bo’s version) |
| Apple | Since we modified the condition, we would like to modify Alt4 as follows:  Alt4. UE calculates path-loss based on periodic DL RS configured in UL TCI state or (if applicable) joint TCI state or configured as the QCL/spatialRelationInfo source of the RS in UL TCI state or (if applicable) joint TCI state |
| MediaTek | We don't have a strong preference on any of the alternatives. However, we have a concern if PL-RS is determined according to the source RSs in the TCI states directly or indirectly, the number of pathloss estimations that UE has to maintain at the same time will be increased by the number of active TCI states. Therefore, we would like to add the following note under this proposal.   * NOTE: As in Rel-16, a UE does not expect to simultaneously maintain more than four pathloss estimates per serving cell for all PUSCH/PUCCH/SRS transmissions. |
| ZTE | Support, and we are also fine with Apple’s update. Regarding the note from MediaTek, it is not our preference (it should be discussed in Rel-17 UE capability session), but we can live with it. |
| vivo | For Alt3, based on yesterday’s exchange of views through email, we would like to update slightly as following. The potential enhancement could be make the *referenceSignal* field in *PUCCH-SpatialRelationInfo* is not optional.  **Alt3. Reuse Rel.16 procedure (MAC CE+DCI based) to indicate PL-RS for UL transmission with minimum enhancement;** |
| OPPO | In the current proposal draft, it looks like Alt 4 is same to the first bullet. Alt4 also assumes PL-RS is not configured in the TCI state. We shall delete Alt4.   * When a PL-RS is not explicitly associated or included in the UL or, if applicable, joint TCI state, a periodic DL RS used as a source RS for determining spatial TX filter ~~is~~ in the UL or, if applicable, joint TCI state, ~~the periodic DL RS~~ is the PL-RS * ~~When a periodic DL RS used as a source RS for determining spatial TX filter is not configured in the UL or, if applicable, joint TCI state~~Otherwise, select one of the following alternatives by RAN1#104bis-e:   + Alt1. PL-RS is always included in UL TCI state or (if applicable) joint TCI state   + Alt2. PL-RS can be associated with (but not included in) UL TCI state or (if applicable) joint TCI state   + Alt3. Reuse Rel.16 procedure (MAC CE+DCI based) to indicate PL-RS for UL transmission without enhancement   + ~~Alt4. UE calculates path-loss based on periodic DL RS configured as the QCL/spatialRelationInfo source of the RS in UL TCI state or (if applicable) joint TCI state~~ |
| Nokia/NSB | Support 1st bullet  For 2nd bullet. The meaning of alt 3 or alt 4 is unclear.  In case Alt 3, we can support MAC CE + DCI based indication/update of PL-RS either with Alt.1, Alt 2. So we suggest companies supporting Alt 3 to make it exclusive with Alt 1 or Alt 2.:   * + Alt3. Reuse Rel.16 procedure with the same signaling structure (MAC CE+ SRI filed in DCI based) to indicate PL-RS for UL transmission without enhancement     - PL-RS is not additionally configured in or associated to UL TCI state or (if applicable) joint TCI state   In case Alt 4, 2nd bullet is for the case when periodic RS is not configured as QCL of UL TCI (or joint TCI). So it is unclear what Alt 4 means. Should it mean UE calculate PL based on aperiodic RS or UL RS? If so, we suggest to delete alt 4, since PL is kind of L3-RSRP. |
| Futurewei | The first bullet indicates that a source RS, which is used for determining spatial TX filter, and which is a periodic DL RS in the UL or, if applicable, joint TCI states, is used as the PL-RS if the PL-RS is not explicitly associated or included in the UL or, if applicable, joint TCI state. We have the same concerns on this bullet as we raised in the Round 1 email discussion: this bullet requires the UE to track a large number of DL RSs for pathloss measurement as the number of UL TCI states and/or joint TCI states in Rel. 17 unified TCI framework could be large. However, it will be difficult for UE to achieve that considering the fact that UE has limited capability on tracking multiple RSs for pathloss measurement. Furthermore, PL-RS needs to be measured irrespective to whether the beam is active or not so separation of TCI/QCL RS from PL-RS needs to be provided, and association is a good approach. Therefore we would like to modify Proposal 1.4 as follows:  **Proposal 1.4**: On Rel.17 unified TCI framework:   * ~~When a periodic DL RS used as a source RS for determining spatial TX filter is not configured in the UL or, if applicable, joint TCI state~~Select one of the following alternatives by RAN1#104bis-e:   + Alt1. PL-RS is always included in UL TCI state or (if applicable) joint TCI state   + Alt2. PL-RS can be associated with (but not included in) UL TCI state or (if applicable) joint TCI state   + Alt3. Reuse Rel.16 procedure (MAC CE+DCI based) to indicate PL-RS for UL transmission without enhancement   + Alt4. UE calculates path-loss based on periodic DL RS configured as the QCL/spatialRelationInfo source of the RS in UL TCI state or (if applicable) joint TCI state |
| Convida Wireless | Support FL proposal 1.4. Prefer Alt 2 or Alt 3. |
| Lenovo/MoM | Support the 1st bullet.  For the 2nd bullet, the meaning of the first three Alternatives are clear. Alt 4 (even with Apple’s proposed text) appears to be the same as Alt 1. We think this proposal shall include only Alt 1-3. |
| Qualcomm | Added one more FFS  **Proposal 1.4**: On Rel.17 unified TCI framework:   * When a PL-RS is not explicitly associated or included in the UL or, if applicable, joint TCI state, a periodic DL RS used as a source RS for determining spatial TX filter ~~is~~ in the UL or, if applicable, joint TCI state, ~~the periodic DL RS~~ is the PL-RS * ~~When a periodic DL RS used as a source RS for determining spatial TX filter is not configured in the UL or, if applicable, joint TCI state~~Otherwise, select one of the following alternatives by RAN1#104bis-e:   + Alt1. PL-RS is always included in UL TCI state or (if applicable) joint TCI state   + Alt2. PL-RS can be associated with (but not included in) UL TCI state or (if applicable) joint TCI state   + Alt3. Reuse Rel.16 procedure (MAC CE+DCI based) to indicate PL-RS for UL transmission without enhancement   + Alt4. UE calculates path-loss based on periodic DL RS configured as the QCL/spatialRelationInfo source of the RS in UL TCI state or (if applicable) joint TCI state * FFS: Application time for PL RS |
| Ericsson | We support the intention of the proposal, but the formulation is somewhat strange. The proposal starts “When a PL RS is not explicitly associated….Otherwise…”  The “otherwise” would have to mean that a PL RS IS explicitly associated” – of course, that explicitly associated PL RS would then be used. The previous formulation was better.  We understand the concern from Futurewei. The FFS Qualcomm added points to that the UE would not immediately have to apply a newly activated PL RS. |

### Issue 2 (L1/L2-centric inter-cell mobility)

Table 3 Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2.2 | Type of beam metric for measurement and reporting:  L1-RSRP or L3-RSRP | Alternatives**:**   * **L1-RSRP (19):** vivo, MTK, Samsung, Qualcomm (L3 can reuse existing), Intel (intra-DU can re-use L1-RSRP), Xiaomi, Sony, NTT Docomo, ZTE, Ericsson, Nokia/NSB, Futurewei, Huawei/HiSi, IDC, APT, ASUS, CMCC * **L3-RSRP (4):** OPPO, Lenovo/MoM, Xiaomi (L3-RSRP only for triggering beam measurement of non-serving cell) * **Hybrid L1+L3-RSRP (2):** Apple, CATT (with SD filter L3-RSRP) |

Note that this issue is relevant not only for L1/L2-centric inter-cell mobility, but also for inter-cell mTRP. Based on the above summary, the following proposals are made:

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| **Proposal 2.1**: On Rel.17 multi beam measurement/reporting enhancements for L1/L2-centric inter-cell mobility and inter-cell mTRP:   * Rel.15 L1-RSRP is used as reporting quantity for measurement and reporting of non-serving-cell(s)   + At least Rel.15 SS-RSRP calculated from SSB of non-serving cell(s) is supported   + FFS: The support of Rel.15 CSI-RSRP depending on whether CSI-RS (for e.g. RRM and/or tracking) is supported as a measurement RS for L1/L2-centric inter-cell mobility and/or inter-cell mTRP * FFS: If other reporting quantities are supported, e.g. L3-RSRP, hybrid L1/L3-RSRP |

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| Action: Interested companies are encouraged to provide their inputs on the proposal  Goal: Finalize the proposal to be ready for endorsement |

Table 4 Inputs: issue 2

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| **Company** | **Input** |
| Moderator |  |
| Apple | We are fine with the proposal in general, but we worry about the case that gNB may configure many CSI-reportConfig with many DL resources for L1-RSRP measurement for a number of neighbor cells. Some measurement may not be that necessary. With that, we would like to suggest we study the dynamic activation/deactivation of CSI-reportConfig based on MAC CE. Hopefully, this can clarify the motivation. With that, we suggest the following FFS.   * **FFS: Dynamic activation/deactivation for CSI-reportConfig for non-serving cell beam measurement by MAC CE**   Without this dynamic activation/deactivation, I think gNB can only use RRC to reconfigure CSI-reportConfig for some neighbor cells, since currently all resources in CSI-reportConfig should be counted as “active” in UE capability, and gNB cannot preconfigure all resources from all neighbor cells by RRC. |
| MediaTek | This proposal is essential. According to current RAN4 requirement (TS 38.133), there should be at least one L1-RSRP measurement reporting for a target TCI state within a period before UE performs DL reception with a TCI state, where the RS for L1-RSRP measurement is the RS in the target TCI state or QCLed to the target TCI state. In order to allow a TCI state associated with non-serving-cell RS(s) to be used for DL reception and UL transmission, the same requirement should be reused, which means at least L1-RSRP measurement reporting has to be introduced for non-serving-cell RS.  Re Apple, a CSI report setting can be either activated/deactivated by MAC-CE if it is SP reporting, or dynamically triggered by DCI if it AP reporting. According to this proposal, this feature will be a part of CSI framework, then the functionality (activation or triggering) will be naturally supported. We believe we are not going to re-design CSI framework for this feature, right? |
| ZTE | We can support this proposal with minor modification and a FFS bullet for clarifying the time behavior of this reporting as MediaTek mentioned:  On Rel.17 multi beam measurement/reporting enhancements for L1/L2-centric inter-cell mobility and inter-cell mTRP:   * Rel.15 L1-RSRP is used as reporting quantity for measurement and reporting of non-serving-cell(s)   + At least Rel.15 SS-RSRP calculated from SSB of non-serving cell(s) is supported   + FFS: The support of Rel.15 CSI-RSRP depending on whether CSI-RS (for e.g. mobility, RRM and/or tracking) is supported as a measurement RS for L1/L2-centric inter-cell mobility and/or inter-cell mTRP   + FFS: time behavior of the reporting, e.g., periodic, semi-persistent, or aperiodic * FFS: If other reporting quantities are supported, e.g. L3-RSRP, hybrid L1/L3-RSRP |
| vivo | For the SS-RSRP measurement, we would like to clarify whether the measurement restriction of legacy non-serving cell SSB is still applied.   * **FFS: Whether the measurement for SS-RSRP is limited within SMTC;**   For the timing assumption for measurement of the non-serving cell RS, we would also like to study the following aspects:   * **FFS: timing assumption for measurement of non-serving cell RS measurement;**   As Apple commented, since the number of non-serving cell RS would be large we would like to study the following but with more general wording:   * **FFS: Dynamic activation/deactivation of the cell for non-serving cell beam measurement by MAC CE;** |
| OPPO | We suggest to limit the number of non-serving cell included in L1-RSRP measurement to be 1. For multi-TRP, we only support up to 2 TRPs, which means at most one non-serving cell. For inter-cell mobility, the L1-RSRP measurement is only used for TCI state, so including only the target cell is sufficient.  **Proposal 2.1**: On Rel.17 multi beam measurement/reporting enhancements for L1/L2-centric inter-cell mobility and inter-cell mTRP:   * Rel.15 L1-RSRP is used as reporting quantity for measurement and reporting of non-serving-cell(s)   + At least Rel.15 SS-RSRP calculated from SSB of non-serving cell~~(s)~~ is supported   + The number of non-serving cell is no more than 1.   + FFS: The support of Rel.15 CSI-RSRP depending on whether CSI-RS (for e.g. RRM and/or tracking) is supported as a measurement RS for L1/L2-centric inter-cell mobility and/or inter-cell mTRP   FFS: If other reporting quantities are supported, e.g. L3-RSRP, hybrid L1/L3-RSRP |
| Sony | We would like to support this proposal just with a minor update. Same as ZTE did, under the first FFS bullet, we think at the moment it is not harmful to add “mobility” i.e. CSI-RS for mobility for further study. |
| Futurewei | We agree FL’s proposal in principle. We also support CSI-RSRP based L1-RSRP for non-serving cell and suggest modifying the FFS bullet as follows:   * + Support Rel.15 CSI-RSRP if CSI-RS (for e.g. RRM and/or tracking) is supported as a measurement RS for L1/L2-centric inter-cell mobility and/or inter-cell mTRP |
| Convida Wireless | Support the FL proposal 2.1. |
| Lenovo/MoM | We OK with this proposal in general. However we do not agree with OPPO’s proposal to limit the number of non-serving cell RSRP measurement to 1. This is different from m-TRP. Before gNB decides the UE can be served by a non-serving cell, it needs to know the UE is in the coverage area of which non-serving cells and their signal strength. Before it can make a down selection and decide on a non-serving cell, it needs information regarding multiple non-serving cells.  Regarding the FFS on other reporting quantities like L3-RSRP or hybrid L1/L3-RSRP, we think we shall consult RAN2 by sending a LS asking for their opinion. |
| Qualcomm | We prefer to add “with or without QCL source” in the FFS. We have concern on CSI-RS from non-serving cell without QCL source  **Proposal 2.1**: On Rel.17 multi beam measurement/reporting enhancements for L1/L2-centric inter-cell mobility and inter-cell mTRP:   * Rel.15 L1-RSRP is used as reporting quantity for measurement and reporting of non-serving-cell(s)   + At least Rel.15 SS-RSRP calculated from SSB of non-serving cell(s) is supported   + FFS: The support of Rel.15 CSI-RSRP depending on whether CSI-RS with or without QCL source (for e.g. RRM and/or tracking) is supported as a measurement RS for L1/L2-centric inter-cell mobility and/or inter-cell mTRP   FFS: If other reporting quantities are supported, e.g. L3-RSRP, hybrid L1/L3-RSRP |
| Ericsson | Support.  We would not be OK to limit the number of non-serving cells to 1 – the NW would not know which non-serving cell is the best (that’s the motivation of doing the measurement). The UE complexity can be controlled by limiting the number of beams to report. |
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### Issue 3 (beam indication signaling medium)

Table 5 Summary: issue 3

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| **#** | **Issue** | **Companies’ views** | **Moderator notes** |
| 3.1 | Beam application time definition:  Alt1: Measured from DCI reception  Alt2: Measured from ACK transmission | **Alt1 (DCI) (7):** Spreadtrum, Xiaomi, Ericsson, CATT, MTK, NEC, Samsung  **Alt2 (ACK) (17):** IDC, Lenovo/MoM, Fujitsu, Nokia/NSB, CMCC, Apple, Huawei/HiSi, ZTE, vivo, Intel, Sony, Qualcomm, NTT Docomo, APT  **Alt1 and Alt 2:** OPPO (Since Alt1 considers the requirement of UE and Alt2 considers the requirement of gNB side), LG | |
| 3.4 | Support for additional DCI formats for Rel.17 unified TCI framework beam indication (TCI state update) | DCI formats 1\_1/1\_2 without DL assignment:   * **Yes (18)**: OPPO, Fujitsu, Spreadtrum, Nokia/NSB, CATT, vivo (at least for UL-only TCI), MTK, Qualcomm, Samsung, Apple (ACK/NACK mechanism is needed), vivo, Lenovo/MoM, Convida, NTT Docomo, ZTE (ACK/NACK is needed), NEC (ACK/NACK needed) * **No (4)**: Ericsson, Huawei/HiSi, LG   DCI formats 0\_1/0\_2 with UL grant:   * **Yes (10)**: IDC, Nokia/NSB, Xiaomi (at least for UL-only TCI), ZTE (at least for UL-only TCI), MTK, LGE, Intel, Sony (Study), Qualcomm * **No (12)**: OPPO, CMCC, Ericsson, Huawei/HiSi, Convida, Apple, vivo, Spreadtrum, CATT, NTT Docomo, NEC   Dedicated DCI format for beam indication, with dedicated ACK based on SPS PDSCH release:   * **Yes (15)**: Futurewei, ZTE, CATT, Intel, Sony, NTT Docomo(keep the same DCI payload as existing DCI format), OPPO (based on format 1\_0 without DL assignment), Samsung, Nokia/NSB (based on format 0\_1/0\_2 without UL grant), Qualcomm, Lenovo/MoM, APT (based on SPS or CG release DCI), NEC * **No (8)**: Ericsson, MTK, Convida, Apple, vivo, Huawei/HiSi, LG   **Support extending existing DCI formats for UL-only TCI**: APT | |

Additional DCI

From Table 5, the reuse of DCI formats 0\_1/0\_2 with UL grant is unlikely agreeable (10 support vs 12 oppose). The remaining alternatives should be down selected

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| **Proposal 3.1**: On the Rel.17 DCI-based beam indication, in RAN1#104bis-e, down-select one of the following alternatives regarding the support of DCI format(s) for beam indication in addition to the agreed DCI formats 1\_1/1\_2 with DL assignment (in RAN1#103-e):   * Alt0: No additional DCI format is supported * Alt1: DCI formats 1\_1 and 1\_2 without DL assignment, applicable for joint TCI as well as separate DL/UL TCI   + FFS: support DCI acknowledgment mechanism, e.g. based on SPS PDSCH release, based on triggered SRS   + FFS: How to identify DCI formats 1\_1/1\_2 used for beam indication only, not scheduling a PDSCH reception, indicating a SPS PDSCH release or indicating SCell dormancy * Alt2: Dedicated DCI format other than 1\_1/1\_2 without DL assignment, applicable for joint TCI as well as separate DL/UL TCI   + Support DCI acknowledgment mechanism based on SPS PDSCH release   + FFS: If the format is based on an existing DCI format, how to identify the DCI format used for beam indication only |

Beam Application Time (BAT)

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| Previous agreement (RAN1#103-e):  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 to apply the minimum indication delay (e.g., when the newly indicated beam is different with the previously indicated beam) |

The main arguments for Alt1 (assuming the agreed DCI formats 1\_1/1\_2 with DL assignment):

* It tends to result in lower beam application latency than Alt2
* Unlike Alt2, for the agreed DCI formats 1\_1/1\_2 with DL assignment, it allows the updated TCI state (signaled in the DCI) to be used for the DL assignment (PDSCH reception) associated with the beam indication DCI provided that the offset between the DCI and the PDSCH resources used for the DL assignment is larger than the threshold. This is not possible in Alt2 since the updated TCI state can be active only after the ACK transmission (hence after the DL assignment).

The main arguments for Alt2 (assuming the agreed DCI formats 1\_1/1\_2 with DL assignment):

* Unlike Alt1 where potential misalignment between gNB and UE assumptions on the TCI state can occur if the DCI is not successfully decoded, Alt2 ensures that the gNB and the UE are aligned (since the gNB can assume that the TCI state update is successfully received after receiving the ACK from the UE).

Assessment: It is argued that since PDCCH error rate is around 1%, the probability of TCI state assumption misalignment associated with Alt1 is 1% (non-negligible), thus Alt2 is preferred.

* However, this reasoning ignores that the misalignment only occurs between the DCI reception and ACK transmission –typically a significantly smaller fraction of the overall UE data traffic even if the UE receives DL assignment in every slot.
* Furthermore, this misalignment (only in a relatively small time period) only occurs for other PDCCH transmission (than the beam indication DCI) and other PDSCH/PUSCH transmissions (not associated with the DL assignment). It does not apply to the DL assignment associated with the beam indication DCI. Nor does it apply to PUCCH resource used for the ACK.
* Furthermore, it is argued that since BAT is configured by the gNB (given the UE capability), the gNB can configure the BAT depending on factors, e.g. UE data traffic, resource allocations, such that the chosen value avoids or minimizes the misalignment while still ensuring lower bema application latency compared to Alt2. Obviously a sufficiently large BAT for Alt1 can replicate the effect of Alt2, but the converse doesn’t always hold.

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| [Placeholder for proposal 3.2] |

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| Action: Interested companies are encouraged to provide their inputs on:   * Proposal 3.1 on DCI format * Beam application time (BAT): after summarizing the arguments from both sides, companies are encouraged to respond and decide between Alt1 vs Alt2   Goal:   * Proposal 3.1: Finalize the proposal for endorsement * BAT: Arrive at a proposal to down select Alt1 vs Alt2 |

Table 6 Inputs: issue 3

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| **Company** | **Input** |
| Moderator |  |
| Apple | Support Alt1 in proposal 3.1. When gNB has no downlink data for transmission, Alt1 can be helpful to avoid dummy data transmission. Dummy data transmission would waste both gNB and UE power. |
| MediaTek | Support Proposal 3.1.  On BAT, we prefer Alt1. We believe FL already captures the arguments why the reliability of Alt1 is not a problem, and the benefit of Alt1 is clear. |
| ZTE | Proposal 3.1: Alt1 is supported. Besides wasting resources as Apple mentioned, BLER for PDSCH is about 10%, and consequently rate of transmission failure is at least 10 times over successful PDCCH decoding. If we just try to list candidate for down-selection next meeting, we think that the following “FFS” in Alt1 can be removed.   * Alt1: DCI formats 1\_1 and 1\_2 without DL assignment, applicable for joint TCI as well as separate DL/UL TCI   + support DCI acknowledgment mechanism, e.g. based on SPS PDSCH release, based on triggered SRS   + FFS: How to identify DCI formats 1\_1/1\_2 used for beam indication only, not scheduling a PDSCH reception, indicating a SPS PDSCH release or indicating SCell dormancy   Regarding BAT, we support Alt.2. Maybe, this discussion should be postponed until we make the final down-selection for candidates in Proposal 3.1. |
| vivo | Support Alt1 in proposal 3.1  Support Alt2 in proposal 3.2. |
| OPPO | Either Alt 1 or Alt 2 in proposal 3 is ok to me.  For Alt1: the benefit is we can remove the dependency of beam indication on PDSCH transmission.  For Alt2: a dedicated DCI can reduce the overhead of beam indication and also improve the reliability of DCI-based beam indication. |
| Sony | For proposal 3.1, support Alt.2.  Reusing the existing DCI format 1\_1 or 1\_2 without DL assignment may not be flexible enough to conduct all necessary information related to TCI state(s) to be applied. So for the newly defined function in Rel.17, it seems proper to design a dedicated DCI format for it.    For BAT, support Alt.2.  It may sound a little conservative that beam updating based on DCI should be 100% aligned at both NW and UE side. Consider a case (perhaps a corner case) that the DCI carrying new TCI targets for PDCCH itself, if the 1% PDCCH decoding failure happens, there could be beam misalignment for PDCCH, which may results in undesirable BFR. |
| Nokia/NSB | Proposal 3.1: Support Alt 1  Proposal 3.2: Support Alt 2. But we are O.K. for further discussion on applying new beam to scheduled/granted PDSCH/PUSCH which is already supported feature in Rel-15/16. We have most concerns on ‘differentiating’ beams between TCI indication DCI and acknowledging N/Ack PUCCH. |
| Futurewei | Support Alt2 in Proposal 3.1. The existing DCI format 1\_1 or 1\_2 without DL assignment lacks the capability to provide information for beam indication for single channel (e.g. PDSCH only, single CORESET) or a subset of channels. |
| Convida Wireless | Support the FL proposal 3.1. Prefer Alt 1. |
| Lenovo/MoM | Proposal 3.1: We agree this shall be decided in RAN1#104bis-e meeting, but we think Alt1 and Alt2 shall not be exclusive. For Alt 1 we agree with Apple’s argument on not wasting UL power. For Alt 2 we think it has the benefit for signaling many UEs simultaneously for reduced delay. Companies should bring back arguments supporting for or against each alternatives for RAN1 to decide in the next meeting.  Proposal 3.2: we support Alt 2 to ensure the ACK is received by the gNB before the new beam is activated. |
| Qualcomm | Added one more example    **Proposal 3.1**: On the Rel.17 DCI-based beam indication, in RAN1#104bis-e, down-select one of the following alternatives regarding the support of DCI format(s) for beam indication in addition to the agreed DCI formats 1\_1/1\_2 with DL assignment (in RAN1#103-e):   * Alt0: No additional DCI format is supported * Alt1: DCI formats 1\_1 and 1\_2 without DL assignment, applicable for joint TCI as well as separate DL/UL TCI   + FFS: support DCI acknowledgment mechanism, e.g. based on SPS PDSCH release, based on triggered SRS, based on DCI indicating SCell dormancy   + FFS: How to identify DCI formats 1\_1/1\_2 used for beam indication only, not scheduling a PDSCH reception, indicating a SPS PDSCH release or indicating SCell dormancy * Alt2: Dedicated DCI format other than 1\_1/1\_2 without DL assignment, applicable for joint TCI as well as separate DL/UL TCI   + Support DCI acknowledgment mechanism based on SPS PDSCH release   FFS: If the format is based on an existing DCI format, how to identify the DCI format used for beam indication only  For potential proposal 3.2, the reliability of Alt.1 may be ensured by configuring the application time after the acknowledgement, so both sides will switch the beam only after the acknowledgement is Txed/Rxed. We are fine for either modified Alt.1 or Alt.2 below.   * + 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     - The gNB configured application time should be after the acknowledgement.   + 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 |
| Ericsson | Support proposal 3.1. Just as was predicted in previous meeting, DCI design takes a long time, and this discussion needs to be finalized.  For BAT: we agree with Qualcomm that with Alt1, the gNB can still configure the application time to be after the ACK – this is up to NW configuration. We think that is the reasonable configuration, but in the future, things may change, and we do not want to stop other NW vendors to perform more aggressive configurations. Therefore, we prefer Alt1, but we would be OK with Alt2 as well. |

### Issue 4 (MP-UE)

Table 7 Summary: issue 4

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| **#** | **Issue** | **Companies’ views** | **Moderator notes** |
| 4.3 | Support for NW-initiated UL panel selection and activation | NW-initiated UL panel selection (of one) and activation (of ≥1)   * **Yes**: IDC, Huawei/HiSi, ZTE, LGE, NTT Docomo,CMCC * **No**: OPPO, Fraunhofer IIS/HHI, CATT, MTK, Intel, Sony, Xiaomi, Qualcomm (NW can initiate selection within active panels but not activation), Spreadtrum, Nokia/NSB   NW-to-MPUE signaling of panel selection/activation:   * **Yes**: NTT Docomo, Lenovo/MoM, Xiaomi, APT, IDC (panel ID in TCI state), Samsung (in case of MPE), CATT, APT, vivo, Qualcomm (NW can signal which active panel to use but not activation), Spreadtrum (select among active panels), Nokia/NSB, Huawei/HiSi (with UE confirmation/rejection), LG, CMCC * **No**: OPPO | |

In RAN1#103-e, the support for UE-initiated UL panel selection/activation was agreed, with FFS on whether NW-initiated panel selection/activation is also supported. This FFS needs to be resolved early.

Based on the above summary, the following proposals are made:

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| **Proposal 4.1**: On Rel.17 enhancement for facilitating fast uplink panel selection, support NW-to-MPUE signalling of UE panel selection and activation:   * For UE panel selection, Rel.17 DCI-based TCI state update (beam indication) is used * For UE panel activation, Rel.17 MAC-CE-based TCI state activation is used * FFS: If additional specification support in TCI state definition to accommodate UE panel is needed or not, and if so, the exact scheme |

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| Action: Interested companies are encouraged to provide their inputs on proposal 4.1  Goal: Finalize the proposal to be ready for endorsement |

Table 8 Inputs: issue 4

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| **Company** | **Input** |
| Moderator | 4.1: This proposal is to ensure that there is beam indication support. The FFS addresses additional TCI state definition for panel. This also depends on what panel entails. Agreeing to this proposal doesn’t imply that we agree on a new TCI state signaling scheme. Similar to the previous agreement on UE-initiated panel selection/activation. |
| Apple | We think gNB can provide the beam indication, but panel selection/activation should still be based on UE. UE may still change the panel due to rotation/power saving and so on. Therefore we suggest revisions as follows:  **Proposal 4.1**: On Rel.17 enhancement for facilitating fast uplink panel selection, support NW-to-MPUE signalling to facilitate UE panel selection and activation:   * For UE panel selection, Rel.17 DCI-based TCI state update (beam indication) is used * For UE panel activation, Rel.17 MAC-CE-based TCI state activation is used   FFS: If additional specification support in TCI state definition to accommodate UE panel is needed or not, and if so, the exact scheme  FFS: If additional specification support to let gNB aware which panel is used is needed or not, and if so, the exact scheme |
| MediaTek | We don't support NW-initiated UE panel activation since there are a lot of UE implementation-related factors (especially UE power consumption) should be considered when decides UE panel activation. Thus, UE panel activation should be left to UE decision.  We also don't see the benefit from NW-initiated UL panel selection. For example, it is natural that UE can initiate UL beam/panel selection to avoid the MPE issue since MPE issue shall be detected by UE itself. If UE detects MPE event on current serving UL panel, UE can attempt to determine other UL panel with good link quality and without suffering from the MPE issue, if any, based on, e.g., estimated UL receive power by taking MPE effect and link quality into account.  Regarding the proposal, in our view, Rel.17 TCI state activation/indication is used to confirm the panel activation/selection initiated by UE. Thus, we cannot support this proposal. |
| ZTE | We support it in principle. Since the panel activation/deactivation is up to UE, the corresponding panel state (e.g., active) corresponding to DL RS should be reported. Apple’s new bullet seems to be a good move-forward solution. We can support it with minor update:  FFS: If additional specification support to let gNB aware spatial filter(s) (e.g., CRI/SSBRI) corresponding to which panel is used is needed or not, and if so, the exact scheme  Regarding comments from MediaTek, if our understanding is correct, this proposal is not to support NW-initialized UL panel selection, but instead to clarify how the system can work in this UE-initialized framework. |
| vivo | Prefer the following update  **Proposal 4.1**: On Rel.17 enhancement for facilitating fast uplink panel selection, support NW-to-MPUE signalling of UE panel selection and activation:   * For UE panel selection, Rel.17 DCI-based TCI state update (beam indication) is used * For UE panel activation, Rel.17 MAC-CE-based TCI state activation is used   FFS: If additional specification support in TCI state definition to associate with UE panel is needed or not, and if so, the exact scheme |
| OPPO | Do not support Proposal 4.1  We do not support NW-initiated UE panel selection/activation.  In the procedure of multi-beam operation, the gNB indicates DL TCI and/or UL TCI to the UE for downlink reception or uplink transmission. How to map a DL TCI or UL TCI to UE panel or beam is up to UE implementation. Just as MTK mentioned, there are a lot of UE implementation-related hardware factors. We do not think that there is benefit and it is feasible to do that.  Furthermore, from the perspective of UE, we do not see the use case for a UE to expose the information of particular hardware/panel implementation to the system. |
| Sony | We tend to trust the from NW-to-MPUE signaling is to facilitate panel activation and selection at UE. But given the agreed MPUE-to-NW signaling (UE controls its panels by nature) and potential MPE event (only detected by UE), there seems a risk as mentioned by MTK that the panel or beam indicated/activated by NW would results in MPE. By far, no mechanism to avoid this is discussed yet, so we would be reluctant to accept the proposal at the moment. Hopefully this issue can be further discussed. |
| Nokia/NSB | Prefer further discussion.  UE panel selection: UE panel selection should be based on UL beam management, and additional indication/mechanism would not be needed in perspective of beam management.  UE panel activation: We still wonder whether gNB based UE panel activation can work, since gNB cannot have any reported measurement via certain UE panel until UE ‘activate’ that panel. But we can be open to allow gNB’s ‘request’ to activate more UE panel.  Please see our modified proposal as:  **Proposal 4.1**: On Rel.17 enhancement for facilitating fast uplink panel selection, not support additional dynamic NW-to-MPUE signalling of UE panel selection ~~and~~ or activation:   * For UE panel selection, gNB utilize Rel.17 DCI-based TCI state update (beam indication) ~~is used~~ * FFS: gNB may request to activate more UE panels utilizing signals for Rel.17 TCI configuration/activation.  ~~For UE panel activation, Rel.17 MAC-CE-based TCI state activation is used~~   FFS: If additional specification support in TCI state definition to accommodate UE panel is needed or not, and if so, the exact scheme |
| Convida Wireless | Support the FL proposal 4.1. |
| Lenovo/MoM | We think NW-initiated panel selection shall be supported because gNB can already signal the UE which UL TCI (UL beam) to use, and a panel is a group of antenna ports with their respective TX beams. The real issue is how to make NW-initiated and UE-initiated panel activation work together. We propose to add an additional FFS to this proposal:  FFS: if additional specification support is needed for UE-initiated panel activation and NW-initiated panel activation to work together. |
| Qualcomm | We do not support NW to decide UE panel activation from day 1. Suggest to remove that part and add FFS for UE decided panel activation.  **Proposal 4.1**: On Rel.17 enhancement for facilitating fast uplink panel selection, support NW-to-MPUE signalling of UE panel selection ~~and activation~~:   * For UE panel selection, Rel.17 DCI-based TCI state update (beam indication) is used * ~~For UE panel activation, Rel.17 MAC-CE-based TCI state activation is used~~   FFS: If additional specification support in TCI state definition to accommodate UE panel is needed or not, and if so, the exact scheme  FFS: UE decided panel activation and corresponding signaling to gNB |
| Ericsson | Support Proposal 4.1. |

### Issue 5 (MPE mitigation)

Table 9 Summary: issue 5

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| **#** | **Issue** | **Companies’ views** | **Moderator notes** |
| 5.3 | Any additional reporting content:   * Alt0: no additional reporting content * Alt1: Additional reporting content | **Alt0**: Ericsson, Intel, Xiaomi, MTK, Spreadtrum, Lenovo/MoM, Huawei/HiSi, APT  **Alt1**:   * CRI/SSBRI + L1-RSRP/L1-SINR + P-MPR: OPPO, MediaTek, Nokia/NSB, IDC * CRI/SSBRI + L1-RSRP/L1-SINR + virtual PHR: Nokia/NSB, Apple, Convida, CMCC * CRI/SSBRI + L1-RSRP/L1-SINR + panel ID: LG, CMCC * CRI/SSBRI + virtual PHR: ZTE, Convida * CRI/SSBRI + UL RSRP + panel ID: Qualcomm * CRI/SSBRI + new/additional param. (indicating MPE): CMCC * P-MPR + panel-ID: vivo, Sony (panel-specific), IDC * P-MPR + alternative panel or UL TX beam: Nokia/NSB * ID of preferred/non-preferred panel: LGE | |

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| **Previous agreements**:  [RAN1#103-e]  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: Whether the above reporting is triggered by UE or configured by NW   [RAN1#104-e]  On Rel.17 enhancements to facilitate MPE mitigation,   * On further enhancing the P-MPR report in Rel.16 (already agreed RAN4 framework, including triggering), down select between beam-level and panel-select reporting * On SSBRI(s)/CRI(s) and/or indication of panel selection, focus study on the following:   + Reporting of at least SSBRI(s)/CRI(s) to indicate gNB beam(s) that is feasible for UL transmission: additional reporting quantities are FFS   + Reporting of at least an indicator associated with a UE ‘panel’ that is feasible for UL transmission: additional reporting quantities are FFS * Note: Just as agreed in RAN1#103-e, the purpose is to assess whether specification is needed or not |

It was agreed that we have to down-select the alternatives for additional reporting content in this meeting. From the summary, L1-RSRP/SINR and virtual PHR are the quantities supported by more companies.

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| **Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, perform study and, if needed, specify the following reporting quantities in addition to the Rel.16-based P-MPR and/or SSBRI(s)/CRI(s)/panel indication:   * L1-RSRP/SINR associated with each of the reported SSBRI(s)/CRI(s)/panel indication (if configured) * Virtual PHR   Note: Performing study and, if needed, specifying Rel.16 based P-MPR and SSBRI(s)/CRI(s)/panel indication was already agreed |

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| Action: Interested companies are encouraged to provide their inputs on proposal 4.1  Goal: Finalize the proposal to be ready for endorsement |

Table 10 Inputs: issue 5

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| **Company** | **Input** |
| Moderator | 5.1: We need to start narrowing down options for study on additional quantities. From the summary, this could be a good starting point |
| Apple | Support proposal 5.1 |
| MediaTek | We support L1-RSRP/SINR associated with each of the reported SSBRI(s)/CRI(s)/panel indication.  If UE selects a set of proper gNB beams to avoid MPE issue, if any, then, at least L1-RSRP/SINR associated with the selected beams can be provided to NW for later decision of which beam is used for UL transmission.  We don't see clear benefit from other report quantities if MPE issue is already handled by UE. |
| ZTE | Support with following modification. In general, virtual PHR calculation should also be based on with each of the reported SSBRI(s)/CRI(s)/panel indication.  **Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, perform study and, if needed, specify the following reporting quantities in addition to the Rel.16-based P-MPR and/or SSBRI(s)/CRI(s)/panel indication:   * L1-RSRP/SINR associated with each of the reported SSBRI(s)/CRI(s)/panel indication (if configured) * Virtual PHR associated with each of the reported SSBRI(s)/CRI(s)/panel indication (if configured)   Note: Performing study and, if needed, specifying Rel.16 based P-MPR and SSBRI(s)/CRI(s)/panel indication was already agreed |
| vivo | Not support. Would like to focus the study on the following already agreed one:  Performing study and, if needed, specifying Rel.16 based P-MPR and SSBRI(s)/CRI(s)/panel indication was already agreed |
| OPPO | Compared with reporting P-MPR information in beam reporting of CRI/SSBRI, we prefer to support P-MPR and/or virtual PHR for each activated UL TCI state.  We propose to update the proposal as follows:  **Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, perform study and, if needed, specify the following reporting quantities in addition to the Rel.16-based P-MPR and/or SSBRI(s)/CRI(s)/panel indication:   * L1-RSRP/SINR associated with each of the reported SSBRI(s)/CRI(s)/panel indication (if configured) * Virtual PHR for each activated UL TCI state |
| Sony | Support the proposal from FL. |
| Nokia/NSB | Support in principle.  We are O.K. with ZTE’s modification.  Question to OPPO: How gNB understand for which of activated UL TCI state UE measured virtual PHR? Should UE report virtual PHR of all activated UL TCI? |
| Convida Wireless | Support the FL proposal 5.1. |
| Lenovo/MoM | Support ZTE’s modification. |
| Qualcomm | Suggest to associate virtual PHR also with beam/panel. Otherwise, no difference from R16.  **Proposal 5.1**: On Rel.17 enhancements to facilitate MPE mitigation, perform study and, if needed, specify the following reporting quantities in addition to the Rel.16-based P-MPR and/or SSBRI(s)/CRI(s)/panel indication:   * L1-RSRP/SINR/Virtual PHR associated with each of the reported SSBRI(s)/CRI(s)/panel indication (if configured) |
| Ericsson | Do not support. L1-RSRP/SINR is already specified, so it is not an additional reporting quantity.  This is unclear. The RSRP report (for SSBRI) would look like this:  SSBRI1 RSRP1 SSBRI2 RSRP2  SSBRI3 RSRP3  SSBRI4 RSRP4  In our understanding, an additional reporting quantity would mean that we define a report that looks like this:  SSBRI1 x1 SSBRI2 x2  SSBRI3 x3  SSBRI4 x4  Where x is not RSRP or SINR. But this is not yet agreed – there are proposals that the beam report would contain multiple measurement quantities per SSBRI. Can we agree that the beam report only contains one measurement per SSBRI, and that the UE reports the 1,2 or 4 highest values for that quantity?  If the reporting is per panel, the problem is similar, but even more complicated, since the NW uses the UL TCI to control the spatial properties of the UL transmission. If the reporting is per panel, how would the NW associate the measurement with the UL TCI?  We have some sympathy for Oppo’s suggestion to report MPR per UL TCI, but the UE should also be able to report for TCI states that are not activated – the network would typically require a report before activating any TCI state.  However, it feels difficult to agree on a reporting quantity before we agree on the scheduling mechanism. Here Proposal 4.1 is a good start. |

### Issue 6 (beam refinement/tracking)

After round-1 discussion was concluded, below is proposal 6.1 revised based on companies’ inputs (a sub-bullet on the second bullet was added to address inquiries).

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| **Proposal 6.1**: On Rel.17 enhancements based on the unified TCI framework, perform study and, if needed, specify the following:   * Beam management with reduced DL signaling (e.g. beam update based on reporting, beam measurement and report triggered by beam indication, multi-SSB indication, semi-static beam transition configuration, UE-initiated beam update/activation)   + Candidate schemes will be down selected or, if possible, combined * Reducing activation delay of TCI states (including other WGs, e.g. RAN4)   + On RAN4-related matters, assessment/study phase can be done in RAN1. If RAN4-based enhancements are found necessary, a LS to RAN4 will be sent (to prepare RAN4 work)   Note: Given its dependence on the maturity of other issues (1 to 5), when to start the work and how much work is done on issue 6 should depend on the progress on the other issues. |

**Support**: Futurewei (clarify 2nd bullet), MTK, Samsung, OPPO, Apple, Intel, NTT Docomo, Qualcomm (clarify 2nd bullet), Ericsson, IDC, Spreadtrum (after other issues progress enough), Xiaomi, Nokia/NSB (clarify 2nd bullet), Convida (after other issues progress enough), Lenovo/MoM

**Not support**: ZTE, Huawei/HiSi, vivo

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| Action: Interested companies are encouraged to share inputs on refining the text for endorsement  Goal: Finalize the proposal to be ready for endorsement |

Table 11 Inputs: issue 6

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| **Company** | **Input** |
| Moderator |  |
| Apple | Support proposal 6.1. |
| MediaTek | With the note under the proposal, we can support this proposal. |
| ZTE | We feel a little bit comfortable for proposal 6.1 with the additional note. Regarding second bullet, we think that the previous example in last meeting can be added back for clarification as follows:   * Reducing activation delay of TCI states (including other WGs, e.g. RAN4)   + For instance, via storing QCL properties of a subset of source RSs for a time period   + On RAN4-related matters, assessment/study phase can be done in RAN1. If RAN4-based enhancements are found necessary, a LS to RAN4 will be sent (to prepare RAN4 work) |
| vivo | Do not support. Concerned on too many examples to study. |
| Sony | The solutions for reducing overhead of DL beam management are quite open, and we see no obvious problem to further study it. Support proposal from FL in principle. |
| Nokia/NSB | O.K. in principle |
| Futurewei | Support FL’s proposal. |
| Convida Wireless | OK |
| Lenovo/MoM | Support proposal 6.1 |
| Qualcomm | Added one more aspect for UE initiated beam measurement. Also added reducing activation delay of PL RS for study, which is as important as TCI state. For the 2nd bullet, please add RAN4 issue description or related doc # for aligned understanding.  **Proposal 6.1**: On Rel.17 enhancements based on the unified TCI framework, perform study and, if needed, specify the following:   * Beam management with reduced DL signaling (e.g. beam update based on reporting, beam measurement and report triggered by beam indication, multi-SSB indication, semi-static beam transition configuration, UE-initiated beam measurement/update/activation)   + Candidate schemes will be down selected or, if possible, combined * Reducing activation delay of TCI states and PL RSs (including other WGs, e.g. RAN4)   + On RAN4-related matters, assessment/study phase can be done in RAN1. If RAN4-based enhancements are found necessary, a LS to RAN4 will be sent (to prepare RAN4 work)   + Add RAN4 issue description or related doc/LS # |
| Ericsson | Support |