**3GPP TSG RAN WG1 #108-e R1-2201994**

**e-Meeting, February 21th – March 3rd, 2022**

**Agenda item:** 8.1.1

**Source:** Moderator (Samsung)

**Title:** Moderator Summary for Maintenance on Rel-17 Multi-Beam

**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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| 1. Enhancement on multi-beam operation, mainly targeting FR2 while also applicable to FR1:    1. Identify and specify features to facilitate more efficient (lower latency and overhead) DL/UL beam management for intra-cell and inter-cell scenarios to support higher UE speed 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)       4. For inter-cell beam management, a UE can transmit to or receive from only a single cell (i.e. serving cell does not change when beam selection is done). This includes L1-only measurement/reporting (i.e. no L3 impact) and beam indication associated with cell(s) with any Physical Cell ID(s)          1. The beam indication is based on Rel-17 unified TCI framework          2. The same beam measurement/reporting mechanism will be reused for inter-cell mTRP          3. This work shall only consider intra-DU and intra-frequency cases    2. 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 |

This summary includes the following:

* Observation and proposal
* Summary of current companies’ positions on each of the aspects within the category

## Summary of companies’ inputs

### Issue 1 (Rel.17 unified TCI framework – note: for intra-cell beam management unless otherwise noted)

Table 1 Summary: issue 1

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| **#** | **Issue** | **Companies’ views** |
| 1.1 | **Proposal 1.A**: Confirm the following working assumption as an agreement with the following refinement (highlighted in **red**):  The UE is not expected to be configured with Rel-15/Rel-16 TCI/SpatialRelationInfo***/PUCCH-SpatialRelationInfo* (except *spatialRelationInfoPos*)** if the UE is configured with Rel-17 TCI in any CC in a band   * The CC list for Rel-16 multi-CC beam indication should not contain any CC configured with Rel-17 TCI assuming different CC lists are used for Rel-16 and Rel-17   **FL Note**: Discussed offline [1] | **Support/fine**: MTK, Qualcomm, Ericsson, OPPO, Samsung, Apple, Nokia/NSB, ZTE, Intel, Lenovo/MotM, NTT Docomo, CATT, Xiaomi, Spreadtrum, CMCC, Huawei/HiSi, LG, Fraunhofer IIS/HHI, vivo, NEC, Futurewei, Ericsson  **Concern**: |
| 1.2 | **Proposal 1.B.1**: On Rel-17 unified TCI framework, for any SRS resource or resource set that does not share the same indicated Rel-17 TCI state(s) as dynamic-grant/configured-grant based PUSCH and all of dedicated PUCCH resources, but can be configured as a target signal of a Rel-17 UL or, if applicable, joint TCI (hence the Rel-17 UL or, if applicable, joint TCI state pool), Rel-17 mechanism(s) which reuse mechanisms similar to the Rel-15/16 spatial relation info update signaling/configuration design(s) are used to update/configure such SRS (s) with Rel-17 UL or, if applicable, joint TCI state(s).   * Including inter-cell case, where SSB with PCI different from the serving cell can be used as a source RS in Rel-17 UL, or if applicable joint, TCI state for these SRS resources * The same UL PC parameter setting (including PL-RS) is guaranteed for SRS resources in the same SRS resource set * The MAC-CE signaling for the Rel-17 mechanism(s) to update the spatial relation of the SRS not sharing the indicated Rel-17 TCI state shall strive to reuse the MAC-CE for the Rel-15/16 spatial relation info update   + Note:  The exact details are up to RAN2. * Note: A Rel-17 UE is not required to support both this feature and Rel-16 AP SRS SpatialRelationInfo update within the same band.   **FL Note**: Discussed offline [1]. Note that supporting companies comment that the preference from ZTE seems to go against previous agreement (association between Rel-17 TCI state and UL PC setting) | **Support/fine**: MTK, Qualcomm, Ericsson, OPPO, Samsung, Apple, Nokia/NSB, Intel, Lenovo/MotM, NTT Docomo, CATT, Xiaomi, Spreadtrum, CMCC, Huawei/HiSi, LG, Fraunhofer IIS/HHI, vivo, NEC, Futurewei, CMCC  **Concern**: ZTE (Reuse the Rel-15/16 per-SRS-resource-set UL PC parameter configuration/activation signalling (including PL-RS)), Ericsson (provide PC parameters in SRS resource set), Apple |
| 1.3 | **Proposal 1.C**: For Rel-17 unified TCI framework, on applying the indicated Rel-17 TCI state to PDCCH reception and the respective PDSCH reception for a CORESET other than CORESET#0 that is associated with both UE-dedicated and non-UE-dedicated reception on PDCCH in a CC and its respective PDSCH reception, at least for intra-cell, UE always applies the indicated Rel-17 TCI state   * TBD (RAN1#108-e): For inter-cell   **FL Note**: Discussed offline [1]. It has been commented that not supporting CORESET C is not an option since it is inherited from Rel-15/16. Also note that most supporters of the proposal is fine with “like CORESET B” alternative | **Support/fine**: MTK (intra), Samsung (intra), Nokia/NSB (intra), Xiaomi (intra), Lenovo/MotM (intra), Spreadtrum, NTT Docomo, LG (intra), Fraunhofer IIS/HHI (intra), NEC, Futurewei, Intel (intra), Ericsson  **Concern**: vivo (like CORESET B), OPPO (don’t support CORESET C), CATT (like CORESET B), LG (like CORESET B), CMCC (CORESET B), Qualcomm (depends on search space), Apple |
| 1.4 | **Proposal 1.D**: For Rel-17 unified TCI framework, in RAN1#107-e, for the Rel-17 TCI state indication of CORESET 0, at least for intra-cell:   * Follow the same rule as ‘CORESET B’, i.e. whether to apply the indicated Rel-17 TCI state associated with the serving cell is configured per CORESET by RRC – if not applied, use the legacy MAC-CE/RACH signalling mechanism * Note: The CSI-RS associated with the Rel-17 TCI state applied to CORESET 0 should be QCLed with an SSB (same as Rel-15)   TBD (RAN1#108-e): For inter-cell  **FL Note**: Discussed offline [1] | **Support/fine**: Qualcomm (for CSS), Lenovo/MotM, Nokia/NSB, MTK, ZTE, CMCC, Samsung, Xiaomi, Apple, NTT Docomo, Huawei/HiSi, Fraunhofer IIS/HHI, OPPO, NEC, CATT, Futurewei, vivo (reuse Rel-15/16 if not indicated TCI state), CMCC, Apple, Ericsson  **Concern**: OPPO (Use MAC CE), Spreadtrum (like CORESET A) |
| 1.5 | **Proposal 1.E**: Agree in principle on the following text proposal for TS 38.214:  **TS38.214 section 5.1.5:**  The UE with activated [*TCI-State]* configured with [*tci-StateId\_r17]* receives DCI format 1\_1/1\_2 providing indicated *TCI-State* with[*tci-StateId\_r17]* for a CC or all CCs in the same CC list configured by *[simultaneousTCI-UpdateList1* or *simultaneousTCI-UpdateList2]*. The DCI format 1\_1/1\_2 can be with or without, if applicable, DL assignment. If the DCI format 1\_1/1\_2/ is without DL assignment, the UE can assume the following:  - …  After a UE receives an initial higher layer configuration of more than one TCI states with[*DLorJoint-TCIState-Id-r17]* and before ~~reception~~ application of an indicated TCI state from the configured TCI states:   * The UE assumes that DM-RS of PDSCH and DM-RS of PDCCH ~~in a CC~~, and the CSI-RS applying the indicated TCI state are quasi co-located with the SS/PBCH block the UE identified during the initial access procedure   After a UE receives an initial higher layer configuration of more than one TCI states with[*DLorJoint-TCIState-Id-r17]* or [*UL-TCIState-Id]* and before application of an indicated TCI state from the configured TCI states:   * The UE assumes that the UL TX spatial filter, if applicable, for dynamic-grant and configured-grant based PUSCH and PUCCH ~~resource in a CC~~, and SRS applying the indicated TCI state is the same as that for a PUSCH transmission scheduled by a RAR UL grant during the initial access procedure   After a UE receives a higher layer configuration of more than one TCI states with[*DLorJoint-TCIState-Id-r17]* as part of a Reconfiguration with sync procedure as described in [12, TS 38.331]and before ~~reception~~ application of an indicated TCI state from the configured TCI states:   * The UE assumes that DM-RS of PDSCH and DM-RS of PDCCH ~~in a CC~~, and the CSI-RS applying the indicated TCI state are quasi co-located with the SS/PBCH block or the CSI-RS resource the UE identified during the random access procedure initiated by the Reconfiguration with sync procedure as described in [12, TS 38.331]   After a UE receives a higher layer configuration of more than one TCI states with[*DLorJoint-TCIState-Id-r17]* or [*UL-TCIState-Id]* as part of a Reconfiguration with sync procedure as described in [12, TS 38.331] and before application of an indicated TCI state from the configured TCI states:   * The UE assumes that the UL TX spatial filter, if applicable, for dynamic-grant and configured-grant based PUSCH and PUCCH ~~resource in a CC~~, and SRS applying the indicated TCI state is the same as that for a PUSCH transmission scheduled by a RAR UL grant during random access procedure initiated by the Reconfiguration with sync procedure as described in [12, TS 38.331]   **FL Note**: Discussed offline [1] | **Support/fine**: MTK, Qualcomm, Ericsson, OPPO, Samsung, Apple, Nokia/NSB, ZTE, Intel, Lenovo/MotM, NTT Docomo, CATT, Xiaomi, Spreadtrum, CMCC, LG, Fraunhofer IIS/HHI, vivo, NEC, Futurewei,  **Concern**: Ericsson |
| 1.6 | **Proposal 1.B.2**: On Rel-17 unified TCI framework, for any SRS resource or resource set that does not share the same indicated Rel-17 TCI state(s) as dynamic-grant/configured-grant based PUSCH and all of dedicated PUCCH resources, but can be configured as a target signal of a Rel-17 UL or, if applicable, joint TCI (hence the Rel-17 UL or, if applicable, joint TCI state pool), the MAC-CE signaling for Rel-17 TCI state indication includes at least the following:   * TCI ID for each SRS resource * SRS resource set’s cell ID * SRS resource set’s BWP ID * The power control parameters for the SRS resource set should be derived based on the power control parameters associated with TCI indicated for the first SRS resource * Note:  The exact MAC CE format is up to RAN2.   **FL Note**: Proposed offline toward the end by Apple to finalize details of proposal 1.B.1[1]. | **Support/fine**: Apple  **Concern**: MTK, Ericsson (not needed) |
| 1.7 | **Proposal 1.C.2**: For Rel-17 unified TCI framework, on applying the indicated Rel-17 TCI state to PDCCH reception and the respective PDSCH reception for a CORESET other than CORESET#0 that is associated with both UE-dedicated and non-UE-dedicated reception on PDCCH in a CC and its respective PDSCH reception, for inter-cell,   * UE always applies the indicated Rel-17 TCI state * UE is not expected to receive common signals from a cell with a different PCI from that of the serving cell   **FL Note**: Possible compromise (based on companies’ views) to finalize details of proposal 1.C.1[1]. Rather than not allowing CORESET C for inter-cell at all, it makes more sense to allow it except for receiving common signals from NSC | **Support/fine**: Ericsson  **Concern**: Apple |
| 1.8 | **Proposal 1.D.2**: For Rel-17 unified TCI framework, in RAN1#107-e, for the Rel-17 TCI state indication of CORESET 0, for inter-cell:   * Follow the same rule as ‘CORESET B’, i.e. whether to apply the indicated Rel-17 TCI state associated with the serving cell is configured per CORESET by RRC – if not applied, use the legacy MAC-CE/RACH signalling mechanism * UE is not expected to receive common signals from a cell with a different PCI from that of the serving cell * Note: The CSI-RS associated with the Rel-17 TCI state applied to CORESET 0 should be QCLed with an SSB (same as Rel-15)   **FL Note**: Possible compromise (based on companies’ views) to finalize details of proposal 1.D.1[1]. Rather than not allowing CORESET 0 for inter-cell at all, it makes more sense to allow it except for receiving common signals from NSC | **Support/fine**: Apple, Ericsson  **Concern**: |
| 1.9 | On Rel-17 unified TCI framework, for P/SP-CSI-RS, the UE assumes that:   * Alt1. The indicated Rel-17 TCI state is always applied * Alt2. Whether to apply the indicated Rel-17 TCI state is configured per per CSI-RS resource by RRC – if not applied, use the legacy MAC-CE signalling mechanism * Alt3. The indicated Rel-17 TCI state is never applied, i.e. the legacy MAC-CE signalling mechanism is always used * Alt4. The indicated Rel-17 TCI state is applied when gNB does not configure any TCI state for the P/SP CSI-RS   **FL Note**: Open issue that needs to be resolved | **Alt1:**  **Alt2:**  **Alt3:** MTK (add RRC)  **Alt4:** Apple, Ericsson |
| 1.10 | On Rel-17 unified TCI framework, when CSI-RS follows the indicated Rel-17 TCI state, “followUnifiedTCI-State-r17” should be configured per CSI-RS resource and applied to AP CSI reporting only | **Support/fine:** Huawei/HiSi  **Concern:** Apple, Ericsson |
| 1.11 | For Rel-17 unified TCI framework, in RAN1#107-e, for the Rel-17 TCI state indication of CORESET 0, the UE assumes TCI state based on latest RA procedure, if no TCI state is indicated after RA procedure. | **Support/fine:** Samsung, Ericsson (could be left to UE implementation)  **Concern:** Apple |
| 1.12 | On Rel.17 unified TCI framework, for Rel-17 unified TCI, for DL channels/signals that share the same indicated Rel-17 TCI state as UE-dedicated reception on PDSCH/PDCCH (via Rel-17 MAC-CE/DCI TCI state update), the following option on source RSs and QCL-Types is also supported:   * Option 3: CSI-RS for CSI is configured for QCL-TypeA and QCL-TypeD source RS   **FL Note**: It was explained that the so-called “circular” issue is avoided in practice via NW implementation, i.e. NW will not configure the same CSI-RS for CSI both as source and target RSs. **Need conclusion**. | **Support/fine**: Sony, CMCC, Ericsson  **Concern**: Apple |
| 1.13 | For cross-carrier scheduling, support cross-carrier DCI-based TCI state indication | **Support/fine:** Qualcomm,Samsung, MTK (support by default)  **Concern:** Ericssion (no spec impact) |
| 1.14 | On path-loss measurement for Rel.17 unified TCI framework, at least for discussion purposes, when both PL-RS and spatial relation RS in the UL or (if applicable) joint TCI state are not the same, “beam alignment” also pertains to the following events:   * The PL-RS is identical to the QCL Type-D source RS or UL spatial relation RS of the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D source RS of PL-RS is identical to the spatial relation RS in the UL or (if applicable) joint TCI state * The QCL Type-D source RS of PL-RS is identical to the QCL Type-D source RS or UL spatial relation RS of the spatial relation RS in the UL or (if applicable) joint TCI state   **FL Note:** Any additional event (bullet) doesn’t seem acceptable for a number of companies. Even the above, some still have concern. **Need conclusion**. | **Support/fine:** MTK  **Concern:** Ericsson (leave to RAN4) |
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Table 2 Additional inputs: issue 1

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 1** 2. **Share more inputs here if needed** |
| MediaTek | Proposal 1.B.1: Regarding the 3rd sub-bullet, we prefer to clarify the MAC-CE is used for semi-persistent SRS as in Rel-15/16. Thus, we suggest:   * The MAC-CE signaling for the Rel-17 mechanism(s) to update the spatial relation of the semi-persistent SRS not sharing the indicated Rel-17 TCI state shall strive to reuse the MAC-CE for the Rel-15/16 spatial relation info update   Proposal 1.D: We suggest to clarify CORESET 0 should be QCLed with an SSB associated with serving cell PCID.  Note: The CSI-RS associated with the Rel-17 TCI state applied to CORESET 0 should be QCLed with an SSB associated with serving cell PCI (same as Rel-15)  Proposal 1.B.2: We feel this proposal may not be necessary. It is clearly indicated in Proposal 1.B that the MAC-CE shall strive to reuse the MAC-CE for the Rel-15/16 spatial relation info update, and details are up to RAN2 design. On the other hand, the 4th sub-bullet (the power control parameters for the SRS resource set …) should be captured in RAN1 spec, which doesn't impact the MAC-CE design.  Proposal 1.C.2 and Proposal 1.D.2: We are fine with these proposals in principle. However, we prefer to further clarify what does “UE is not expected to receive common signals from a cell associated with a different PCI from that of the serving cell” mean. Does it mean UE doesn't perform PDCCH monitoring on CSS set if the indicated TCI state is associated with a different PCI from that of the serving cell? Or it means UE doesn't expect the indicated TCI state is associated with a different PCI from that of the serving cell.  Issue 1.9: We prefer Alt3 since P/SP-CSI-RS is usually used as source RS, especially TRS. BTW, RRC should be added in Alt3 for P-CSI-RS.   * Alt3. The indicated Rel-17 TCI state is never applied, i.e. the legacy RRC/MAC-CE signalling mechanism is always used   Issue 1.10: In the incoming LS R1-2200887 (R2-2202002), RAN2 raised some questions related to this issue. We can discuss this when reply the LS to RAN2.  Issue 1.11: It seems the proposal overlaps with Proposal 1.E.  Issue 1.13: We see cross-carrier DCI-based TCI state indication is not precluded from Rel-17 TCI, additional agreement may not be needed.  We’d like to point out one another issue on BFR. There are some remaining issues (but not critical) need to be addressed according the agreements from the last meeting.  **Agreement from RAN1#107**  On Rel-17 unified TCI framework, for intra-cell beam management, after X symbols from the UE receives the BFRR from NW, the UE assumes the same QCL parameter as the ones associated with the index q new for all PDSCH /PDCCH receptions in a CC, as well as other signals/channels configured to sharing the same indicated Rel-17 TCI state as PDSCH /PDCCH reception.   * The above applies to Rel-15 SpCell BFR, Rel-16 CBRA based SpCell BFR , and Rel-16 SCell BFR * Note: q new is a candidate beam identified by the UE in set q1. q1 is the set of candidate beams   **Agreement from RAN1#107**  On Rel-17 unified TCI framework, after X symbols from the UE receives the BFRR from NW, the UE uses the same UL spatial filter as the one associated with the index q new or the last PRACH transmission for all PUSCH transmissions and all of PUCCH resources in a CC, as well as other signals/channels configured to sharing the same indicated Rel-17 TCI state as PUSCH and all of PUCCH resources.   * The above applies to Rel-15/16 SpCell BFR, Rel-16 CBRA based SpCell BFR, and Rel-16 SCell BFR * Note: q new is a candidate beam identified by the UE in set q1. q1 is the set of candidate beams   FFS: UL PC control including q u , q d , and closed loop index |
| Apple | 1.2: We think RAN1 should make the content for the MAC CE clear instead of leaving everything to RAN2, and the MAC CE format can be up to RAN2, as discussed in issue 1.6.  1.3: We think the application of the indicated TCI should be determined based on the type of SS, based on the agreement before that UE-dedicated signal always share the indicated TCI and whether non-UE dedicated signal shares the indicated TCI is configured by gNB  1.6: Since legacy MAC CE cannot support to indicate non-serving cell SSB for the beam indication and pathloss RS indication, enhancement of MAC CE is needed.  1.7: Similar to 1.3, we think the application of the indicated TCI should be determined based on the type of SS, based on the agreement before that UE-dedicated signal always share the indicated TCI and whether non-UE dedicated signal shares the indicated TCI is configured by gNB  1.9: Alt4 is added  1.10: We are not sure why “applied to AP CSI reporting only” is needed  1.11: It seems this is covered by 1.8  1.12: In our view, this does not seem to be a valid issue in maintenance phase  1.13: We think some more details needs be provided. Does it mean the CC ID indicated in DCI can indicate the target applicable CC for the indicated TCI?  1.14: We are open, but it seems this is not quite necessary.  Additional issue: we think the following proposals can be discussed to make the virtual PHR meaningful. Currently virtual PHR is always based on a default power control parameters set, which could be different from what is configured for current transmission.  ***Support to report virtual PHR based on the power control parameters associated with indicated TCI state for PUSCH/PUCCH transmission.*** |
| Nokia | 1.1: Support Proposal 1.A  1.2: Support Proposal 1.B.1  1.3: Support Proposal 1.C  1.4: Support Proposal 1.D  1.5: Support Proposal 1.E  1.6: In principle we are fine with the proposal but it seems a bit weird if the PL RS needs to be assumed to be the same for the SRS resources that can be provided with different TCI state and thus different QCL-Type RS. Thus, we would consider the following update for the second last bullet:   * The power control parameters, except PL RS, for the SRS resource set should be derived based on the power control parameters associated with TCI indicated for the first SRS resource   1.7: Support Proposal 1.C.2  1.8: Same as CORESET B. If the TCI state indicates RS associated with PCI different from that of a serving cell, the follow unified TCI does not apply (until TCI indicates RS of a serving cell)  1.9: We think that the following alternative should be added:   * Alt4. Whether to apply the indicated Rel-17 TCI state is configured per CSI-RS resource by RRC – if not applied, use the legacy MAC-CE signalling mechanism   1.10: We don’t see need to restrict to aperiodic reporting.  1.11: Support  1.12: Support  1.13: Support  1.14: Ok |
| Ericsson | P1.B.1: We would be OK with the proposal, if we remove “The same UL PC parameter setting (including PL-RS) is guaranteed for SRS resources in the same SRS resource set”. This is up to NW configuration.  P.1.E: The expression “TCI states with [DLorJoint-TCIState-Id-r17]” is somewhat difficult to understand, and unnecessarily complicated. There is an IE called DLorJoint-TCIState-r17:  DLorJoint-TCIState-r17 ::= SEQUENCE {  tci-StateUnifiedId-r17 DLorJoint-TCIState-Id-r17,  tci-StateType-r17 ENUMERATED {DLOnly, JointULDL},  qcl-Type1-r17 QCL-Info,  qcl-Type2-r17 QCL-Info OPTIONAL -- Need R  }  and using that name to refer to the type of TCI state is both shorter and easier to understand. We propose the following modification:  **TS38.214 section 5.1.5:**  The UE with activated [*TCI-State]* configured with [*tci-StateId\_r17]* receives DCI format 1\_1/1\_2 providing indicated *TCI-State* with[*tci-StateId\_r17]* for a CC or all CCs in the same CC list configured by *[simultaneousTCI-UpdateList1* or *simultaneousTCI-UpdateList2]*. The DCI format 1\_1/1\_2 can be with or without, if applicable, DL assignment. If the DCI format 1\_1/1\_2/ is without DL assignment, the UE can assume the following:  - …  After a UE receives an initial higher layer configuration of more than one [*DLorJoint-TCIState-r17]* and before ~~reception~~ application of an indicated TCI state from the configured TCI states:   * The UE assumes that DM-RS of PDSCH and DM-RS of PDCCH ~~in a CC~~, and the CSI-RS applying the indicated TCI state are quasi co-located with the SS/PBCH block the UE identified during the initial access procedure   After a UE receives an initial higher layer configuration of more than one [*DLorJoint-TCIState-r17]* or [*UL-TCIState-r17]* and before application of an indicated TCI state from the configured TCI states:   * The UE assumes that the UL TX spatial filter, if applicable, for dynamic-grant and configured-grant based PUSCH and PUCCH ~~resource in a CC~~, and SRS applying the indicated TCI state is the same as that for a PUSCH transmission scheduled by a RAR UL grant during the initial access procedure   After a UE receives a higher layer configuration of more than one [*DLorJoint-TCIState-r17]* as part of a Reconfiguration with sync procedure as described in [12, TS 38.331]and before ~~reception~~ application of an indicated TCI state from the configured TCI states:   * The UE assumes that DM-RS of PDSCH and DM-RS of PDCCH ~~in a CC~~, and the CSI-RS applying the indicated TCI state are quasi co-located with the SS/PBCH block or the CSI-RS resource the UE identified during the random access procedure initiated by the Reconfiguration with sync procedure as described in [12, TS 38.331]   After a UE receives a higher layer configuration of more than one [*DLorJoint-TCIState-r17]* or [*UL-TCIState-r17]* as part of a Reconfiguration with sync procedure as described in [12, TS 38.331] and before application of an indicated TCI state from the configured TCI states:   * The UE assumes that the UL TX spatial filter, if applicable, for dynamic-grant and configured-grant based PUSCH and PUCCH ~~resource in a CC~~, and SRS applying the indicated TCI state is the same as that for a PUSCH transmission scheduled by a RAR UL grant during random access procedure initiated by the Reconfiguration with sync procedure as described in [12, TS 38.331]   1.10: Here we should note that the running CR is lacking the configuration of Rel-17 TCI states, and perhaps that the use of the field “followUnifiedTCI-State-r17” is unfortunate: the interpretation would be that if the field “followUnifiedTCI-State-r17” is missing, the UE would require configuration of Rel-17 TCI states. However, the main mode of operation is that when Rel17 TCI states are provided, all signals should follow the unified TCI. Having said that, it would seem sufficient to configure “followUnifiedTCI-State-r17” in the CSI-AssociatedReportConfig IE, since when R17 TCI states would be configured explicitly, full flexibility exists.  1.11: We could also consider leaving this to UE implementation. If the UE finds a better SSB for CORESET#0 reception, the UE would be free to use that.  1.13: This is supported by default, and there is no spec impact.  1.14: RAN4 is discussing a full definition of beam alignment. Leave to RAN4. |
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### Issue 2 (inter-cell beam management)

Table 3 Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2.1 | Report L1-RSRP for the subset of configured SSBs detected during the L3 measurement | **Support/fine:** Ericsson, MTK  **Concern**: |
| 2.2 | Resource configuration for supporting mixed SC and NSC beam reports in a single reporting instance | **PCIs associated with multiple SSB sets:** Xiaomi  **PCIs associated with SSBs in a set**: Huawei/HiSi, MTK (already agreed)  **Not needed:** Ericsson |
| 2.3 | Measuring overlapped SSBs from different PCIs  **FL note**: This issue needs RAN4 input first | **Not supported:** OPPO  **UE capability (max. number)**: Qualcomm, MTK, Apple |
| 2.4 | MAC CE activates non-serving cell SSBs for measurement | **Support/fine:** ZTE, Apple  **Concern**: MTK |

Table 4 Additional inputs: issue 2

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 3** 2. **Share more inputs here if needed** |
| MediaTek | ~~Issue 2.1: This proposal is unclear to us. Is it event-driven reporting based on the event of L3 measurement? We thought this is already precluded from Rel-17.~~  Issue 2.2: Singe set of SSBs associated with multiple PCI indices has been agreed in RAN1#107 to our understanding.  **Agreement**  On Rel-17 enhancements for inter-cell beam management and inter-cell mTRP, a CSI-SSB-ResourceSet configured for L1-RSRP measurement/reporting includes at least a set of SSB indices where PCI indices are associated with the set of SSB indices, respectively. The PCI indices refer to PCIs within the set of PCIs configured for inter-cell beam management or inter-cell multi-TRP.   * The additionalInfo associated with SSB(s) with PCI(s) different from the serving cell agreed in RAN1 Agenda Item 8.1.2.2 is also applicable to inter-cell BM * Detailed signaling design is up to RAN2 * FFS (to be concluded in RAN1#107-e): Whether the above L1-RSRP measurement/reporting also includes group-based beam report for inter-cell mTRP   Issue 2.4: Prefer not to introduce any new functionality at this stage. |
| Apple | 2.1: We think some clarification may be needed. In our understanding, L3 measurement could be the first step for UE to perform L1 measurement, since L3 measurement can provide some rough timing/beam assumption. But is this proposal to ask UE to perform L1 and L3 measurement at the same time, or to ask UE to perform L1 measurement after it measured L3 results?  2.2: Based on our understanding, mixed SC/NSC for one beam report instance has already been agreed.  2.3: We think this should be a UE capability.  2.4: We support this operation. It is not necessary for UE to measure SSBs from all neighbor cells. Based on current UE capability, it is also hard for gNB to provide such configuration. Then gNB can only use RRC reconfiguration to change the SSBs to be measured. |
| Nokia/NSB | 2.1. The issue should capture that this is for inter-cell SSBs. Anyway, this sounds more of a RAN4 issue.  2.2. RAN1 should indicate to RAN2 e.g. in the LS reply that resource configuration needs to support mixed reporting in a single reporting instance.Already in R2-2202000 the PCI is associated with SSBs in a CSI-SSB-ResourceSet. To support mixed mode reporting e.g. with additional PCI, the number of these sets could be increased to 2 (also discussed in the CR). However, this is RAN2 issue.  2.3. wait for RAN4.  2.4. To aid NW activation of SSBs, UE should be able to indicate network that it has detected or determined that reporting configuration should be activated. |
| MediaTek | Issue 2.1: After further check the intention of 2.1, we understood this proposal requires UE only needs to perform L1-RSRS measurement/reporting on the SSBs that are detected during L3 measurements. We are supportive to this proposal. |
| Ericsson | 2.1: The idea is not to perform event-driven reporting: we still use NW-controlled reporting. However, the UE may choose to report only some of the configured RSs – the RSs the UE anyway detected as part of the L3 mobility.  2.2: There is no need to include different PCIs in the resource configuration, since measurements from multiple resource sets can be included in the same report.  2.3: RAN4 input could be valuable. But overlapping SSBs is the only relevant deployment. A UE that does not support measurements in overlapping SSBs does not support mobility.  2.4: Already supported. |

### Issue 3 (signaling medium)

Table 5 Summary: issue 3

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| **#** | **Issue** | **Companies’ views** |
| 3.1 | **Proposed conclusion 3.A**: On Rel-17 DCI-based beam indication, regarding application time of the beam indication, there is no consensus on supporting a second configured BAT for, e.g. MPUE or inter-cell BM, for a given SCS and all the CCs configured with the common TCI state ID update.  **FL Note**: Discussed offline [1]. This has been discussed since RAN1#107-e. While more companies prefer to support a second BAT (for MPUE or inter-cell), there are significant number of companies against this.    Single BAT: vivo, Oppo, DCM, CMCC  Two BATs: HW, CATT, LG, Ericsson | |
| 3.2 | **Proposal 3.B**: On Rel-17 DCI-based beam indication, regarding application time of the beam indication for CA, in RAN1#108-e, further discuss and select one from the following alternatives for BAT configuration across CCs when common TCI state ID update is not configured/supported:   * Alt1. The BAT is configured per-CC * Alt2. Use the same scheme as that with common TCI state ID update, i.e. a common BAT is determined by the CC(s) with the smallest SCS in a band * Alt3. A BAT list is configured under the cell group config and applied for each CC in the CG. For CCs not configured with a common TCI state ID update, the BAT is determined by the SCS of the active BWP of the CC.   **FL Note**: Discussed offline [1]. | **Alt1**: Huawei/HiSi, NTT Docomo, Xiaomi, Ericsson (no additional restriction), Samsung, CMCC, Intel (when common TCI state ID update is not configured/supported), MTK(also for non-CA case), NEC, CATT, OPPO, LG, CMCC  **Alt2:** Qualcomm, ZTE, Apple, Lenovo/MotM, Spreadtrum,  **Alt3**: vivo |
| 3.3 | **Proposal 3.C**: On Rel-17 DCI-based beam indication, regarding the CC list for common TCI state ID update, introduce new RRC parameter(s) to configure the CC list  **FL Note**: Discussed offline [1]. | **Support/fine**: NTT Docomo, Qualcomm, OPPO, Fraunhofer IIS/HHI, LG, vivo, CMCC, Intel, MTK, Lenovo/MotM, Samsung, CATT, Apple, Ericsson  **Concern**: |
| 3.4 | When the gap between the last symbol of beam indication DCI and the determined first slot does not meet the UE capability, the UE starts to apply the indicated TCI state in the first slot that can satisfy the UE capability | **Support/fine:** OPPO  **Concern**: MTK, Ericsson (the UE rejects the RRC configuration) |
| 3.5 | For DCI format 1\_1 and 1\_2 with PDSCH assignment indicating TCI state, the acknowledgement to the TCI state update is the ACK of the PDSCH | **Support/fine:** OPPO  **Concern**: |
| 3.6 | The value range of RRC configured BAT (beamAppTime-r17)   * {0, ..., 14} from NTT Docomo | **Support/fine**: NTT Docomo  **Other proposals**: MTK, Ericsson ({7, 14, 28, 42, 56, 70, 84, 98}), Apple ({24, 28, 42}) |
| 3.7 | If the UE is configured with Rel-17 TCI, TCI field is always present in DCI format 1\_1/1\_2 | **Support/fine:** MTK, Samsung  **Concern**: Apple, Ericsson |
| 3.8 | For DCI format 1\_2 for TCI update and without DL assignment, the RV field should always present | **Support/fine:** Qualcomm  **Concern**: Ericsson |
| 3.9 | Regarding TCI indication by DCI without DL assignment, for type-1 HARQ-ACK codebook determination, virtual PDSCH is assumed in the same slot of the DCI by UE. | **Support/fine**: ZTE  **Concern**: |
| 3.10 | For DCI formats 1\_1 and 1\_2 without DL assignment, the UCI carrying the HARQ feedback should be mapped to high priority HARQ codebook and PUCCH resources associated with priority index 1 when the UE is configured with two priority indexes. If UE is configured with single priority index, the UCI carrying the HARQ feedback for beam indication should be prioritized over other UCI. | **Support/fine**: Intel  **Concern**: Ericssson (not essential) |
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Table 6 Additional inputs: issue 3

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 5** 2. **Share more inputs here if needed** |
| MediaTek | Proposal 3.B: There are two possible cases including CA and non-CA when common TCI state ID update is not configured/supported. For CA case, how to provide BAT is clarified in this proposal. However, it is still unclear how to provide BAT for non-CA case. Thus, we suggest to have another proposal for non-CA case, and it seems there is only one solution as follows:  **Proposal 3.B.1**: On Rel-17 DCI-based beam indication, regarding application time of the beam indication for non-CA, the BAT is configured per-CC.  Proposal 3.C: Suggest to add “activation” in the main bullet. Meanwhile, since common TCI state ID update and activation is only agreed for intra-band CA, we also expect multiple CC lists may be needed, where each band requires at least one. Thus, we suggest:   * **Proposal 3.C**: On Rel-17 DCI-based beam indication, regarding the CC list(s) for common TCI state ID update and activation, introduce new RRC parameter(s) to configure the CC list(s)FFS: The maximum number of CC lists can be configured   Issue 3.4: This doesn't seem necessary. A UE capability is already defined for the BAT.  Issue 3.6: We suggest {7, 14, 28, 42, 56, 70, 84, 98}. This may need to be concluded in order to provide answer to the incoming LS R1-2200887 (R2-2202002) from RAN2.  Issue 3.7: In Rel-15/16, whether the TCI field is present in DCI is configured by an RRC parameter in a CORESET. Since the TCI field in Rel-15/16 is used only for the scheduled PDSCH reception, it can be absent and UE will follow the PDCCH beam indicated for the corresponding CORESET for the scheduled PDSCH reception. However, in Rel-17 unified TCI framework, the TCI field is used for almost all DL and UL channels. Thus, it should be present if Rel-17 TCI is configured rather than per-CORESET configured. Even the DCI-based TCI update may not be used when there is only one active TCI states, the TCI field sill can be present since the DCI payload size should not be changed dynamically according to TCI activation. For UE that cannot support TCI update via DCI, UE ignores this bit field, which is similar to the BWP indicator field. |
| Apple | 3.4: We failed to see the necessity, but we think the default PDSCH/aperiodic CSI-RS beam can be discussed for scheduling offset below threshold  3.6: We think candidate value can be {14, 28, 42}  3.7: What is the benefit?  3.8: It seems this has already been agreed? Current validation rule requires the value of RV=all 1  3.9: We do not know why this is needed, and some clarification could be helpful.  3.10: We would like to understand what the consequence would be without this proposal. |
| Nokia | 3.1: We consider single BAT is needed as TCI state indication is from the activate TCI states and thus expect there is no panel switch on needed. Thus, we support proposed conclusion 3.A.  3.2: We support Alt1.  3.3: Support Proposal 3.C.  3.4: Not sure we understand the proposal – our understanding is that it cannot happen per agreements.  3.5: Ok  3.6: Ok  3.7: Ok  3.9: Ok |
| Ericssson | P 3.B: Alt1 states how the BAT is configured, whereas Alt2 states how the BATs are interpreted. (RAN2 plans to configure the BAT in the PDSCH-Config, i.e., per BWP.) On top of this configuration, we can add a configuration restriction in 38.331. This is how we see that the common TCI state update will be handled. So the remaining issue is if we should add additional restrictions in the specification on CCs that are not configured for common TCI update. Here we do not see why this is needed: a reasonable NW implementation will include all the CCs in a band in the CC list.  P3.C: We propose to use the same principle as in R16: configure 2 CCs lists (to handle inter-band CA)  Issue 3.4: If the configured BATs do not meet the UE capability, the UE should reject the RRC configuration.  Issue 3.6: Large values are needed, so that the NW can react on a missing ACK. Note that the NW cannot distinguish between a missed beam indication (the UE missed the PDCCH) and a missed ACK (the NW missed the PUCCH).  Issue 3.7: Operation with a single activated TCI state would not require a TCI field.  Issue 3.8: The spec is clear: if the RV field is not there, it’s not a beam indication. |
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### Issue 4 (MP-UE)

Table 7 Summary: issue 4

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| **#** | **Issue** | **Companies’ views** |
| 4.1 | **Proposal 4.A**: Confirm the following working assumption as an agreement with the following refinement (highlighted in **red**):  Support the UE reporting a list of UE capability value sets   * Each UE capability value set comprises the max supported number of SRS ports * For any two different value sets, at least one capability value needs to be different   + ~~FFS:~~ In addition also identical value sets are allowed. * Whether the UE capability value set can be common across all BWPs/CCs in same band or BC can be discussed in UE feature session   **FL Note:** Discussed offline [1] | **Support/fine**: MTK, Apple, Nokia  **Concern**: Ericsson |
| 4.2 | **Proposal 4.B**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection,   * From the perspective of UE capability, maximum number of supported UL Tx layers = min{maximum number of SRS ports for a reported set, maximum number of UL Tx layers reported by UE ~~capability~~}   **FL Note:** Discussed offline [1] | **Support/fine**: MTK, Apple, Nokia  **Concern**: Ericsson (no need to discuss) |
| 4.3 | **Proposal 4.C**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection, UE can report one index of UE capability value set for each reported CRI/SSBRI in one beam reporting.  **FL Note:** Discussed offline [1] | **Support/fine**: MTK, Apple, Nokia, Ericsson  **Concern**: |
| 4.4 | **Proposal 4.D**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection, one value of the max supported number of SRS ports (e.g., 0) is reserved to indicate the DL-only panel  **FL Note:** Discussed offline [1] | **Support/fine**: MTK, Ericsson  **Concern**: Apple, Nokia |
| 4.5 | **Proposal 4.E**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection, all types of time-domain behavior, i.e., periodic, semi-persistent, and aperiodic reporting, are supported for the enhanced beam report with index(es) of UE capability value set.   * [FFS: Semi-persistent and/or aperiodic reporting is triggered only when periodic reporting is configured] * [In such case, the candidate periodicities for periodic report are subjective to UE capability]   **FL Note:** Discussed offline [1] | **Support/fine**: MTK, Nokia, Ericsson  **Concern**: Apple (On SP/AP report) |
| 4.6 | **Proposal 4.F**: Regarding acknowledgement mechanism of the reported correspondence from NW to UE, down-select the following alternatives:   * Alt-1: Being based on TCI state activation/update mechanism where the activated TCI state includes reported RS (SSBRI or CSI-RS) [and is additionally associated with the index of UE capability value set]; * Alt-2: A dedicated SS can be configured to send the ACK, which is like PCell-BFR. * Alt-3: A scheme based on the BFR response in SCell BFR * Alt-4: acknowledgement mechanism is not supported.   **FL Note:** Discussed offline [1] | **Support/fine**: MTK (Alt1)  **Concern**: Apple (Alt1 is unclear on whether the text in bracket should be included or not), Ericsson |
| 4.7 | **Proposal 4.G**: Regarding how to update the number of SRS ports according to UE reporting, down-select the following alternatives:   * [Alt1: via UL BWP switching where each UL BWP has different number of SRS ports   + FFS: BWP fallback mechanism which would let NW to control UE panel, i.e. switch to a specific UE panel or panel type when timer expires.] * Alt2: via SRS resource set selection by DCI where each set has different number of ports   + Note1: ‘SRS resource set indicator’ is already specified in DCI format 0\_1/0\_2 and it provides functionality to select one SRS resource set by the DCI between two SRS resource sets configured by RRC   + Note2: TPMI/TRI mapping for varying number of SRS ports is already specified for fullpowerMode2. * FFS: Any other RRC parameters, e.g., the maximum number of UL layers, codebook subset, uplink full power mode, configuration of SRS for antenna switching and so on, may need to be updated simultaneously with the number of configured SRS ports.   **FL Note:** Discussed offline [1] | **Support/fine**: MTK (Alt1, no spec impact) , Nokia (Alt-1)  **Concern**: Apple, Ericsson |
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Table 8 Additional inputs: issue 4

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 7** 2. **Share more inputs here if needed** |
| Apple | 4.4: We think current discussion is for uplink panel selection. We do not know why this is needed.  4.5: We have concern on SP/AP report, as UE is not free to change panel if gNB does not trigger beam report any more.  4.6: We suggest we clearly state each alternative without bracket, which can be helpful for further down-selection.  4.7: We think the first issue is to discuss what parameters need to be updated. The solution should be general for all parameters. |
| Nokia | 4.1: Support Proposal 4.A as it would be future-proof for potential multi-panel UL transmission in Rel18.  4.2: Support Proposal 4.B  4.3: Support Proposal 4.C  4.4: In such case the UE should also provide SSBRI/CRI with valid capability value set index for the UL transmission purpose, i.e. that UE cannot report only reserved value.  4.5: Support without any additional rule.  4.6: TCI state activation/update mechanism is a logical mechanism to update the correspondence assumption.  4.7: We think that this can be done jointly with 4.6, i.e. with TCI state activation/update mechanism. Thus, we propose to add yet another alternative:   * Alt3: via TCI state update/activation mechanism with two options   + Opt1: MAC-CE based TCI state update is targeted to a certain SRS resource set that the SRS resource set if the target set is different from the previous used set.   + Opt2: UE can assume that the SRS resource set which can be triggered (aperiodic) or which is to be used (periodic or semi-persistent) is the one that is associated with the same capability set index as the UE provided in the report together with the reported RS and included in the activated TCI state. |
| Ericsson | P 4.A: we made a working assumption so that we can work out the remaining details. So far, there are many remaining details. We should not confirm the WA before those details have been worked out. We would in any case have strong concerns of removing the FFS, as it is not useful for the considered functionality.  P4.B: This would seem to be a natural consequence.  P4.F: There is no need for an acknowledgment.  P4.G: The proposal is a bit unclear with Alt1 in brackets. It would seem that the only thing that is actually proposed is Alt2, which could be formulated in a more compact way. |
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### Issue 5 (MPE)

Table 9 Summary: issue 5

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| **#** | **Issue** | **Companies’ views** |
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Table 10 Additional inputs: issue 5

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| **Company** | **Input** |
| Mod V0 | 1. **Check and update your view in Table 9** 2. **Share more inputs here if needed** |
| MediaTek | In our view, NW may not be able to perform UL beam selection from the reported SSBs/CSI-RSs only based on corresponding P-MPR values, and at least we see corresponding L1-RSRP/SINR values are essential. In normal case, NW performs beam UL beam selection based on L1-RSRP/SINR reporting from UE. When P-MPR reporting is triggered and reported from UE, in additional to L1-RSRP/SINR reporting, NW can use the P-MPR reporting as a reference for UL beam selection. In order to make sure that UE can perform measurement on the same set of RS resources and report the SSBRIs/CRIs for L1-RSRP/SINR and P-MPR reporting, the SSB/CSI-RS resource set associated with P-MPR reporting should be also associated with L1-RSRP/SINR reporting. Thus, we’d like to propose the following:  **Proposal: On Rel-17 enhancements to facilitate MPE mitigation, the SSB/CSI-RS resource set associated with P-MPR reporting should be also associated with L1-RSRP/SINR reporting** |
| Apple | In our view, the triggering condition for P-MPR report needs to be clarified. Currently the trigger condition is per UE basis, which is not aligned with the beam-specific P-MPR supported in Rel-17. We suggest discussing the following proposal.  ***The beam-specific P-MPR should be triggered when the P-MPR for indicated UL/joint TCI met legacy condition defined in 38.321, i.e. P-MPR for the indicated TCI is above mpe-Threshold or P-MPR change for this TCI is above phr-Tx-PowerFactorChange.*** |

# References

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | R1-2201995 | Moderator Summary of Offline Discussion on Rel-17 Multi-Beam | Moderator (Samsung) |
| 2 | [R1-2200929](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2200929.zip) | Remaining issues on multi-beam operation in Rel-17 | Huawei, HiSilicon |
| 3 | [R1-2200996](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2200996.zip) | Enhancement on multi-beam operation | FUTUREWEI |
| 4 | [R1-2201078](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201078.zip) | Maintenance on multi beam enhancement | vivo |
| 5 | [R1-2201185](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201185.zip) | Remaining issues on multi-beam enhancements | ZTE |
| 6 | [R1-2201223](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201223.zip) | Enhancements on Multi-beam Operation | OPPO |
| 7 | [R1-2201328](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201328.zip) | Discussion on remaining issues on Rel-17 multi-beam operation | CATT |
| 8 | [R1-2201425](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201425.zip) | Remaining issues in enhancements on multi-beam operation | Fraunhofer IIS, Fraunhofer HHI |
| 9 | [R1-2201426](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201426.zip) | Enhancements on Multi-beam Operation | Lenovo, Motorola Mobility |
| 10 | [R1-2201463](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201463.zip) | Remaining issues on multi-beam operation | NTT DOCOMO, INC. |
| 11 | [R1-2201534](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201534.zip) | Remaining issues on multi-beam enhancements | Spreadtrum Communications |
| 12 | [R1-2201567](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201567.zip) | Enhancements on Multi-beam Operation | LG Electronics |
| 13 | [R1-2201575](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201575.zip) | Remaining issues on Multi-beam Operation | Sony |
| 14 | [R1-2201644](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201644.zip) | Remaining issues on multi-beam enhancements | Ericsson |
| 15 | [R1-2201682](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201682.zip) | Enhancements to Multi-Beam Operations | Intel Corporation |
| 16 | [R1-2201758](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201758.zip) | Views on Rel-17 Beam Management enhancement | Apple |
| 17 | [R1-2201844](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201844.zip) | Remaining issues of enhancements on multi-beam operation | CMCC |
| 18 | [R1-2201896](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201896.zip) | Discussion on remaining issues on multi-beam operation | NEC |
| 19 | [R1-2201943](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201943.zip) | Remaining issues on multi-beam operation enhancement | Xiaomi |
| 20 | [R1-2201996](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2201996.zip) | Maintenance on Rel-17 Multi-Beam | Samsung |
| 21 | [R1-2202057](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2202057.zip) | Remaining issues on Rel-17 multi-beam operation | MediaTek Inc. |
| 22 | [R1-2202122](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2202122.zip) | Enhancements on Multi-beam Operation | Qualcomm Incorporated |
| 23 | [R1-2202316](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2202316.zip) | Maintenance of enhancements for Multi-beam Operation | Nokia, Nokia Shanghai Bell |
| 24 | [R1-2202003](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_108-e/Docs/R1-2202003.zip) | Other Potential Enhancements for Rel-17 Multi-beam | Samsung |
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