**3GPP TSG RAN WG1 #109-e R1-220XXXX**

**e-Meeting, May 9th – 20th, 2022**

**Agenda item:** 8.1.1

**Source:** Moderator (ZTE)

**Title:** Moderator Summary #1 for Maintenance on Rel-17 Multi-Beam

**Document for:** Discussion and Decision

## Introduction

The following email thread is assigned for email discussion on maintenance of Rel-17 Multi-Beam, please provide your comments in corresponding sections below

[109-e-R17-MIMO-02] Maintenance on beam management (description of issues in R1-2205130) – Bo (ZTE)

* Issues 1-1, 1-2, 1-7, 1-14, 1-15, 1-20, 1-30, 2-2, 2-3, 2-7, 3-1, 3-3, 3-4, 3-5, 3-7, 3-10, 4-2 by May 18
* Editorial Issues: 1-5, 1-6, 1-11, 1-13, 1-19, 1-31, 2-4, 2-5, 2-8, 3-8, 3-11, 4-1 by May 11

## Summary of High priority (H) issues

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

Table 1 Summary: issue 1

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| **#** | **Issue** | **Companies’ views** |
| 1-1 | **TP 1-1**: To endorse the following text proposal for TS 38.213:  **6 Link recovery procedures**  <Unchanged part omitted>  If a UE is provided *TCI-State\_r17* indicating a unified TCI state for the PCell or the PSCell [6, TS 38.214], after ~~X~~28 symbols from a last symbol of a first PDCCH reception in a search space set provided by *recoverySearchSpaceId* where the UE detects a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI, the UE  - if *AdditionalPCIInfo* is not provided, monitors PDCCH in all CORESETs, and receives PDSCH and aperiodic CSI-RS in a resource from a CSI-RS resource set with same indicated TCI state as for the PDCCH and PDSCH, using the same antenna port quasi co-location parameters as the ones associated with the corresponding index , if any  - transmits PUCCH, PUSCH and SRS that uses a same spatial domain filter with same indicated TCI state as for the PUCCH and the PUSCH, using a same spatial domain filter as for the last PRACH transmission. A power parameter is determined with:  - the RS index for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission  - the values of , , and the PUSCH power control adjustment state are provided by *p0-Alpha-CLID-PUSCH-Set* associated with the lowest value of *ul-powercontrolId-r17* configured for the PCell or the PSCell  - the values of and the PUCCH power control adjustment state are provided by *p0-Alpha-CLID-PUCCH-Set* associated with the lowest value of *ul-powercontrolId-r17* configured for the PCell or the PSCell  - the values of , , and SRS power control adjustment state are provided by *p0-Alpha-CLID-SRS-Set* associated with the lowest value of *ul-powercontrolId-r17* configured for the PCell or the PSCell  <Unchanged part omitted>  If a UE is provided *TCI-State\_r17* indicating a unified TCI state for the PCell or the PSCell and the UE provides BFR MAC CE in Msg3 or MsgA of contention based random access procedure, after ~~X~~28 symbols from the last symbol of the PDCCH reception that determines the completion of the contention based random access procedure as described in [11, TS 38.321], the UE  - if *AdditionalPCIInfo* is not provided, monitors PDCCH in all CORESETs, and receives PDSCH and aperiodic CSI-RS resource in a CSI-RS resource set with same indicated TCI state as for the PDCCH and PDSCH using the same antenna port quasi co-location parameters as the ones associated with the corresponding index , if any  - transmits PUCCH, PUSCH and SRS that uses a same spatial domain filter with same indicated TCI state as for the PUCCH and PUSCH, using a same spatial domain filter as for the last PRACH transmission. A power parameter is determined with:  - the RS index for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission  - the values of , , and the PUSCH power control adjustment state are provided by *p0-Alpha-CLID-PUSCH-Set* associated with the lowest value of *ul-powercontrolId-r17* configured for the PCell or the PSCell  - the values of and the PUCCH power control adjustment state are provided by *p0-Alpha-CLID-PUCCH-Set* associated with the lowest value of *ul-powercontrolId-r17* configured for the PCell or the PSCell  - the values of , , and SRS power control adjustment state are provided by *p0-Alpha-CLID-SRS-Set* associated with the lowest value of *ul-powercontrolId-r17* configured for the PCell or the PSCell  <Unchanged part omitted>  If a UE is provided *TCI-State\_r17* indicating a unified TCI state, after ~~X~~28 symbols from a last symbol of a PDCCH reception with a DCI format scheduling a PUSCH transmission with a same HARQ process number as for the transmission of the first PUSCH and having a toggled NDI field value, the UE  - monitors PDCCH in all CORESETs, and receives PDSCH and aperiodic CSI-RS in a resource from a CSI-RS resource set using the same antenna port quasi co-location parameters as the ones associated with the corresponding index , if any  - transmits PUCCH, PUSCH and SRS that uses a same spatial domain filter with same indicated TCI state as for the PUCCH and PUSCH, using a same spatial domain filter as the one corresponding to , if any. A power parameter is determined with:  - the RS index for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission  - the values of , , and the PUSCH power control adjustment state are provided by *p0-Alpha-CLID-PUSCH-Set* associated with the lowest value of *ul-powercontrolId-r17* configured for the corresponding SCell  - the values of and the PUCCH power control adjustment state are provided by *p0-Alpha-CLID-PUCCH-Set* associated with the lowest value of *ul-powercontrolId-r17* configured for the corresponding SCell  - the values of , , and SRS power control adjustment state are provided by *p0-Alpha-CLID-SRS-Set* associated with the lowest value of *ul-powercontrolId-r17* configured for the corresponding SCell  <Unchanged part omitted>  **FL Note**: Rel-15/16 UL power control setting may not be configured in unified TCI framework in Rel-17, and consequently we may need to identify the default setting in the pool of RRC UL power control setting for unified TCI. The following as proposed by some proponents is unclear, according to my best knowledge.  …, where a power determined as described in clause 7.1.1, 7.2.1 and 7.3.1 with , , , and  So, let’s try TP2 in R1-2203257 firstly with some modification. The other issue, e.g., updating closed loop value, can be discussed in the second round. | **Support/fine**: QC, Apple, ZTE, vivo, Huawei/HiSilicon,CATT, Nokia, Docomo, Lenovo  **Not support:** SS,Ericsson |
| 1-2 | **Alt-2: Section 7 Uplink Power control in TS 38.213**  In the remaining of this clause, if a UE is provided *DLorJoint-TCIState* or *UL-TCIstate* and for an indicated *DLorJoint-TCIState* or *UL-TCIstate* as described in [6, TS 38.214]  - in clauses 7.1.1, 7.2.1, and 7.3.1, the RS index for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission is provided by *PL-RS* associated with or included in the indicated *DLorJoint-TCIState* or *UL-TCIstate* except for SRS transmission that is not provided *useIndicatedTCIState*  - in clause 7.1.1, if *p0-Alpha-CLID-PUSCH-Set* is provided, the values of , , and the PUSCH power control adjustment state are provided by *p0-Alpha-CLID-PUSCH-Set* associated with the indicated *DLorJoint-TCIState* or *UL-TCIstate*  - in clause 7.2.1, if *p0-Alpha-CLID-PUCCHSet* is provided, the values of and the PUCCH power control adjustment state are provided by *p0-Alpha-CLID-PUCCH-Set* associated with the indicated *DLorJoint-TCIState* or *UL-TCIstate*  - in clause 7.3.1, if *p0-Alpha-CLID-SRS-Set* is provided,  - if *useIndicatedTCIState* is provided for a SRS resource set, the values of , , and SRS power control adjustment state are provided by *p0-Alpha-CLID-SRS-Set* associated with the indicated *DLorJoint-TCIState* or *UL-TCIState*  - else, if *useIndicatedTCIState* is not provided for a SRS resource set and for a first SRS resource from the SRS resource set, the values of , , and SRS power control adjustment state are provided by *p0-Alpha-CLID-SRS-Set* associated with *DLorJoint-TCIState* or *UL-TCIState* of an SRS resource with lowest *SRS-ResourceId* in the SRS resource set and a RS index for obtaining a pathloss estimate for the SRS transmission is provided by PL-RS associated with or included in the indicated *DLorJoint-TCIState* or *UL-TCIState* of an SRS resource with lowest *SRS-ResourceId* in the SRS resource set  - in clauses 7.1.1, 7.2.1, and 7.3.1, if the *TCI-State\_r17* configurations is absent in a BWP of the CC, the UE can apply the RS index , , , the PUSCH power control adjustment state , , the PUCCH power control adjustment state , , , and SRS power control adjustment state included in the indicated *TCI-StateID\_r17* from a reference BWP of a reference CC.  **FL Note**: Besides, the cross-CC PL-RS indication by ‘pathlossReferenceLinking’ as mentioned in TP1 in R1-2203257 can be discussed in the second round. | **~~Alt-1~~**~~: vivo~~  **Alt-2: Apple, ZTE,** Huawei/HiSilicon, LG, CATT, Nokia, Docomo, QC (2nd)  **~~Alt-3: QC (1~~~~st~~~~)~~**  **~~Not support:~~** ~~SS,Ericsson~~ |
| 1-7 | **TP 1-7**: To endorse the following text proposal for TS 38.213:  **7 Uplink Power control**  < Unchanged parts are omitted >  In the remaining of this clause, if a UE is provided *DLorJoint-TCIState* or *UL-TCIstate* and for an indicated *DLorJoint-TCIState* or *UL-TCIstate* as described in [6, TS 38.214]  - in clauses 7.1.1, 7.2.1, and 7.3.1, the RS index for obtaining the downlink pathloss estimate for PUSCH, PUCCH, and SRS transmission is provided by *PL-RS* associated with or included in the indicated *DLorJoint-TCIState* or *UL-TCIstate* except for SRS transmission that is not provided *useIndicatedTCIState*  - for the case when *AdditionalPCIInfo* is provided, and if the *PL-RS* maps to a SS/PBCH index, the UE assumes that the *PL-RS* is associated with the PCI associated with *DLorJoint-TCIState* or *UL-TCIstate*  - in clause 7.1.1, if *p0-Alpha-CLID-PUSCH-Set* is provided, the values of , , and the PUSCH power control adjustment state are provided by *p0-Alpha-CLID-PUSCH-Set* associated with the indicated *DLorJoint-TCIState* or *UL-TCIstate*  - in clause 7.2.1, if *p0-Alpha-CLID-PUCCHSet* is provided, the values of and the PUCCH power control adjustment state are provided by *p0-Alpha-CLID-PUCCH-Set* associated with the indicated *DLorJoint-TCIState* or *UL-TCIstate*  - in clause 7.3.1, if *p0-Alpha-CLID-SRS-Set* is provided,  - if *useIndicatedTCIState* is provided for a SRS resource set, the values of , , and SRS power control adjustment state are provided by *p0-Alpha-CLID-SRS-Set* associated with the indicated *DLorJoint-TCIState* or *UL-TCIState*  - else, if *useIndicatedTCIState* is not provided for a SRS resource set and for a first SRS resource from the SRS resource set, the values of , , and SRS power control adjustment state are provided by *p0-Alpha-CLID-SRS-Set* associated with *DLorJoint-TCIState* or *UL-TCIState* of an SRS resource with lowest *SRS-ResourceId* in the SRS resource set and a RS index for obtaining a pathloss estimate for the SRS transmission is provided by PL-RS associated with or included in the indicated *DLorJoint-TCIState* or *UL-TCIState* of an SRS resource with lowest *SRS-ResourceId* in the SRS resource set  < Unchanged parts are omitted >  **FL Note**: The Rel-17 TCI state applied for SRS can be associated with serving cell PCI or additional PCI different from the serving cell for inter-cell beam indication. For inter-cell case, to align the spatial relation RS in Rel-17 TCI state and the associated PLRS, the PCI information in TCI state configured by RRC can be applied to the PLRS. | **Support/fine**:  **Not support: QC** |
| 1-14 | **TP 1-14**: To endorse the following text proposal for TS 38.214:  **5.1.5 Antenna ports quasi co-location**  < Unchanged parts are omitted >  If a UE receives a higher layer configuration of a single DLorJoint-TCIState or UL-TCIState, that can be used as an indicated TCI state, the UE determines an UL TX spatial filter, if applicable, from the configured TCI state for dynamic-grant and configured-grant based PUSCH and PUCCH, and SRS applying the indicated TCI state.  If a UE is provided *followUnifiedTCIstate-r17* for a CORESET with index 0   * After a random access procedure not initiated by a PDCCH order that triggers a contention-free random access procedure, if no DCI Format or MAC CE indicating a TCI state is received, the UE assumes that DM-RS of PDCCH and DM-RS of PDSCH associated with the CORESET with index 0 are quasi co-located with the SS/PBCH block the UE identified during the random access procedure, and the UE assumes that the UL TX spatial filter, if applicable, for dynamic-grant based PUSCH and PUCCH associated with the CORESET of index 0 is the same as that for a PUSCH transmission scheduled by a RAR UL grant during the initial access procedure. * After the UE receives a DCI Format or MAC CE indicating a TCI state, and after a beam application delay as described in this clause; the UE obtains the QCL assumptions from the indicated [*DLorJoint-TCIState-r17]* TCI state for DM-RS of PDCCH and DM-RS of PDSCH associated with the CORESET with index 0, and the UE determines an UL TX spatial filter, if applicable, from the indicated [*DLorJoint-TCIState-r17]* or [*UL-TCIState-r17]* for a dynamic-grant based PUSCH and PUCCH associated with the CORESET with index 0.   **FL Note**: When CORESET 0 has been configured by RRC to follow the unified TCI state (or not configured to no follow the unified TCI state), the TCI state/quasi-co-location is determined by the indicated (unified) TCI state, or the most recent random access procedure if no unified TCI state has been indicated after the most recent random access procedure. | **Support/fine**: OPPO, Apple, ZTE, SS, Google, Spreadtrum, Nokia, Docomo  **Not support:** MTK, QC, vivo (need clarification on scenarios), Huawei/HiSilicon, LG, CATT, Ericsson |
| 1-15 | **TP 1-15**: To endorse the following text proposal for TS 38.214:  **5.1.5 Antenna ports quasi co-location**  < Unchanged parts are omitted >  When *tci-PresentInDCI* is set as 'enabled' or *tci-PresentDCI-1-2* is configured for the CORESET, the UE with activated *DLorJointTCIState* or *UL-TCIState* receives DCI format 1\_1/1\_2 providing indicated *DLorJointTCIState* or *UL-TCIState* for a CC or all CCs in the same CC list configured by *simultaneousTCI-UpdateList1-r17, simultaneousTCI-UpdateList2-r17, simultaneousTCI-UpdateList3-r17, simultaneousTCI-UpdateList4-r17*. 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:  - CS-RNTI is used to scramble the CRC for the DCI  - The values of the following DCI fields are set as follows:  - RV = all '1's  - MCS = all '1's  - NDI = 0  - Set to all '0's for FDRA Type 0, or all '1's for FDRA Type 1, or all '0's for dynamicSwitch (same as in Table 10.2-4 of [6, TS 38.213]).  If a UE is configured with *CrossCarrierSchedulingConfig* for a serving cell the value of the DCI field ‘*carrier indicator*’ corresponds to the value indicated by *CrossCarrierSchedulingConfig.* The codepoint indicated by the DCI field ‘*Transmission Configuration Indicator*’ is applied to the carrier indicated by the DCI field ‘*carrier indicator*’ and all CCs configured in a same CC list as that carrier, and corresponds to indicated TCI state configured and activated for that carrier and all CCs, respectively.  **FL Note**: For the Rel-17 unified TCI framework, update 38.214 to describe cross carrier beam indication based on the "carrier indicator field" in DCI Format 1\_1 or DCI Format 1\_2 based on the above TP. | **Support/fine**: Apple, SS, Google, Huawei/HiSilicon, Nokia, Ericsson, Docomo  **Not support:** MTK, QC, OPPO, ZTE, Spreadtrum, LG, CATT |
| 1-20 | **Proposal 1-20: To calculate the Type 1 power headroom based on a reference PUSCH, the UE uses the pathloss reference signal associated with or included in the indicated joint/UL-TCI state.**  **FL Note**: For virtual PHR, we may firstly discuss above proposal from E/// (with some modification in red) on confirming the functionality of virtual PHR calculation in unified TCI for reference PUSCH. After that, we can further review whether/how to draft the corresponding TP in the second round. | **Support/fine**: MTK, Apple, ZTE, vivo, Google, CATT, Nokia, Ericsson, Docomo  **Not support:** SS, Huawei/HiSilicon, QC |
| 1-30 | **TP 1-30**: To endorse the following text proposal for TS 38.213:  **7 Uplink Power control**  < Unchanged parts are omitted >  - else, if *useIndicatedTCIState* is not provided for a SRS resource set and for a first SRS resource from the SRS resource set, the values of , , and SRS power control adjustment state are provided by *p0-Alpha-CLID-SRS-Set* associated with *DLorJoint-TCIState* or *UL-TCIState* of an SRS resource with lowest *SRS-ResourceId* in the SRS resource set and a RS index for obtaining a pathloss estimate for the SRS transmission is provided by PL-RS associated with or included in the indicated *DLorJoint-TCIState* or *UL-TCIState* of an SRS resource with lowest *SRS-ResourceId* in the SRS resource set. If two SRS resource sets are configured by higher layer parameter *srs-ResourceSetToAddModList* and *srs-ResourceSetToAddModListDCI-0-2*, respectively, and associated with the higher layer parameter usage of value 'codeBook' or 'nonCodeBook', and if *useIndicatedTCIState* is not provided for at least one SRS resource set of the two, UE expects the power control parameters associated with the TCI state of the SRS resources with the lowest *SRS-ResourceId* in the SRS resource set are the same as those applied for the other SRS resource set.  **FL Note**: For unified TCI framework, if *useIndicatedTCIState* is not provided for a SRS resource set, the SRS is not to follow the PC parameters may not be identical for the two SRS resource sets configured by srs-ResourceSetToAddModList and srs-ResourceSetToAddModListDCI-0-2. Therefore, in R1-2204976, it is proposed that we should have identical PC parameters as above two sets. | **Support/fine**: QC, OPPO  **Not support:** MTK, Apple, ZTE, vivo, Huawei/HiSilicon, LG, CATT, Nokia, Docomo |

Table 2 Additional inputs: issue 1

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| **Company** | **Input** |
| Mod V0 | **Re 1-1, technically speaking, it is dangerous for NW operation if P0/alpha/*l* is not defined. @SS, E/// can you live with the majority views for progress.**  **Re 1-2, thanks for QC’s being flexible. @vivo, SS, HW can you live with the majority views, i.e., Alt-2?**  **Re 1-7, it seems that many companies mentioned that only the case that SSB is used as PL-RS should be considered. How about above update?**  **Re 1-20, @HW, based on your command, the proposal is updated. Generally, legacy UL power control parameter is precluded for unified TCI. Either way, we need to identify the new behavior for virtual PHR determination.**   * **@HW, SS, Could you live with majority companies views?**   **After that, the following issues are still controversial. If still unchanged, we have to conclude the corresponding issue with no consensus. Any suggestion?**   * **1-14, 1-15 , 1-30** |
| QC | For TP 1-7, we think perhaps the clean way is to ask RAN2 to add PCI for the PL RS, which may provide more flexibility  For TP 1-20, we think PUSCH-PathlossReferenceRS-Id is still used by unified TCI, and the default PUSCH-PathlossReferenceRS-Id = 0 can still be configured. So it still works as in legacy VPHR. |
| Apple | For TP 1-20, @QC, according to latest ASN.1, the UL PC parameters should be as follows, and the RRC parameters in the statement in current 38.213 “where and are obtained using and *p0-PUSCH-AlphaSetId* *=* 0, is obtained using *pusch-PathlossReferenceRS-Id =* 0, and .” may be missing. In addition, with the help of unified TCI, why not use the correct PC parameters to calculate vPHR?  DLorJoint-TCIState-r17 ::= SEQUENCE {  tci-StateUnifiedId-r17 TCI-StateId,  qcl-Type1-r17 QCL-Info,  qcl-Type2-r17 QCL-Info OPTIONAL, -- Need R  ul-powerControl-r17 Uplink-powerControlId-r17 OPTIONAL, -- Need R  pathlossReferenceRS-Id-r17 PUSCH-PathlossReferenceRS-Id OPTIONAL -- Need S  -- Editor's Note: Check if new id -r17 is needed to cover full ID range    }  Uplink-powerControl-r17 ::= SEQUENCE {  ul-powercontrolId-r17 Uplink-powerControlId-r17 OPTIONAL, -- Need R  p0AlphaSetforPUSCH-r17 P0AlphaSet-r17 OPTIONAL, -- Need R  p0AlphaSetforPUCCH-r17 P0AlphaSet-r17 OPTIONAL, -- Need R  p0AlphaSetforSRS-r17 P0AlphaSet-r17 OPTIONAL -- Need R  } |
| vivo | For TP 1-2, still prefer Alt-1. Alt-1 is more flexible by configuring PC parameters per BWP/CC. And compared to Alt-2, the spec change is smaller. Could companies elaborate why they prefer Alt-2?  For TP 1-7, Ok with the updated TP.  The clarification in RRC is another solution, i.e. the PCI of PLRS follows that of the TCI state. If so, RAN1 needs to have a conclusion and send LS to RAN2. |
| LG | TP 1-7: Fine with the update TP considering SSB case only. |
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### Issue 2 (inter-cell beam management)

Table 3 Summary: issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2-2 | **Proposal 2-2A:** On inter-cell beam management, The PDCCH/PDSCH should be rate matched around the SSBs associated with an activate TCI state which is associated with the same PCI as the PDSCH/PDCCH  **FL note**: It was pointed out that there are some concerns about further introducing others except for rate matching. Hence, let’s firstly handle the above rate matching issue (based on the proposal in P16 in R1-2203505) and then the corresponding TP. If we still have sufficient time after handling above, we can handle the others in the second/third round. | **Option-1:** MTK, QC, OPPO, Apple (change “L1-RSRP measurement” into “L1-RSRP/CBD measurement or associated with active TCI”), ZTE (with change), SS, vivo, Google, Huawei, HiSilicon, Spreadtrum, CATT, Nokia, Ericsson (with ZTE’s change), Docomo (with ZTE’s change), Lenovo (with ZTE’s change)  **Option-2:** |
| **Proposal 2-2B:** On inter-cell beam management, introduce additional CRS-rate matching pattern parameter for each additional PCI  **FL note**: Like *crs-RateMatch-PerCORESETPoolIndex-r16* in Rel-16 mDCI-mTRP. | **Support/fine**: ~~QC,~~ Apple, ZTE, Nokia, Ericsson, Docomo, Lenovo  **Not support:** SS, Huawei/HiSilicon, CATT |
| 2-3 | **Proposal 2-3 (For discussion purpose):** On inter-cell beam management, the following should be supported.   * non-UE-dedicated PDSCH with scheduling offset < a threshold (TBD: default QCL assumption, e.g., reusing Rel-15/16) * Note: non-UE-dedicated PDSCH refers to PDSCH scheduled from the CORESET associated with CSS   **FL note**: It was pointed out that, before the detailed discussion, we may need to identify whether the above scenario should be supported or not. After that, we may identify the solution in the second round. | **Support/fine**: QC, OPPO, Apple (This is already in spec), ZTE, vivo, Google, Spreadtrum, CATT, Nokia, Ericsson  **Not support:** SS, Huawei/HiSilicon |
| 2-7 | **Proposal 2-7:** On inter-cell beam management, the following QCL Types should be additionally supported:   * For a TCI state configured for periodic TRS,   + Alt-1a: SS/PBCH block associated with additional PCI w.r.t. QCL-TypeC + the same SS/PBCH w.r.t. QCL-TypeD   + Alt-1b: SS/PBCH block associated with additional PCI w.r.t. QCL-TypeC + CSI-RS for BM w.r.t. QCL-TypeD * For a TCI state configured for CSI-RS for CSI,   + Alt-2: TRS w.r.t. QCL-TypeA + SS/PBCH block associated with additional PCI w.r.t. QCL-TypeD   **FL note**: The above alternatives are from P3 in R1-2204682 and Section 2.1 in R1-2204763, respectively. For instance, they provide the corresponding TPs as follows:  **Example-1: 5.1.5 Antenna ports quasi co-location in TS 38.214**  \*\*\* Unchanged text is omitted \*\*\*  For a periodic CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info*, the UE shall expect that a TCI-State indicates one of the following quasi co-location type(s):  - 'typeC' with an SS/PBCH block and, when applicable, 'typeD' with the same SS/PBCH block, where SS/PBCH block may have a PCI different from the PCI of the serving cell, and the UE can assume center frequency, SCS, SFN offset are the same for SS/PBCH block from the serving cell and SS/PBCH block having a PCI different from the serving cell, or  - 'typeC' with an SS/PBCH block and, when applicable,'typeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*.  **Example-2: 5.1.5 Antenna ports quasi co-location in TS 38.214**  <Unchanged Parts omitted>  For a periodic CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info*, the UE shall expect that a TCI-State indicates one of the following quasi co-location type(s):  - 'typeC' with an SS/PBCH block and, when applicable, 'typeD' with the same SS/PBCH block, the reference RS may additionally be an SS/PBCH block having a PCI different from the PCI of the serving cell, or  - 'typeC' with an SS/PBCH block reference RS may additionally be an SS/PBCH block having a PCI different from the PCI of the serving cell and, when applicable,'typeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*.  <Unchanged Parts omitted>  For a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured without higher layer parameter *trs-Info* and without the higher layer parameter *repetition*, the UE shall expect that a TCI-State indicates one of the following quasi co-location type(s):  - 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with the same CSI-RS resource, or  - 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with an SS/PBCH block, the reference RS may additionally be an SS/PBCH block having a PCI different from the PCI of the serving cell, or  - 'typeA' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* and, when applicable, 'typeD' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*, or  - 'typeB' with a CSI-RS resource in a *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info* when 'typeD' is not applicable. | **Alt-1a**   * Support/fine: MTK, QC, OPPO, Apple, ZTE, SS (proposal is fine, some refinement needed for TP), vivo, Huawei/HiSilicon, Spreadtrum, LG, CATT, Nokia, Ericsson, Docomo, Lenovo * Not support:   **Alt-1b**:   * Support/fine: Apple, ZTE, SS (proposal is fine, some refinement needed for TP), Huawei/HiSilicon, CATT, Ericsson, Docomo * Not support: MTK   **Alt-2:**   * Support/fine: Apple, ZTE, Huawei/HiSilicon, Spreadtrum, CATT, Ericsson, Docomo * Not support: MTK, SS |

Table 4 Additional inputs: issue 2

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| **Company** | **Input** |
| Mod V0 | **Re 2-2A, it seems that majority companies seem fine with ZTE’s update. Let’s check the new version.**  **Re 2-2B, from moderator perspective, the intention of this proposal is to achieve the same target as ‘***crs-RateMatch-PerCORESETPoolIndex-r16***’ as for mTRP. But, no doubt that the legacy parameter can not be used in inter-cell beam management. So, opponents please double check it.**  **Re 2-3, discuss by email directly together with Samsung’s new proposal in Issue 1-31.**  **Re 2-7, @MTK and SS, can you be flexible for Alt-1b and Alt 1-c?** |
| QC | For Proposal 2-2A, the wording seems to only rate match around SSBs in those active TCIs. To our understanding, it should be matched around ALL SSBs indicated by ssb-PositionsInBurst for the same PCI associated with TCI of PDSCH/PDCCH. This is based on the agreement below as well as 214->5.1.4. Therefore, we suggest the following change  **Proposal 2-2A:** On inter-cell beam management, The PDCCH/PDSCH should be rate matched around the SSBs ~~associated with an activate TCI state which is associated with~~ indicated by ssb-PositionsInBurst-r17 for the same PCI as that associated with TCI state of the PDSCH/PDCCH  **Agreement**  Agree on scheme1   * Scheme1: PDSCH/PDCCH from non-serving cell (PCI) associated with TCI state and/or QCL-info is rate matched around non-serving cell SSB with the same PCI * FFS: whether PDSCH /PDCCH from serving cell (PCI) is rate matched around non-serving cell SSB * FFS: whether PDSCH/PDCCH from non-serving cell (PCI) associated with TCI state and/or QCL-info is rate matched around serving cell SSB   For Proposal 2-2B, we are fine to withdraw the support |
| vivo | For 2-2A, if we have to go through this route, we prefer to rate match around all SSBs associated with activated TCI. Since these SSBs can potentially be used for measurement.  **Proposal 2-2A:** On inter-cell beam management, The PDCCH/PDSCH should be rate matched around the SSBs associated with an activate TCI state. ~~which is associated with the same PCI as the PDSCH/PDCCH~~ |
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### Issue 3 (signaling medium)

Table 5 Summary: issue 3

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| **#** | **Issue** | **Companies’ views** |
| 3-1 | **Alt-4: TS 38.214** 6.1.1.1 Codebook based UL transmission <Unchanged parts are omitted>  The UE shall transmit PUSCH using the same antenna port(s) as the SRS port(s) in the SRS resource indicated by the DCI format 0\_1 or 0\_2 or by *configuredGrantConfig* according to clause 6.1.2.3.  If an SRS resource set with parameter *usage* set to 'codebook' is not configured with *followUnifiedTCIstate,* the UE shall expect that the configured [TCI-State]s with [tci-StateId\_r17] of the SRS resource(s) are always equal to the indicated *[TCI-State]* with *[tci-StateId\_r17].* 6.1.1.2 Non-Codebook based UL transmission <Unchanged parts are omitted>  The UE shall transmit PUSCH using the same antenna ports as the SRS port(s) in the SRS resource(s) indicated by SRI(s) given by DCI format 0\_1 or 0\_2 or by *configuredGrantConfig* according to clause 6.1.2.3, where the SRS port in (*i*+1)-th SRS resource in the SRS resource set is indexed as .  If an SRS resource set with parameter *usage* set to 'nonCodebook' is not configured with *followUnifiedTCIstate,* the UE shall expect that the configured *[TCI-State]s* with *[tci-StateId\_r17]* of the SRS resource(s) are equal to the indicated *[TCI-State]* with *[tci-StateId\_r17].*    **FL note**: The above four alternatives are from R1-2203105, TP5 in R1-2203257, P2 in R1-2203673, P2 in R1-2203948, respectively. | **~~Alt-1~~**~~: ZTE, Huawei/HiSilicon, Nokia~~  **~~Alt-2:~~** ~~ZTE~~  **~~Alt-3:~~** ~~ZTE, NEC, Nokia, Lenovo~~  **Alt-4:** MTK, QC, OPPO, Apple, SS (also fine to have no TP and leave for network implementation), vivo, Spreadtrum, LG, CATT, Ericsson (with reformulation) , Docomo, Lenovo, Intel,  Not support: |
| 3-3 | **Proposal 3-3A:** On Rel-17 DCI-based beam indication, for both CA and non-CA cases,   * ~~Alt-1: TCI update signaling is applied to all configured BWP(s).~~ * Alt-2: TCI update signaling is applied to active BWP(s)   **FL note**: The corresponding TP can be discussed in the second round. | **~~Alt-1~~**~~: Apple, ZTE, Spreadtrum~~  **Alt-2: QC, OPPO, SS, vivo, Google, Huawei/HiSilicon, Xiaomi, CATT, Nokia, Ericsson, Docomo, Intel,** **Spreadtrum, Samsung** |
| **Proposal 3-3B:** On Rel-17 DCI-based beam indication, for both CA and non-CA cases,   * ~~Alt-1: BAT should count the BeamAppTime\_r17 in all configured BWP(s).~~ * Alt-2: BAT should count the BeamAppTime\_r17 in active BWP(s) only   **FL note**: The corresponding TP can be discussed in the second round. | **~~Alt-1~~**~~: Apple, ZTE, Spreadtrum~~  **Alt-2: QC, OPPO, SS, vivo, Google, Huawei/HiSilicon, Xiaomi, CATT, Nokia, Ericsson, Docomo, Intel,** **Spreadtrum, Samsung,** |
| 3-4 | **Alt 2:** **TS 38.214**  The DM-RS antenna ports  in Clause 6.4.1.1.3 of [4, TS 38.211] are determined according to the ordering of DM-RS port(s) given by Tables 7.3.1.1.2-6 to 7.3.1.1.2-23 in Clause 7.3.1.1.2 of [5, TS 38.212].  For non-codebook based transmission, the UE does not expect to be configured with both *spatialRelationInfo* for SRS resource and *associatedCSI-RS* in *SRS-ResourceSet* for SRS resource set.  For non-codebook based transmission, the UE does not expect to be configured with both *DLorJoint-TCIState* or *UL*-*TCIState* for SRS resource and *associatedCSI-RS* in *SRS-ResourceSet* for SRS resource set.  For non-codebook based transmission, when the SRS resource set is configured with *followUnifiedTCIstate-r17*, the UE does not expect to be configured *associatedCSI-RS* in *SRS-ResourceSet* for SRS resource set.  For non-codebook based transmission, the UE can be scheduled with DCI format 0\_1 or 0\_2 when at least one SRS resource is configured in *SRS-ResourceSet* with *usage* set to 'nonCodebook'.  **FL note**: The above two alternatives are from R1-2203257 and R1-2204169, respectively. | **~~Alt-1~~**~~: ZTE, Huawei/HiSilicon, LG~~  **Alt-2:** MTK, QC, OPPO, Apple, vivo, Spreadtrum, CATT, Nokia, Ericsson, Lenovo  No change: SS |
| 3-5 | **Alt 1**: **Section 5.1.5 Antenna ports quasi co-location in TS 38.214**  < Unchanged parts are omitted >  When the UE would transmit the last symbol of a PUCCH with HARQ-ACK information corresponding to the DCI carrying the TCI State indication and without DL assignment, or corresponding to the PDSCH scheduling by the DCI carrying the TCI State indication, and if the indicated TCI State is different from the previously indicated one, the indicated *DLorJointTCIState* or *UL-TCIstate* should be applied starting from the first slot that is at least symbols after the last symbol of the PUCCH. The first slot and the symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. The applied indicated TCI state should be based on the activated TCI states in each slot.  < Unchanged parts are omitted >  **Alt 2**: **Section 5.1.5 Antenna ports quasi co-location in TS 38.214**  <Unchanged parts are omitted>  If a PDSCH is scheduled by a DCI format having the TCI field present, the TCI field in DCI in the scheduling component carrier points to the activated TCI states in the scheduled component carrier or DL BWP, the UE shall use the *TCI-State* according to the value of the '*Transmission Configuration Indication*' field in the detected PDCCH with DCI for determining PDSCH antenna port quasi co-location. The UE may assume that the DM-RS ports of PDSCH of a serving cell are quasi co-located with the RS(s) in the TCI state with respect to the QCL type parameter(s) given by the indicated TCI state if the time offset between the reception of the DL DCI and the corresponding PDSCH is equal to or greater than a threshold *timeDurationForQCL*, where the threshold is based on reported UE capability [13, TS 38.306]. When the UE is configured with a single slot PDSCH, the indicated TCI state should be based on the activated TCI states in the slot with the scheduled PDSCH. When the UE is configured with a multi-slot PDSCH, the indicated TCI state should be based on the activated TCI states in the first slot with the scheduled PDSCH, and UE shall expect the activated TCI states are the same across the slots with the scheduled PDSCH. When the UE is configured with DLorJoint-TCIState-r17 ~~and~~ or UL-TCIState-r17, the indicated TCI state(s) should be based on the activated TCI states in the slot with the TCI state indication DCI. When the UE is configured with CORESET associated with a search space set for cross-carrier scheduling and the UE is not configured with *enableDefaultBeamForCCS*, the UE expects *tci-PresentInDCI* is set as 'enabled' or *tci-PresentDCI-1-2* is configured for the CORESET, and if one or more of the TCI states configured for the serving cell scheduled by the search space set contains *qcl-Type* set to 'typeD', the UE expects the time offset between the reception of the detected PDCCH in the search space set and the corresponding PDSCH is larger than or equal to the threshold *timeDurationForQCL.*  <Unchanged parts are omitted>  **FL note**: The above are from P7 in R1-2203505 and P6 in R1-2203948, respectively. | **Alt-1**: MTK, ZTE, vivo, Google, Ericsson, Docomo  **Alt-2: OPPO, Apple,** SS (reword “DLorJoint-TCIState-r17 and UL-TCIState-r17” to “DLorJoint-TCIState-r17 or UL-TCIState-r17”)  **Not supported: QC, Huawei/HiSilicon, CATT, Nokia, Intel** |
| 3-7 | **Proposal 3-7:** 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  **FL note**: The above has been discussed for several meeting, and either way we need to make a conclusion (or NACK is still possible). After that, we may discuss the following issues: in case of HARQ-ACK multiplexing, the TCI state(s) indicated in a DCI corresponding to last position with ACK value in the HARQ-ACK codebook is applied after application timing (P5 in R1-2203673, P6 in R1-2203771, P2 in R1-2204535). | **Support/fine**: QC, OPPO, Apple, ZTE, NEC, SS (when gNB can’t distinguish NACK and DTX)), Spreadtrum, Xiaomi, CATT, Nokia, Ericsson, Docomo, Intel  **Not support:** MTK, Google |
| 3-10 | **TP 3-10**: To endorse the following text proposal for TS 38.214:  **5.1.5 Antenna ports quasi co-location**  <Unchanged parts are omitted>  When the UE would transmit the last symbol of a PUCCH with HARQ-ACK information or a PUSCH with HARQ-ACK information corresponding to the DCI carrying the TCI State indication and without DL assignment, or corresponding to the PDSCH scheduling by the DCI carrying the TCI State indication, and if the indicated TCI State is different from the previously indicated one, the indicated *DLorJointTCIState* or *UL-TCIstate* should be applied starting from the first slot that is at least symbols after the last symbol of the PUCCH or the PUSCH. The first slot and the symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication.  <Unchanged parts are omitted> | **Support/fine**: MTK, QC, OPPO (ok with the TP even through it is not 100% needed.) Apple (clarification for PUSCH repetition case is needed), ZTE, NEC, SS, vivo, Google, Huawei/HiSilicon, Spreadtrum, Xiaomi, CATT, Nokia, Ericsson, Docomo, Intel  **Not support:** |

Table 6 Additional inputs: issue 3

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| **Company** | **Input** |
| Mod V0 | **Re 3-1, we have super majority views. Let’s try Alt-4 in second round, and any wording refinement is highly appreciated.**   * **@ZTE, HW, Nokia, Lenovo, can you live with that?**   **Re 3-3, let’s go with supper majority views (Alt-2 for both), and any objection @Apple, ZTE?**  **Re 3-4, can we go with majority view, Alt-2?@ LG, HW, ZTE, SS**  **Re 3-5, the wording is refined according to comments. Either way, from the moderator perspective, we may need to have a decision.**  **Re 3-7, let’s go with supper majority views. @MTK and Google, can you live with that?**  **Re 3-10, let’s approve that by email.** |
| QC | For 3-5, Alt1 is the legacy rule and is not needed to specify just for R17. The applied indicated TCI is based on the activated TCI definition in that slot. For the case of multi-slot PDSCH and multi-PDSCH, the activated TCI cannot be changed across slots as in existing spec, so the indicated TCI will also not be changed. |
| Apple | Issue 3-3: If the indicated TCI is only applied to active BWP, we would like to understand how BWP switching can work. When should gNB update the beam for the new BWP? If this can only be done after BWP switching, how to receive this TCI update signaling in the new BWP as the TCI in this new BWP has already got outdated. We may need to think about the case when UE falls back to the default BWP, how to maintain the communication.  Issue 3-5: We can also accept Alt1.  Issue 3-10: We would like to clarify for PUSCH with HARQ transmitted in multiple repetitions, should we count the starting point at the last repetition with HARQ or the whole PUSCH transmission? |
| vivo | For 3-5, @companies who believe current specification is working: legacy rule in current spec cannot be applicable to unified TCI and it is necessary to clarify which TCI state is applied for the channel/RS following the indicated TCI state when there is MAC CE update of active TCI state list between beam indication and PDSCH/PUSCH/PUCCH transmission and reception.  In 38.214 5.1.5, the TCI state determination rule is as follows. It is only applicable for Rel-15/16 mechanism since it only mentions PDSCH.   |  | | --- | | For a single slot PDSCH, the indicated TCI state(s) should be based on the activated TCI states in the slot with the scheduled PDSCH. For a multi-slot PDSCH or the UE is configured with higher layer parameter [*pdsch-TimeDomainAllocationListForMultiPDSCH-r17*], the indicated TCI state(s) should be based on the activated TCI states in the first slot with the scheduled PDSCH(s), and UE shall expect the activated TCI states are the same across the slots with the scheduled PDSCH(s). |   There are at least the following two cases need clarification.  Case 1, for single slot PDSCH  In RAN1 #94 agreement, when the UE is configured with a single slot PDSCH, if the candidate TCI states for PDSCH are updated by MAC CE between the PDCCH and the corresponding PDSCH, the indicated TCI state should be based on the activated TCI states in the slot with the scheduled PDSCH.  The rule is only used for single slot PDSCH but not for all DL/UL channels/RSs following the indicated Rel-17 TCI state. For example, as the figure below, when a PDSCH is scheduled by a PDCCH after BAT, the indicated TCI state for scheduled PDSCH is based on the activated TCI states by first MAC CE, if the application time of the second MAC CE for TCI state activation is between PDSCH and PUCCH, we think the indicated TCI state for the PUCCH should be based on the activated TCI states by second MAC CE. The 38.214 only specifies ‘the indicated *DLorJointTCIState* or *UL-TCIstate* should be applied starting from the first slot that is at least symbols after the last symbol of the PUCCH.’ However, the current rules are not enough to clarify which TCI state is used for DCI based beam indication when there is MAC CE update of active TCI state list.    Case 2, for multi-transmission and reception.  In current spec, the TCI state determination rule is for multi-slot PDSCH and multi-PDSCH. However, not only for PDSCH, but also for any multi-slot transmission and reception configured for a UE, e.g. PUCCH repetition, PUSCH repetition, multi-slot PUSCH, multiple PUSCHs scheduled by DCI and so on. When the first slot of BAT is a slot in the transmission occasions, it is unclear whether the new indicated TCI state needs to be applied for the transmission occasions after the BAT.  If the TCI state of the transmission occasions after the BAT also is based on the TCI state in the first occasion, there may be some issues as follows.  - Need to clarify that the BAT is postponed until the last transmission occasion of these DL/UL channels.  - During the multiple transmission occasions, the network cannot apply the optimal TCI state to transmit other channels/RSs sharing the indicated TCI state, which will affect the performance of these channels/RSs and limit the scheduling flexibility, especially when the CC list with common TCI state update is configured.  - If another channel overlaps with the transmission occasion after the BAT, at this time the UE needs to maintain multiple beams, which is contrary to the purpose of the unified TCI framework and also requires to define new behaviors to clarify the priority of these overlapped channels.    According to the analysis mentioned above, it is necessary to be clarified in current spec that the indicated TCI state should be based on the activated TCI states in each slot for single slot transmission and is applied to the transmission occasion after BAT for these channels across multi-slots. |
| NEC | 3-1: We appreciate if proponents of alt4 could kindly clarify the follow question.  How could it be possible that NW can configure a TCI state of SRS (say configuration is at time n) being equal to the TCI state indicated afterward (say, indication is at time n’> n)? |
| LG | Issue 3-1: Based on Mod’s comment in Round 0, we suggest the following for alt 4 to make it more clear as  When UE is indicated with an SRI corresponding to the UL transmission and UE is configured *DLorJointTCIState* or *UL-TCIState*, if the spatial domain transmission filter associated with the indicated SRI is different from the spatial domain transmission filter by the TCI state, the UE applies the UL spatial filter determined from the indicated *DLorJointTCIState* or *UL-TCIState*  Issue 3-4: Concerned. Regarding Alt2, it causes another problem on the determination of precoder for SRS resources if *associatedCSI* is not configured and the SRS resource set is configured with *followUnifiedTCIstate-r17* as ZTE pointed out in Round 0. Alt1 can address the problem when the associated NZP CSI-RS resource follows the indicated TCI state, the precoder of SRS can be aligned with the indicated TCI state for non-codebook based transmission where the UE calculates the precoder based on measurement of an associated NZP CSI-RS resource. |
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### Issue 4 (MP-UE)

Table 7 Summary: issue 4

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| **#** | **Issue** | **Companies’ views** |
| 4-2 | **Proposal 4-2**: On Rel.17 enhancements to facilitate UE-initiated panel activation and selection, down-select one of the following   * Alt-1: Introduce an RRC parameter to provide the indication of enabled UE capability index(es)   + The bitwidth and interpretation of the capability index reported in beam report should be based on the configured UE capability index(es) instead of UE capability report * Alt-2: The bitwidth of the capability index reported in beam report is fixed to 2-bit.   **FL Note:** Besides for Alt1 from Apple, Alt-2 is based on E///, SS and OPPO’s suggestion in the preparation phase. | **Alt-1**: MTK, QC, Apple, ZTE, NTT DOCOMO, Huawei/HiSilicon, CATT, Nokia, Lenovo  **Alt-2:** OPPO, Ericsson, Intel |

Table 8 Additional inputs: issue 4

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| **Company** | **Input** |
| Mod V0 | **No doubt that we need to make a conclusion on this issue. Although it may be relevant to optimization, but it is simple/straightforward as mentioned by several companies in first round.**  **Can we go with majority views? Could opponent companies double check it. Highly appreciated.** |
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### Issue 5 (MPE)

None.

# References

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| 1 | [R1-2203064](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203064.zip) | Enhancement on multi-beam operation | FUTUREWEI |
| 2 | [R1-2203105](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203105.zip) | Remaining issues on multi-beam operation in Rel-17 | Huawei, HiSilicon |
| 3 | [R1-2203257](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203257.zip) | Remaining issues on multi-beam enhancements | ZTE |
| 4 | [R1-2203301](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203301.zip) | Remaining issues on multi-beam enhancements | Spreadtrum Communications |
| 5 | [R1-2203421](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203421.zip) | Maintenance issues on Rel-17 multi-beam operation | CATT |
| 6 | [R1-2203505](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203505.zip) | Maintenance on multi-beam enhancement | vivo |
| 7 | [R1-2203673](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203673.zip) | Discussion on remaining issues on multi-beam operation | NEC |
| 8 | [R1-2203764](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203764.zip) | Maintenance of Enhancements on Multi-beam Operation | Langbo |
| 9 | [R1-2203771](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203771.zip) | Remaining issues on multi-beam operation enhancement | xiaomi |
| 10 | [R1-2203855](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203855.zip) | Maintenance on Rel-17 multi-beam | Samsung |
| 11 | [R1-2203948](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203948.zip) | Remaining Issues of Enhancements on Multi-Beam Operation | OPPO |
| 12 | [R1-2204031](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204031.zip) | Maintenance of multi-beam enhancements | Ericsson |
| 13 | [R1-2204137](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204137.zip) | Text proposal on multi-beam operation | LG Electronics |
| 14 | [R1-2204169](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204169.zip) | Remaining issues on muiti-beam operation | Lenovo |
| 15 | [R1-2204192](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204192.zip) | Maintenance issue of unified TCI power control | ASUSTeK |
| 16 | [R1-2204199](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204199.zip) | Remaining Issues on Beam Management Enhancement | Apple |
| 17 | [R1-2204274](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204274.zip) | Remaining issues of enhancements on multi-beam operation | CMCC |
| 18 | [R1-2204335](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204335.zip) | Remaining issues on multi-beam operation | NTT DOCOMO, INC. |
| 19 | R1-2204447 | Remaining issues on multi-beam enhancements | Spreadtrum Communications |
| 20 | [R1-2204535](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204535.zip) | Maintenance of enhancements on Multi-beam Operation | Nokia, Nokia Shanghai Bell |
| 21 | [R1-2204680](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204680.zip) | Maintenance of enhancements on multi-beam operation | Google Inc. |
| 22 | [R1-2204682](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204682.zip) | Maintenance of Rel-17 multi-beam operation | MediaTek Inc. |
| 23 | [R1-2204763](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204763.zip) | Enhancements on Multi-Beam Operations | Intel Corporation |
| 24 | [R1-2204976](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204976.zip) | Enhancements on Multi-beam Operation | Qualcomm Incorporated |
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