**3GPP TSG-RAN WG4 Meeting # 104-bis-e R4-2216924**

**Electronic Meeting, 10– 19 October 2022**

**Agenda item:** 6.8.3.4

**Source:** Moderator (Ericsson)

**Title:** Email discussion summary for [104-bis-e][213] FR2\_multiRx\_RRM\_part3

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round: TBA
* 2nd round: TBA

It is appreciated that the delegates for this topic put their contact information in the table below.

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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)

# Topic #1: TCI state switching in multi-rx chain DL reception

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2215362 | Intel Corporation | Proposal 1: Dual TCI state switching delay requirements shall base on Rel-15/16 TCI framework.  Proposal 2: For dual TCI state switch, the legacy Rel-15/16 TCI state switch delay requirement can be reused. |
| R4-2215465 | Xiaomi | Observation 1: The Rel-15/Rel-16/Rel-17 based TCI state activation/deactivation have different MAC CE.  Proposal 1: Dual TCI state switching delay requirement shall base on Rel-15/16 framework.  Proposal 2: For scenario 1, 3, 7 as one MAC CE is used before and one MAC CE is used after the TCI state switching, the legacy MAC CE based delay requirement apply.  Proposal 3: For scenario 8, the legacy TCI state switching delay requirement will be used for each TCI state switching.  Proposal 4: The MAC CE processing time will need to be further considered in certain scenario as the 2nd MAC CE comes within the 1st MAC CE processing time.  Proposal 5: If one of the target TCI state of the group of Dual-TCI state is unknown, then it should be considered as unknown. |
| R4-2215762 | MediaTek Inc. | Proposal 1: In R18 multi-Rx, to define the TCI state requirement based on R15/R16 TCI framework.  Proposal 2: For known and unknown condition of TCI state in R18 multi-Rx, the legacy R15/R16 requirement can be reused.  Observation 1: For legacy TCI state switch delay requirement in TS 38.133, the transient time for panel power ON/OFF is not considered.  Proposal 3: Reuse Rel-15/16 TCI state switch delay unless RF session achieves a new conclusion on panels ON/OFF switch time.  Proposal 4: For dual TCI state switch, the legacy TCI state switch delay requirement can be reused. |
| R4-2215806 | LG Electronics Inc. | Proposal 1: Independent TCI state switching delay requirements for multi-Rx chain could be based on Rel-15/Rel-16 TCI state switching delay requirements.  Proposal 2: Further study UE behaviour in case one of the TCI states is unknown for dual TCI state switching. |
| R4-2215815 | OPPO | Observation 1: The RRM impact of inside-panel TCI state switching and cross-panel TCI state switching due to different UE implementation needs to be studied.  Observation 2: For the case of cross-panel TCI state switching, additional panel/RF chain switching time needs to be evaluated.  Proposal 1: Dual TCI state switching delay requirements shall base on Rel-15/16 TCI framework.  Proposal 2: For dual TCI state switching delay requirements, the followings can be discussed:  - the scenarios of different trigger events, e.g., 1 or 2 MAC-CE, 1 or 2 DCI  - whether to update the definition of known/unknown TCI state  - whether TCI association to different PCI is allowed |
| R4-2215870 | vivo | Proposal 1: UE with multi-Rx chain should track timing/frequency independently for each TCI state when dual TCI states are activated.  Proposal 2: Dual TCI state switching delay requirements shall be based on Rel-15/16 TCI framework in this WI.  Proposal 3: When defining Dual TCI state switching delay requirements, following cases shall be considered.  • PDCCH non-SFN: Two MAC CE with one for each TCI state  • PDCCH SFN: single MAC CE for two TCI states  • PDSCH single DCI: single DCI for two TCI states  • PDSCH multiple DCI: Two DCI with one for each TCI state  Proposal 4: The legacy known/unknown condition can be reused for each TCI state of the dual TCI states.  Proposal 5: For MAC-CE based dual TCI states switch, requirements for both known and unknown conditions are specified.  Proposal 6: For DCI based dual TCI states switch, requirements are only specified for known condition, i.e., each of the dual TCI states are known.  Proposal 7: For dual TCI states switch, delay requirements are specified for each TCI state and legacy TCI state switch delay requirements are reused.  Proposal 8: Legacy TCI states switch delay requirements are enhanced for UE with multi-Rx chain. |
| R4-2216277 | Huawei, HiSilicon | Observation 1: Rel-17 unified TCI is not jointly considered with dual TCI, which is listed as an objective in Rel-18 MIMO.  Proposal 1: Define dual TCI state switching delay requirements base on Rel-15/16 TCI framework.  Proposal 2: Define dual TCI state switching requirements for following cases:  • PDCCH non-SFN: Two MAC CE with one for each TCI state  • PDCCH SFN: single MAC CE for two TCI states  • PDSCH single DCI: single DCI for two TCI states  • PDSCH multiple DCI: Two DCI with one for each TCI state  Proposal 3:  The definition of dual TCI state switch shall be clarified considering following cases:  1. Single TCI to dual TCI  2. Dual TCI to single TCI  3. Dual TCI with changes of both QCL Type D RSs  4. Dual TCI with change of only one of QCL type D RS.  Observation 2: For dual TCI switching requirements, the conditions shall be considered that the two TCIs with different QCL type D RS shall be the ones that UE can simultaneously receive.  Observation 3: The requirements shall apply provided that two directions with different QCL typeD are received by different UE panels.  Proposal 4: Following conditions shall be considered for the known conditions:  • The UE has sent at least one L1-RSRP report for the target TCI states before the TCI state switch command where the associated QCL type D RSs are reported within one group configured by groupBasedBeamReporting-r17.  • The associated QCL type D RSs in target TCI states satisfy the conditions that the RSs are received from different panels, where the conditions shall follow RF conclusion. |
| R4-2216477 | ZTE Corporation | Proposal 1: Referring to dual TCI state switching, we can have two assumptions：  2) Independent candidate TCI state pool for each Rx chain/panel. Then the TCI state switching is only allowed within one candidate TCI state pool, cross-pool switching is not allowed.  2）Without the limitation of not cross pool switching allowed, the target TCI state can be in any pool, same of different with the pool of current TCI state, i.e. each TCI state switching can be within panel/Rx chain or cross panels/Rx chains.  Proposal 2: Under the 1st assumption, basically UE can perform dual parallel TCI state switching simultaneously. Under the 2nd assumption, the following three different cases should be considered:  Case 1: Dual known TCI state switching  Case 2: One known TCI state switching + one unknown TCI state switching  Case 3: Dual unknown TCI state switching  And it seems that dual parallel TCI state switching is only possible for Case 1. |
| R4-2216581 | Nokia, Nokia Shanghai Bell | Proposal 1: For definition of TCI state switching delay for dual TCIs, RAN4 to consider at least the scenarios below, without precluding other scenarios in future discussions:  - Single-DCI, multi-TRP scenario  - Multi-DCI, multi-TRP scenario  Proposal 2: Multi-Rx UEs are assumed to support at least 2 active TCI states in Rel-18.  Proposal 3: The dual TCI state switch requirements are applicable when the corresponding TCI states are in the same, or in different panels.  Observation 1: Strict timing synchronization between Rx chains is challenging in case of distributed TRPs (non-ideal backhaul).  Observation 2: In multi-Rx chain, time and frequency can be tracked independently per Rx chain.  Proposal 4: In the case of dual TCIs, consider independent frequency/time tracking per Rx chain.  Proposal 5: Each TCI switching per RX chain is assumed to be independent in aspect of TCI switching delay.  Proposal 6: RAN4 to consider legacy Rel-15/Rel-16 TCI switching delay requirements as baseline to Rel-18 UE requirements with multi-RX chains in multi DCI and multi TRP scenarios.  Observation 3: TCI state switch delay depends on TL1-RSPR\_Measurement\_Period\_SSB and TL1-RSRP\_Measurement\_Period\_CSI-RS  Proposal 7: Enhancements on L1 RSRP delays should be reflected on TCI state switch delay.  Observation 4: UE is expected to track all the active TCI states independent of the panel being used. It is already assumed that that there is no need of any additional delay for cross panel TCI state switching.  Proposal 8: RAN4 not to define additional TCI state switching delay for cross panel TCI state switching.  Observation 5: The use of multiple Rx chains is not necessarily helping on the conditions for a target TCI state to be known or unknown.  Proposal 9: Reuse existing conditions for known/ unknown TCI state for multi Rx chain capable UEs. |
| R4-2216827 | Ericsson | Proposal 1: The new RRM requirements (e.g., measurement or beam management requirements) defined for simultaneous measurements and procedures on two chains need to apply, provided:  o the corresponding active TCI states are configured and used for simultaneous reception during the entire measurement or evaluation period.  Proposal 2: RAN4 to define the necessary UE behaviour and measurement requirements for simultaneous reception when the set of active TCI states changes during the measurement or evaluation period, e.g., when:  o A new active TCI state is added,  o An active TCI state is removed,  o An active TCI state is switched/replaced.  Proposal 3: RAN4 to discuss and decide on how to differentiate in the specification the set of active TCI states which can be used for simultaneous reception from other active TCI states which cannot be used for simultaneous reception.  Proposal 4: RAN4 to discuss the active TCI states requirements for any change to the set of active TCI states used for simultaneous reception, i.e., requirements for:  o addition of an active TCI state to the set of active TCI states for simultaneous reception,  o removal of an active TCI state from the set of active TCI states for simultaneous reception,  o switching/replacement of an active TCI state in the set of active TCI states for simultaneous reception.  Proposal 5: RAN4 to discuss whether there is an issue when the number of active TCI states is at any time larger than the UE capability for simultaneous reception. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1: Requirements and Scenarios

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 1-1-1: Requirements to be defined**

* Proposals
  + Proposal 1: TCI state switching requirements
    - DL TCI state switch requirements
      * Note: It is my understanding that WI is only for DL reception.
  + Proposal 2: TCI state list update requirements
    - Addition/removal/update of TCI states in the list
* Recommended WF
  + Agree on the proposal 1 and 2.

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| **Company** | **Comments** |
| Qualcomm | If we look at the whole procedure, from a group-based L1 measurement/report all the way to CSI feedback, to enable 4-layer MIMO from two TRPs, Proposal 2 seems to make sense to us. But if the proposal is to cover all possible scenarios without any context, we don’t support it.  It would be good to see the details of Proposal 2 in terms of the scope and requirement impacts. |
| MediaTek | Support proposal 1.  FFS: proposal 2. Same concern as QC. |
| OPPO | In general, agree with P1 and P2. FFS the details. |
| Huawei | Support proposal 1. The scenario of proposal 2 needs further clarification. |
| Nokia | Agree on Proposal 1 and Proposal 2 with caution.  From P1 it is not clear if the proposal relates to whether also UL TCI switch is discussed (UL spatial relation). Anyway, we assume this is not the case (UL is not within the WI).  However, if we have two Rx chain receiving DL from two spatially differently located sources using separate Rx settings (and possibly panels) on UE side, RAN4 would have to discuss whether the TCI states are managed separately or not.  Likely, but probably needs more discussion, the TCI state switch delay requirements for each separate TCI state could be the same as is applicable currently (when assuming single Rx only).  Whether TCI state list update requirements needs to be updated need more discussion.  This issue may also depend on other Issues in other threads of this WI. |
| ZTE | Prefer Option 1.  We understand the motivation of Proposal 2, which can be further discuss. |
| Ericsson | Support proposal 1 and 2.  As per RAN1, UE would be indicating to gNB through group-based reporting about the beam pair UE could simultaneously receive. Based on beam measurement reports, NW needs to add or modify or delete the TCI state list. |
| Intel | Support opiton1. Further discuss option 2. |
| Samsung | Support proposal 1 and 2.  Proposal 1: We agree with moderator’s Note that UL TCI state switch is out of the scope, and the introduced simultaneous multi-RX is nothing related to UL TCI state switching (including UL spatial relationship update).  Proposal 2: Can be discussed further. |
| Apple | We support proposal 1. We also want to further discuss proposal 2. |
| vivo | Agree with option 1.  For option 2, it is not clear what the difference would be compared to legacy TCI state list update. |
| Xiaomi | Support proposal 1. Agree to further discuss proposal 2. |

**Issue 1-1-2: Scenarios to be considered w.r.t Intra-cell/Inter-cell multi-TRP.**

* Proposals
  + Scenario 1: Intra-cell multi-TRP. That means same PCI is assumed for two TRP and two TCI states are from same PCI
  + Scenario 2: Inter-cell multi-TRP. That means PCI is different for two TRP and TCI states may be from different PCI.
* Recommended WF
  + Discussion is needed.

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| **Company** | **Comments** |
| Qualcomm | This can be up to an outcome of Thread#211. And we support Scenario 1. For Scenario 2, more general requirements can be discussed under R18 eFeMIMO WI. |
| LGE | We can follow the conclusion of thread#211. |
| MediaTek | Support scenario 1.  To our understanding, this WI is mainly for 4 MIMO layer transmission. For the inter cell, UE is high probable located in the middle of SC and the cell with different PCI from serving cell. We tend to believe UE may not use 4 MIMO layer data transmission in that scenario since the channel is not good for both serving cell and the cell with different PCI. |
| OPPO | Follow the conclusion of thread#211 |
| Huawei | Follow the conclusion in 211 |
| Nokia | This is also discussed in other email summary threads of this WI. We see that both scenarios are included  To our understanding this WI is not only MIMO WI. It is a generic WI addressing multi-Rx chain DL reception in FR2. It includes MIMO but also has more general aspects:  Introduce necessary requirement(s) for enhanced FR2-1 UEs with simultaneous DL reception from different directions with different QCL TypeD RSs on a single component carrier  We are fine discussing MIMO related aspect but RAN4 also need to discuss general RRM aspects as it is part of the WID. Hence, we can include both intra-cell and inter-cell.  RAN4 should distinguish the scenarios in:   * R18 Multi-Rx MIMO * R18 Multi-Rx RRM   And at least for R18 Multi-Rx RRM inter-cell scenario is very relevant |
| ZTE | Follow the conclusion in 211 |
| Ericsson | We can follow conclusion on 211. |
| Intel | Discussed in thread 211 either. Follow the conclusion from 211. |
| Samsung | Follow conclusions of 211 |
| CMCC | Follow conclusion of #211 (Issue 1-1-3). |
| Apple | We also think it is better to follow conclusion in thread [211]. |
| vivo | Follow conclusion of email [211]. |
| Xiaomi | Agree to follow the conclusion in thread 211. |

**Issue 1-1-3: Scenarios to be considered w.r.t single DCI/multi-DCI.**

* Proposals
  + Scenario 1: Single-DCI, multi-TRP scenario
  + Scenario 2: Multi-DCI, multi-TRP scenario
* Recommended WF
  + Discussion is needed.

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| **Company** | **Comments** |
| Qualcomm | With Scenario 1 in Issue 1-1-2, Scenario 1 (single-DCI) is the only option. And this Issue is also up to an outcome of Thread#211. |
| LGE | We can follow the conclusion of thread#211. |
| MediaTek | Support scenario 1. It will increase UE complexity if two PDSCHs are partially overlapped in frequency domain, which is one of possible scenario with multiple DCI. |
| OPPO | Ok to focus on scenario 1 firstly. |
| Huawei | Support both scenarios. |
| Nokia | Both Scenario 1 and Scenario 2 to be supported. |
| ZTE | Support both of them. |
| Ericsson | We can follow the conclusion of thread 211 |
| Intel | Follow the conclusion of thread 211. |
| Samsung | Follow the conclusions of 211.  We prefer to consider both scenarios. But we think the issue keeps to open depends on operator’s deployment actually. |
| CMCC | Follow conclusion of #211 (Issue 1-1-4). |
| Apple | Better to follow conclusion in thread [211]. |
| vivo | Follow conclusion of email [211].  We would like to see analysis on difference for single-DCI and multi-DCI from TCI state switching requirements perspective. |
| Xiaomi | Ok to follow thread 211. But we prefer both scenarios. |

### Sub-topic 1-2: TCI state switching requirements

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 1-2-1: Assumptions for dual TCI state switching**

**Issue 1-2-1-1: Dual TCI state switching requirements shall be based on**

* Proposals
  + Option 1: Rel-15/Rel-16 TCI framework
  + Option 2: unified TCI framework
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| Qualcomm | Support Option 1.  In our understanding, Option 2 (unified TCI) is only for single TRP at a given time up to Rel-18. |
| LGE | We support option 1. Unified TCI cannot be configured from multi-TRP. |
| MediaTek | Support option 1. Same view as QC and LGE, i.e. unified TCI is not applicable for mTRP scenario. |
| OPPO | Support Option 1. unified TCI for.multi-TRP is still under discussion in RAN1 R18. |
| Huawei | Support option 1. Unified TCI with mTRP is under discussion in RAN1. |
| Nokia | We prefer to go with Option 1 for Rel-18 assuming existing limitations are open for discussion (i.e. not only for serving cell).  Are we here discussing unified TCI framework as defined in Rel-17 or ongoing in Rel18?  Our understanding is that unified TCI state framework in R17 is defined only for inter-cell BM. Hence, R17 unified TCI framework can be used in this WI for inter-cell discussions. However, currently the TCI state switch requirements applies to serving cell.  So we believe we cannot agree to either option right now as either selection will exclude some scenarios etc. which we’re discussing in 211. |
| ZTE | Do not have strong view, if the majority prefer Option 1, we are fine. |
| Ericsson | Agree with option 1 |
| Intel | Support option 1. |
| Samsung | Support option 1.  From our view, for UE supporting multi-RX chain with simultaneous DL reception, multiple RX chains can be controlled independently, the two TCI state switch on two panels can be performed independently, and then the TCI state switching requirements for the two panels can be applied accordance with the received TCI type.  Since in Rel-17 FeMIMO, unified TCI is mainly focusing on single TRP and it is not jointly considered with mTRP scenarios, and the extension of unified TCI to mTRP is in the scope of Rel-18 MIMO WI, Rel-15/Rel-16 TCI framework can be seen as a baseline |
| Apple | If unified TCI is not specified for mTRP, we can take Option 1. |
| vivo | We are fine with option 1.  Option 2 may be considered in this WI depending on progress of R18 MIMO evo WI. |
| Xiaomi | Support option 1. |

**Issue 1-2-1-2: Can the TCI switch is assumed to be independent on each RX chain?**

* Proposals
  + Option 1: Yes. For each RX chain, the TCI state switch is assumed to be independent.
  + Option 2: No. Both the TCI states should be switched together.
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| Qualcomm | It is a bit unclear to us whether Option 2 precludes any possibility of Option 1 and some of bullets of Option 1 in Issue 1-2-2-1 for good. |
| LGE | We think both options could be considered on a case by case. |
| MediaTek | Need more discussion. We expect each RX chain can switch its TCI state independently. However, if the purpose is to receive 4MIMO layers with two panels, then delay requirement of dual TCI state should consider the longest delay of two panels. |
| OPPO | TCI states switch independent or together could be possible. |
| Huawei | Suggest to hold on the discussion until the scenarios/conditions for dual TCI switching are clarified. |
| Nokia | Option 1  Considering the earlier discussions in RAN4 in Rel-16 and Rel17 related to FR2 inter-band CA it seems clear that at least in some scenarios independent BM (IBM) is needed. Whether this is for all scenarios we can discuss further (e.g. also for split panel scenario). However, we also see this related to whether UE tracks BM RS on one or both DL Rx beams.  We understand that the TCI switching timing and known/unknown conditions are independent. So it is more reasonable to assume that they are independent. |
| ZTE | We believe UE can perform one TCI state switching by each RX chain independently. Whether dual TCI state switching happening together, which depend on NW triggering. |
| Ericsson | Both options are possible. We think with dual TCI state switching, there is a possibility that both TCI or single TCI can be changed at a given time. Their switch delay can be independent and shall take same switching delay as single TCI state switch delay. |
| Intel | We think TCI switching can be triggered separately or simultaneously for two panels. It depends on NW configuration. |
| Samsung | We support option 1  From our view, for UE supporting multi-RX chain with simultaneous DL reception from different directions, multiple RX chains can be controlled independently, the two TCI state switch on two panels can be performed independently, that is to say, for each RX chain, the TCI state switch is assumed to be independent. |
| CMCC | In our understanding, for UE supporting multi-Rx chain DL reception, TCI switch is assumed to be independent on each RX chain. As for whether they are switched simultaneously or not, it is up to NW configuration. |
| Apple | More clarification is needed on the application scenarios. |
| vivo | Option 1 should be considered. |
| Xiaomi | We think this depends on the TCI state switching scenario as well as the s-DCI/m-DCI configuration.  If the switching is for one MAC CE to one MAC CE, then the legacy requirement apply.  If the switching is for two MAC CE to two MAC CE, then the legacy requirement apply for each TCI state switching.  If the switching is for one to two or two to one MAC CE, further discussion is needed. |

If the TCI activation is assumed to be independent on each RX chain, each TCI state can be switched independent and at a time single or two TCI state can be switched. If one TCI state is switched at a time, existing requirements may be applicable. When two TCI states are switched at the same time, new requirements may need to be specified.

**Issue 1-2-2: Switch command for dual TCI state switch**

**Issue 1-2-2-1: When two TCI states are switched simultaneously, assumption on the switch commands**

* Proposals
  + Option 1 (Vivo, Huawei): requirements are defined for following modes of switching
    - Two DCI one for each TCI state (PDSCH multiple DCI)
    - Two MAC CE one for each TCI state (PDCCH non-SFN)
    - One DCI for two TCI states (PDSCH single DCI)
    - One MAC CE for two TCI states (PDCCH SFN)
* Recommended WF
  + My understanding is above modes are supported from RAN1 perspective and suggest to agree on option 1.

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| **Company** | **Comments** |
| Qualcomm | Is this a standalone issue, meaning any bullet of Option 1 does not have any impact to other issues and does not need any prerequisite/constraints, e.g. single- vs. multi-DCI, intra- vs. inter-cell mTRP, etc? It doesn’t seem so. |
| LGE | Is it different issue from Issue 1-2-2-2? |
| MediaTek | More discussion is needed. It seems depends on other issue, e.g. sDCI v.s. mDCI. |
| OPPO | Same views as MTK. |
| Huawei | Option 1 is related to the discussion about sDCI and mDCI. |
| Nokia | It is not clear to us what the options are about – are these options or proposals? Some TCI switches are for PDCSH and some for PDCCH. However, we are fine to discuss but as mentioned by MTK it depends on other ongoing discussions. |
| ZTE | Further discussion is needed. |
| Ericsson | All the options are possible for mDCI. For sDCI, only last two are possible. |
| Intel | Depend on conclusion from single DCI and multi-DCI first. |
| Samsung | Further discussion is needed. And this issue is related to the discussion of DCI or mDCI |
| Apple | We prefer to have further discussions on this. |
| vivo | Support option 1. Fine to wait for outcome of other relevant issues. |
| Xiaomi | Can be wait to see the s-DCI and m-DCI discussion. |

**Issue 1-2-2-2: TCI state switch scenarios to be considered**

* Proposal 1 (Xiaomi):
  + 1, Single TCI state to Dual TCI state within one MAC CE
  + 2, Single TCI state to Dual TCI state with two MAC CE
  + 3, Dual TCI state within one MAC CE to Single TCI state
  + 4, Dual TCI state with two MAC CE to Single TCI state
  + 5, Dual TCI state with one MAC CE to Dual TCI state with two MAC CE
  + 6, Dual TCI state with two MAC CE to Dual TCI state with one MAC CE
  + 7, Dual TCI state with one MAC CE to Dual TCI state with one MAC CE
  + 8, Dual TCI state with two MAC CE to Dual TCI state with two MAC CE
* Proposal 2 (Huawei): The definition of dual TCI state switch shall be clarified considering following cases:
  + Single TCI to dual TCI
  + Dual TCI to single TCI
  + Dual TCI with changes of both QCL Type D RSs
  + Dual TCI with change of only one of QCL type D RS.
* Recommended WF
  + Both proposals look similar. Can they be merged into proposal 1? Further discussion needed.

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| **Company** | **Comments** |
| Qualcomm | For Proposal 1: The same comment as Issue 1-2-2-1. |
| LGE | Fine with proposal 1. For further clarification, could single DCI to dual DCI be considered the same as the single panel to two panel activation from the UE behavior perspective? |
| MediaTek | Same comment as issue 1-2-2-1 |
| OPPO | Same comment as issue 1-2-2-1 |
| Huawei | For proposal 1, could proponent clarify why there are MAC CE before and after TCI switching? And are these cases all for PDCCH? |
| Nokia | Proposal 1 seems to only cover PDCCH TCI State switching options.  Proposal 2 is generic. Discussion is needed to conclude for PDCCH and PDSCH TCI State switching scenarios.  We agree with Huawei that the definition of dual TCI state switch shall be clarified. |
| ZTE | Same comments as in Issue 1-2-2-1. |
| Ericsson | Pending on whether to support mDCI. |
| Samsung | Agree with Ericsson. And we think the number of cases in propose 1 is huge, which will bring large workload, we also need discuss and cut some down. |
| vivo | Proposal 2 would be considered as starting point for further discussion. |
| Xiaomi | As proponent of proposal 1, we are trying to figure out all the possible situations. It includes the legacy single TCI, dual TCI with s-DCI, dual TCI with m-DCI and the switching between these three different scenarios and consequently, 8 scenarios are listed.  Although the scenarios looks a lot, the requirements can be reused in most of the cases as proposed also in issue 1-2-1-2.  To Huawei, the MAC-CE number is used for differentiate s-DCI and m-DCI since they all have two TCI states. |

**Issue 1-2-2-3: If the proposal 1 to issue 1-2-2-2 is acceptable, can the following proposal be acceptable.**

* + Proposal 1 (Xiaomi): For scenario 1, 3, 7 as one MAC CE is used before and one MAC CE is used after the TCI state switching, the legacy MAC CE based delay requirement apply
  + Proposal 2 (Xiaomi): For scenario 8, the legacy TCI state switching delay requirement will be used for each TCI state switching.
  + Proposal 3 (Xiaomi): The MAC CE processing time will need to be further considered in certain scenario as the 2nd MAC CE comes within the 1st MAC CE processing time
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| Qualcomm | We’d like to wait until Issues 1-2-2-1 and 1-2-2-2 are settled. To us, here the issue is more or less MAC CE processing time. |
| LGE | Further discuss after conclusion of Issue 1-2-2-2. |
| MediaTek | Wait for the conclusion in Issue 1-2-2-2 |
| OPPO | Wait for the conclusion in Issue 1-2-2-2 |
| Huawei | Same comments as issue 1-2-2-2 |
| Nokia | Wait for the conclusion in Issues 1-2-2-1 and 1-2-2-2 |
| Ericsson | Can be FFS for now |
| Samsung | Wait for the conclusion of issue 1-2-2-2 |
| vivo | Wait for the conclusion of Issues 1-2-2-1 and 1-2-2-2 |
| Xiaomi | We can further discuss the switching case first. |

**Issue 1-2-3: Known condition**

**Issue 1-2-3-1: When two TCI states are switched simultaneously, known condition for the TCI states is:**

* Proposals
  + Option 1 (Xiaomi): Assumed known if both TCI states are known. If anyone of the TCI state is unknown, both the TCI states considered unknown.
  + Option 2: Dual TCI states are independent, and each of the TCI state can be known or unknown.
  + Option 3 (MTK, Nokia): the legacy R15/R16 definition can be reused
  + Option 4 (OPPO): Further study whether to update the definition of known/unknown
  + Option 5 (Huawei): Following conditions shall be considered for the known conditions:
    - The UE has sent at least one L1-RSRP report for the target TCI states before the TCI state switch command where the associated QCL type D RSs are reported within one group configured by groupBasedBeamReporting-r17.
    - The associated QCL type D RSs in target TCI states satisfy the conditions that the RSs are received from different panels, where the conditions shall follow RF conclusion.
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| Qualcomm | In this WI, the scenario is that NW activates UE TCIs based on group-based L1 measurement report, hence, we do not think the case of “one known TCI + one unknown TCI” is not much relevant.  Regarding the additional aspect of “RSs are received from different panels” in Option 5, we do not support it yet. |
| MediaTek | Support option 3.  We think how to receive the signals is up to UE implementation. If UE transmitted L1 report for target TCI state based on a certain panel, the same panel will be used for later TCI state switch. So, as long as network indicates UE to switch to the target TCI state, UE behavior and the required delay are clear from both UE and network perspectives.  In general we are fine with second bullet in option 5. But, after checking, it seems more like a requirement applicability? |
| OPPO | Option 2 and 3 are similar and can be used as baseline. More clarification on the relation of the two TCI states is needed |
| Huawei | We support option 5. In existing requirements, the known condition means that UE is aware of the beam of the target TCI. However, in dual TCI switching, the known condition should additionally serve the purpose that these two TCI with different QCL typed can be simultaneously received by UE.  Based on option 1-3, it means UE only know the beam of the two target TCI, but it is possible that UE cannot receive simultaneously. In this case, dual TCI switching does not make sense and cannot be verified.  To QC and MTK: yes the second bullet is working as the applicability condition (probably the RF conclusion). |
| Nokia | We are fine with Option 2 and 3.  We think there is no reason to review the known condition for the TCI states for UE suporting multi Rx. The conditions are not depending on this capability, since they depend solely on whether the RS for the target has up to date measurements and the side conditions. Therefore, we believe that the condition can remain the same. |
| ZTE | Support Option 2 and 3. |
| Ericsson | We do not support option 2. Other options can be further discussed. |
| Intel | Support option 3. If one TCI state is known and another one is unknown, the TCI state switching delay is different for two panels. It can be further discussed. |
| Samsung | Prefer option 5.  We think when two TCI states are switched simultaneously, known condition for the TCI states depends on how UE receive and process two signals from different AOA directions simultaneously.  For UE supporting multi-RX chain with simultaneous DL reception (different QCL Type D RSs), based on the *groupBasedBeamReporting-r17* described in TS 38.214: when the UE is configured with groupBasedBeamReporting-r17, the number of CSI Resource Sets configured is S=2, otherwise the number of CSI-RS Resource Sets configured is limited to S=1, then if the parameter is configured, at least one L1-RSRP report for the target TCI state from UE can be performed by using one of the RSs. And known condition for the TCI states can be realized. |
| Apple | For option 5, RF session agreed “panel” will not be referenced in core requirement. So the condition may be hard to enforce. However, we agree we need to consider if the two target TCIs can be supported by the UE. |
| vivo | In general, we agree with option 3. Open for further discussion. |
| Xiaomi | We would like to further clarify option 1. The option 1 only applies to the case of s-DCI where the two TCI states are considered as a pair. From this perspective, we believe option 1 is agreeable.  For option 2, it depends on previous issue 1-2-1-2 discussion.  Option 3 is agreeable. |

**Issue 1-2-4: Delay requirements:**

**Issue 1-2-4-1: Requirements are specified for following cases only. Do you agree with below proposals?**

* Proposals
* Proposal 1 (Vivo): For DCI based switching, only known TCI state switching requirement are defined
* Proposal 2 (Vivo): For MAC-CE based dual TCI states switch, requirements for both known and unknown conditions are specified.
* Recommended WF
  + Discussion is needed.

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| **Company** | **Comments** |
| Qualcomm | For Proposal 2, we are yet to be quite convinced whether TCI switching to unknown one is really relevant to the concerned scenario of the WI. |
| MediaTek | Wait for the conclusion of known/unknown condition. |
| Huawei | Depends on above issue. We want to know what is the difference between DCI based and MAC CE based. |
| Nokia | Proposal 1 and 2 are ok. This follows existing framework. We are wondering why there would be a difference to existing. |
| ZTE | If two independent TCI state switching can be assumed, it seems reuse legacy is fine. |
| Ericsson | Can be FFS for now |
| Intel | Depend on 1-2-3-1. |
| Samsung | Both follow the existing framework. If known/unknown condition is not modified in this WI, and if independent TCI state switching are assumed, both proposals are OK. |
| Apple | Since the UE needs to make sure it can support two AoAs, it is unclear if there is a need to consider the unknow case. |
| vivo | Support P1 and P2. |

**Issue 1-2-4-2: Does the cross-panel switch time needs to be defined.**

* Proposals
  + Option 1 (MTK): Reuse Rel-15/16 TCI state switch delay unless RF session achieves a new conclusion on panels ON/OFF switch time. I.e., transient time is not considered for cross panel switch.
  + Option 2 (Nokia): RAN4 not to define additional TCI state switching delay for cross panel TCI state switching
  + Option 3 (new): RAN4 not to define additional TCI state switching delay for cross panel TCI state switching **unless RF session achieves a new conclusion on panels ON/OFF switch time**.
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| Qualcomm | Okay with Option 1. Even in the legacy requirement, there could be a case where TCI switching is across panels, for which we don’t think there is any specific requirement. Why does this need to be differently considered in this WI? |
| LGE | We think that further clarification for cross-panel switch issue in multi-Rx chain is needed before deciding whether to define requirements or not. |
| MediaTek | Support option 1. Same view as QC. In R18 WI, the delay for cross panel switch should not be considered because we do not consider such time in the R15/R16 legacy requirement. |
| OPPO | Fine with option 1 at this stage, |
| Huawei | Cross-panel or within panel is transparent to gNB and cannot be differentiated in the spec. Can be FFS if RF achieve new conclusions. No need to draw any conclusions in RRM |
| Nokia | Prefer Option 2 or Option 3.  We see the point of Option 1, but in our view the proposal is mixing the reuse of Rel 15/16 delay with the cross panel switching time. Which is discussed on Issue 1-2-1-1 and Issue 1-2-4-2.  Therefore, we suggested a new Option 3, which we believe captures the spirit of Option 1. |
| ZTE | Generally fine with Option 1. |
| Ericsson | We agree with QC and MTK. |
| Samsung | We support option 1 or option 3 .  Whether to define additional cross-panel switch time should be decided after RF conclusion |
| Apple | Current requirement should account for the switching delay, however, with dual TCI switching, we need to consider if there is additional constraint at the UE that would justify extra delay. |
| vivo | Option 3 is ok for this issue. |
| Xiaomi | Before agreeing on option 1, we believe this issue only focus on the cross-panel while if the legacy switching delay requirement can be directly reused is not decided under this issue.  For the cross-panel effect, we agree that the transient time is not considered. |

**Issue 1-2-4-3: TCI state switch delay requirements**

* Proposals
  + Option 1 (Vivo): for known TCI state, reuse legacy requirements. For unknown state, legacy TCI states switch delay requirements are enhanced for UE with multi-Rx chain
  + Option 2 (Intel): For dual TCI state switch, the legacy Rel-15/16 TCI state switch delay requirement can be reused
  + Option 3(MTK): Legacy TCI states switch delay requirements are reused for UE with multi-Rx chain
  + Option 4 (Nokia): Enhancements on L1 RSRP delays should be reflected on TCI state switch delay
  + Option 5 (LGE): Further study UE behavior in case one of the TCI states is unknown for dual TCI state switching
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| Qualcomm | This issue depends on conclusions of other Issue items. |
| LGE | We think legacy requirements could be reused, but further discussion for all the options should be needed depending on the conclusion of other issues. |
| MediaTek | Ok to discuss this issue when other issues are concluded. |
| OPPO | We can further discuss this after clear assumption. |
| Huawei | It is too early to draw the conclusion on whether legacy requirements can be reused since the scenario and conditions are not clear. Suggest to focus on the basic question first. |
| Nokia | Option 4. But fine to discuss further. |
| ZTE | Wait for the conclusion of other related issues. |
| Ericsson | Can be FFS. |
| Intel | Fine to discuss later. |
| Samsung | Support option 4. But OK to discuss the issue in the future based on related conclusions |
| Apple | Should be considered together with the previous issue. |
| vivo | Fine to FFS. |
| Xiaomi | Can wait for the previous issue conclusion. |

**Issue 1-2-5: Time frequency tracking requirements**

* Proposals
  + Option 1: UE with multi-Rx chain should track timing/frequency independently for each TCI state when dual TCI states are activated.
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| Qualcomm | This is up to UE implementation and whether it is so-called “panel split” or “separate panel” based beams at a given time. In general, if we don’t have this term of “chain” in Option 1, UE should anyway follow the configured/activated TCI states in terms of QCL-type A/C. |
| MediaTek | We share the same view as QC. UE should anyway follow the configured/activated TCI states in terms of QCL-type A/C. |
| OPPO | FFS |
| Huawei | The conditions/scenarios of dual TCI switching should be concluded first. |
| Nokia | We agree with option 1.  To QC and MTK: we would need to define some way to address this. We earlier use common/independent BM (CBM/IBM) but this was for FR2 inter-CA discussions. We are not using ‘chain’ and ‘panel’ but we need to somehow find a terminology to describe reception by use of two different spatial setting on UE side. Otherwise, the discussion may become more complicated.  Related to the Option we can clarify a bit: UE of course follow the TCI states as requested. The question here is whether UE follow time and frequency tracking for each TCI state?  This is also related to the discussion on thread 211 on architecture. UE should be tracking time for e  ach TCI independently. |
| ZTE | To our understanding, UE should perform T/F tracking if the target TCI state is not maintained in the active TCI state list no matter single TCI state switching or dual TCI state switching. |
| Ericsson | We agree with Option 1 |
| Samsung | Option 1 is OK |
| Apple | This is a strong assumption on implementation. We wonder if we really need this proposal. |
| vivo | We agree with option 1. When it is combined with QCL type A, UE needs to do T/F tracking independently. |

### Sub-topic 1-3: TCI state list update requirements

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 1-3-1: TCI state pools**

* Proposals
  + Option 1: Independent candidate TCI state pool for each Rx chain/panel. Then the TCI state switching is only allowed within one candidate TCI state pool, cross-pool switching is not allowed.
  + Option 2: Cross pool switching is allowed, i.e., the target TCI state can be in any pool, same of different with the pool of current TCI state, i.e., each TCI state switching can be within panel/Rx chain or cross panels/Rx chains.

Clarification required from the proponent. Is the TCI state pool referred here same as active TCI state list?

* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| Qualcomm | Please clarify the term of “TCI state pool.” Is this just a discussion language or spec-defined term, e.g. simultaneousTCI-UpdateList or TCI pool for unified TCI? And is there any explicit relation (in spec) about TCI state pool and UE panel? |
| MediaTek | More discussion is needed. Unclear about the concept of independent candidate TCI state pools. Could proponent explain more? Thanks. |
| Huawei | It is not very clear to us what the TCI state pool refer to? It seems not supported by current RAN1/2 spec. |
| Nokia | More discussion needed  We also don’t understand what is meant by TCI state pools.  For option 1, we don’t understand why limiting to case 1, since the UE might switch to a TCI state from a sidelobe. So, the good candidate options are not so linear and easy to identify as in this pool.  For option 2 we also don’t understand the intention. |
| ZTE | Here we use “TCI state pool” to reflect the candidate TCI states which can be covered by a single panel. In our opinion, each panel has certain coverage of directions, not any two TCI states can be supported to be simultaneous received by UE, only when each of them belongs to the coverage of each panel, simultaneous reception is allowed.  Here Option 1 means each of the dual TCI state switching is only limited within a same panel coverge, i.e. the target TCI state of procedure 1 is only limited within the coverage of panel 1, and the target TCI state of procedure 2 is only limited within the coverage of panel 2.  Here Option 2 means each of the dual TCI state switching can be cross panel switching.  We are wondering companies’ view between Option 1 and Option 2. |
| Ericsson | It’s configured by the network, and we see no need for this limitation. |
| Samsung | We have concerns on this new concept of “TCI state pool” since it totally depends on UE implementation, while the information is unknown to network, so we expect the impacted RAN4 requirement is just delay.... But if “cross-pool switching is not allowed”, how NW can know this restriction? |
| vivo | FFS. Clarification on multi-Rx chain/ multi-panel specific TCI state pool is needed. |

**Issue 1-3-2: Active TCI state list update requirements**

* Proposals
  + Proposal 1: RAN4 to discuss the active TCI states requirements for any change to the set of active TCI states used for simultaneous reception, i.e., requirements for:
    - addition of an active TCI state to the set of active TCI states for simultaneous reception,
    - removal of an active TCI state from the set of active TCI states for simultaneous reception,
    - switching/replacement of an active TCI state in the set of active TCI states for simultaneous reception.
* Recommended WF
  + Can the above proposal be agreed? Companies are requested provide their views on the above proposal.

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| **Company** | **Comments** |
| Qualcomm | In principle, okay with Proposal 1. But there seems to be a correlation between Issue 1-1-1 and this. How are they different from each other? |
| MediaTek | Same comment in Issue 1-1-1. |
| Huawei | Similar question as issue 1-3-2, does the “set” stands for a set of TCI states? |
| Nokia | We support Proposal 1.  Yes, TCI state to be removed/replaced can be currently active and used in case of simultaneous reception too. But this issue of addition/removal/replacement of the active TCI state will be applicable for legacy TCI state management too. We assume dual TCI state management should be same as legacy TCI state management as dual TCI states need to be independently managed. |
| Ericsson | Agree to Proposal 1. One should also note that the enhanced measurement requirements will apply on the set of two TCI states which are intended for simultaneous reception, i.e., if they cannot be used then the legacy requirements should apply. |
| Samsung | Discuss the necessity of active TCI state list update first |
| vivo | As in legacy TCI state list update requirements, we think only addition of a new TCI state to the current TCI state list is needed. |

**Issue 1-3-3: Other proposals**

* Proposals
  + Proposal 1: The new RRM requirements (e.g., measurement or beam management requirements) defined for simultaneous measurements and procedures on two chains need to apply, provided:
    - the corresponding active TCI states are configured and used for simultaneous reception during the entire measurement or evaluation period.
  + Proposal 2: RAN4 to define the necessary UE behaviour and measurement requirements for simultaneous reception when the set of active TCI states changes during the measurement or evaluation period, e.g., when:
    - A new active TCI state is added,
    - An active TCI state is removed,
    - An active TCI state is switched/replaced.
  + Proposal 3: RAN4 to discuss and decide on how to differentiate in the specification the set of active TCI states which can be used for simultaneous reception from other active TCI states which cannot be used for simultaneous reception.
* Recommended WF
  + Can the above proposals be agreed? Companies are requested to provide your views on above proposals.

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| **Company** | **Comments** |
| Qualcomm | Proposals do not seem mutual exclusive. We are open to further discussion. |
| MediaTek | For proposal 1, we are unclear the explicit spec impact. Why we have to mention “during the entire measurement or evaluation period” Could proponent explain more?  FFS for proposal 2 and 3. |
| Huawei | For proposal 1, clarification is needed. Is it talking about the impact of dual TCI switching to other RRM requirements? What is the difference compared with legacy requirements (measure restriction and scheduling restriction)  For proposal 2, the definition of Set needs clarification.  For proposal 3, conclusion from RF about the separation between two AoAs is needed. |
| Nokia | For proposal 1, we have some question, why do we need to discuss measurement or evaluation period? Are there exceptions here that would avoid the requirements to apply? Is the proposal concerning only TCI state switching or also other RRM procedures?  For proposal 2, how is this different than the TCI switching delay we are discussing? Discussion on this proposal might be influenced by decision on Issue 1-2-1-2 and others.  For Proposal 3, we don’t think this is needed. We can use groupBasedReporting pairs to identify whether the TCI States can be enabled for simultaneous reception or not. |
| Ericsson | Agree on Proposal 1, Proposal 2, and Proposal 3, as proponents.  To Qualcomm: the proposals are not mutually exclusive, i.e., these are not options where one needs to select just one.  To MediaTek: if simultaneous reception is not used for receiving all instances of each of the two RSs, then the enhanced requirements may not apply, at least not for both RSs. This does not mean that both panels must be kept continuously active all the time.  To Huawei: from the NW perspective, the UE is not expected to meet the enhanced requirements if there are no two active TCI states configured for a specific purpose (simultaneous reception of RSs). This applies for TCI but also for RRM requirements. We are not defining requirements just for any TCI combination, rather these requirements shall be linked to the purpose of simultaneous reception of RSs (and this purpose actually defines also the "set"). If needed, RAN4 can later work on a more detailed definition of the "set".  To Nokia: We think the proposal is for other RRM procedures too. We mean to say, the enhanced requirements that are going to introduced are need to be meet only if the UE is receiving from two beams simultaneously during the requirements period (e.g., measurement period in some cases and evaluation period in some other cases). If the UE is changed to single TCI state (or single beam) in between some of the procedure, the requirements defined here need not apply. |
| Samsung | Same comments in issue 1-3-2 |
| vivo | P2 would be the same as in issue 1-3-2. P1 and P3 needs further discussion. |

## Companies views’ collection for 1st round

### Open issues

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

Sub-topic 1-1: Requirements and Scenarios

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|  | **Status summary** |
| Issue 1-1-1: Requirements to be defined | *Tentative agreements:*   * *Define DL TCI state switch requirements. UL TCI state switching, and UL spatial relation info switch are not in the scope of the WI.* * *TCI state list update requirements can be further discussed in detail in sub-topic 1-3.*   *Candidate options: None*  *Recommendations for 2nd round:*  *No further discussion is expected on this issue in second round. Proposal 2 can be discussed in Sub-topic 1-3. Proponents of proposal 2 are requested provide more details in second round.* |
| Issue 1-1-2: Scenarios to be considered w.r.t Intra-cell/Inter-cell multi-TRP | *Tentative agreements:*   * *Follow conclusion from thread 211.*   *Candidate options: None*  *Recommendations for 2nd round:*  *No further discussion is expected on this issue in this thread.* |
| Issue 1-1-3: Scenarios to be considered w.r.t single DCI/multi-DCI. | *Tentative agreements:*   * *Follow conclusion from thread 211.*   *Candidate options: None*  *Recommendations for 2nd round:*  *No further discussion is expected on this issue in this thread.* |

Sub-topic 1-2: TCI state switching requirements

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| Issue 1-2-1: Assumptions for dual TCI state switching | |
| Issue 1-2-1-1: Dual TCI state switching requirements shall be based on | *This WI is based on the Rel-16/17 MIMO. Hence, unified TCI state switching discussed in Rel-18 in RAN1 is not part of the scope as per moderator understanding. Hence, I suggest making following agreements. @Nokia and Vivo: Can you please check if this agreement is fine with you.*  *Tentative agreements:*   * *Rel-15/Rel-16 TCI framework*   *Candidate options: None*  *Recommendations for 2nd round:*  *If the tentative agreement is fine with all the companies, this issue can be closed, otherwise further discuss in second round about unified TCI framework inclusion.* |
| Issue 1-2-1-2: Can the TCI switch is assumed to be independent on each RX chain? | *TCI state switching can be triggered separately or simultaneously. It depends on NW configuration. Agreeing Option 2 alone kind of put limitation on NW configuration or NW behaviour. Option 1 can include simultaneous TCI state switch of Dual TCI states or independent TCI states of each TCI state. Since option 1 is not precluding anything, suggest we agree on option 1.*  *Tentative agreements:*   * *Agree on option 1, as option 2 kind of puts limitation on NW configuration or behaviour.*   *Candidate options: confirm tentative agreement*  *Recommendations for 2nd round:*  *Confirm whether tentative agreement is agreeable or not.* |
| Issue 1-2-2: Switch command for dual TCI state switch | |
| Issue 1-2-2-1: When two TCI states are switched simultaneously, assumption on the switch commands | *Tentative agreements:*   * *Wait for conclusion on scenarios in other thread w.r.t sDCI vs mDCI.*   *Candidate options: None*  *Recommendations for 2nd round:*  *No further discussion is expected on this issue in this thread for 2nd round.* |
| Issue 1-2-2-2: TCI state switch scenarios to be considered | *Tentative agreements:*   * *While waiting for the scenarios in other thread w.r.t sDCI vs mDCI, discuss the definition of dual TCI state switching.*   *Candidate options:*  *Recommendations for 2nd round:*  *One company commented that we need to define what is dual TCI state switch. Please provide your views on whether we need to discuss what is dual TCI state switch definition? If so, please provide your views in second round on the definition.* |
| Issue 1-2-2-3: If the proposal 1 to issue 1-2-2-2 is acceptable, can the following proposal be acceptable. | *Tentative agreements:*   * *Wait for conclusion on issue 1-2-2-2.*   *Candidate options: None*  *Recommendations for 2nd round:*  *Since we do not have enough progress to discuss the details proposed in this issue, the issue is suggested to be closed for this meeting. Request proponents to bring this issue in next meeting.* |

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| Issue 1-2-3: Known condition | |
| Issue 1-2-3-1: When two TCI states are switched simultaneously, known condition for the TCI states is: | *Tentative agreements: None*  *Candidate options:*   * + *Option 1: For sDCI framework, TCI state pair can be either both known or both unknown*   + *Option 2: Dual TCI states are independent, and each of the TCI state can be known or unknown. The definition of known/unknown for individual TCI state can follow R15/R16 definition.*   + *Option 3: Following conditions shall be considered for the known conditions:*     - *The UE has sent at least one L1-RSRP report for the target TCI states before the TCI state switch command where the associated QCL type D RSs are reported within one group configured by groupBasedBeamReporting-r17.*     - *The associated QCL type D RSs in target TCI states satisfy the conditions that the RSs are received from different panels, where the conditions shall follow RF conclusion.*   + *Option 4: any other option, please specify*   *Recommendations for 2nd round:*  *Continue further discussion.* |
| Issue 1-2-4: Delay requirements: | |
| Issue 1-2-4-1: Requirements are specified for following cases only. Do you agree with below proposals? | *Though proposal 1 and 2 follow legacy framework, since the definition of known/unknown is not yet agreed, it may be early to discuss these details. Considering that, can we come back to this issue in next meeting.*  *Tentative agreements: None*  *Candidate options: None*  *Recommendations for 2nd round:*  *This issue is closed for this meeting. This can be further discussed in next meeting after agreement on definition of known/unknown.*  *@Vivo: Can you please check if the recommendation is agreeable for you.* |
| Issue 1-2-4-2: Does the cross-panel switch time needs to be defined. | *Tentative agreements:*   * *RRM not to define additional TCI state switching delay for cross panel TCI state switching. If RF session achieves a new conclusion on panels ON/OFF switch time, RRM session may revisit the issue if required.*   *Candidate options:*  *Recommendations for 2nd round:*  *No further discussion is expected on this issue. Issue can be closed.*  *@Companies, please check if the tentative agreement is OK.* |
| Issue 1-2-4-3: TCI state switch delay requirements | *It is my understanding that, unless known and unknown definition is clear, delay requirements cannot be agreed. I suggest, we focus on the known/unknown definition in this meeting and come to delay discussion in next meeting.*  *Tentative agreements: None*  *Candidate options:*  *Recommendations for 2nd round:*  *This issue can be closed for this meeting. Come back in next meeting.*  *@Companies, please check if the recommendation is OK* |
| Issue 1-2-5: Time frequency tracking requirements | |
| Issue 1-2-5: Time frequency tracking requirements | *Tentative agreements: None*  *Candidate options:*  *Option 1: UE with multi-Rx chain should track timing/frequency independently for each TCI state when dual TCI states are activated.*  *Recommendations for 2nd round:*  *Further discuss in the 2nd round.* |

Sub-topic 1-3: TCI state list update requirements

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|  | **Status summary** |
| Issue 1-3-1: TCI state pools | *Tentative agreements: None*  *Candidate options:*   * *Option 1: Independent candidate TCI state pool for each Rx chain/panel. Then the TCI state switching is only allowed within one candidate TCI state pool, cross-pool switching is not allowed.* * *Option 2: Cross pool switching is allowed, i.e., the target TCI state can be in any pool, same of different with the pool of current TCI state, i.e., each TCI state switching can be within panel/Rx chain or cross panels/Rx chains.*   *Recommendations for 2nd round:*  *Continue discussion in 2nd round.* |
| Issue 1-3-2: Active TCI state list update requirements | *Tentative agreements: None*  *Candidate options:*   * + *Proposal 1: RAN4 to discuss the active TCI states requirements for any change to the set of active TCI states used for simultaneous reception, i.e., requirements for:*     - *addition of an active TCI state to the set of active TCI states for simultaneous reception,*     - *removal of an active TCI state from the set of active TCI states for simultaneous reception,*     - *switching/replacement of an active TCI state in the set of active TCI states for simultaneous reception*   *Recommendations for 2nd round:*  *Continue discussion in 2nd round.* |
| *Issue 1-3-3: Other proposals* | *Proposal 2 mentioned here looks different from proposal mentioned in issue 1-3-2. Suggest we discuss all the three proposals in the second round.*  *Tentative agreements: None*  *Candidate options:*   * + *Proposal 1: The new RRM requirements (e.g., measurement or beam management requirements) defined for simultaneous measurements and procedures on two chains need to apply, provided:*     - *the corresponding active TCI states are configured and used for simultaneous reception during the entire measurement or evaluation period.*   + *Proposal 2: RAN4 to define the necessary UE behaviour and measurement requirements for simultaneous reception when the set of active TCI states changes during the measurement or evaluation period, e.g., when:*     - *A new active TCI state is added,*     - *An active TCI state is removed,*     - *An active TCI state is switched/replaced.* * *Proposal 3: RAN4 to discuss and decide on how to differentiate in the specification the set of active TCI states which can be used for simultaneous reception from other active TCI states which cannot be used for simultaneous reception.*   *Recommendations for 2nd round:*  *Continue discussion in 2nd round.* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

### Sub-topic 1-2: TCI state switching requirements

**Issue 1-2-1: Assumptions for dual TCI state switching**

**Issue 1-2-1-2: Can the TCI switch is assumed to be independent on each RX chain?**

*TCI state switching can be triggered separately or simultaneously. It depends on NW configuration. Agreeing Option 2 alone kind of put limitation on NW configuration or NW behaviour. Option 1 can include simultaneous TCI state switch of Dual TCI states or independent TCI states of each TCI state. Since option 1 is not precluding anything, suggest we agree on option 1.*

*o Option 1: Yes. For each RX chain, the TCI state switch is assumed to be independent.*

*o Option 2: No. Both the TCI states should be switched together.*

*Tentative agreement:*

* *Agree on option 1. That means, for each RX chain, the TCI state switch is assumed to be independent*

Recommended WF

* + Further discuss if the tentative agreement can be agreed.

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| **Company** | **Comments** |
| Qualcomm | In principle okay with Option 1. We expect the definition and scope of “independent” to be clarified further later. Maybe it would be safter to add something like “FFS on the definition/scope of “independency.” |
| LGE | We are fine with option 1 with moderator’s clarification. |
| Intel | Fine with Tentative agreement. From our understanding, here, independent means that the two TCI states are not required to be switched simultaneously. |
| Samsung | Need more clarification that whether the TCI sate switch within one panel or switch cross the panel? If it switches within one panel, the TCI state switch can be assumed to be independent.  From our understanding, if UE supports receiving the two target TCIs from different directions with multi-RX simultaneously, 4 MIMO layers can be achieved. |
| MediaTek | We are fine with option 1. But it does not mean the delay requirement can be applied independently. Because, to our understanding, two TCI state should be switched together to achieve 4 MIMO layers. |
| Xiaomi | Fine with moderator’s clarification. However, the wording still has ambiguity with assumed to be independent. As presented in our paper, for single-DCI dual-TCI cases, the enhanced TCI state activation/deactivation for UE-specific PDSCH MAC CE will be used and in this case the TCI state IDi,1 and IDi,2 will be used for TRP1 and TRP2. In this case we believe the TCI state switch happens simultaneously. Hence we propose the option 1a as:  Option 1a:  For m-DCI case, for each RX chain, the TCI state switch is assumed to be independent.  For s-DCI case, the TCI state switch should be switched together. |
| CMCC | OK with option 1. |
| Huawei | Generally fine with option 1 with the clarification from Moderator. But we also agree with MTK that it does not means the delay requirements can be applied independently. From our understanding, it is only from the configuration perspective. We also support to add the note as recommended by QC. |
| OPPO | Fine with option 1. The requirements can include simultaneous TCI state switch of Dual TCI states or independent TCI states of each TCI state. |
| Nokia | Agree on option 1. |
| vivo | Agree with option 1. |
| ZTE | Agree with Option 1 and the tentative agreement. |
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**Issue 1-2-2: Switch command for dual TCI state switch**

**Issue 1-2-2-2: TCI state switch scenarios to be considered**

**Recommendation for 2nd round:**

* *In the first round of discussion one company commented that we need to define what is dual TCI state switch. Please provide your views on whether we need to define what is dual TCI state switch? If so, please provide your views on the definition.*

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| **Company** | **Comments** |
| Xiaomi | This issue is also depends on the issue 1-2-1-2 as discussed above.  For s-DCI case, the dual TCI state switch happens together. The enhanced MAC CE as stated above is received with dual TCI state in the MAC CE. The TCI state IDi,1 and IDi,2 will be activated accordingly. There will be at least one change of the TCI state IDi,1 and IDi,2 and the legacy TCI state switch delay requirement can apply.  For m-DCI case, the dual TCI state switch can be regarded as independent TCI state switch for each RX chain.  And we would like to further point out that between the independent TCI state switch procedure, there might be the situation that the 2nd MAC CE comes within the 1st MAC CE processing time. |
| Huawei | We are fine to further discuss based Xiaomi’s comments. And it should be differentiated into PDCCH and PDSCH. |
| OPPO | Fine to further discuss based Xiaomi’s comments |
| Nokia | We agree that the definition needs to be clarified.  Based on the comments from Xiaomi we believe changing DL TCI on one or both Rx chains simultaneously either by use of single or multi DCI.  However, do we want to regard both as ‘dual’ TCI state switch or would the m-DCI case be regarded as 2 single TCI state changes (with the possible impact mentioned by Xiaomi)? |
| vivo | We are open to discuss. Option 1 in the 1st round can be discussed as starting point. |
| ZTE | Regarding to Xiaomi’s comments, can we regard the dual TCI state switching as two independent single TCI state switching for both s-DCI case and m-DCI case? |
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**Issue 1-2-3: Known condition**

**Issue 1-2-3-1: When two TCI states are switched simultaneously, known condition for the TCI states is:**

* Proposals
  + *Option 1: For sDCI framework, TCI state pair can be either both known or both unknown*
  + *Option 2: Dual TCI states are independent, and each of the TCI state can be known or unknown. The definition of known/unknown for individual TCI state can follow R15/R16 definition.*
  + *Option 3: Following conditions shall be considered for the known conditions:*
    - *The UE has sent at least one L1-RSRP report for the target TCI states before the TCI state switch command where the associated QCL type D RSs are reported within one group configured by groupBasedBeamReporting-r17.*
    - *The associated QCL type D RSs in target TCI states satisfy the conditions that the RSs are received from different panels, where the conditions shall follow RF conclusion.*
  + *Option 4: any other option, please specify*
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| LGE | Based on option 2 and option 3, it could be further discussed. |
| Intel | Prefer option 1. When two TCI states are switched simultaneously, if one TCI state is known and another one is unknown, the TCI state switching delay is different for two panels.  We are fine with the 2nd bullet in option 3 where applicability shall apply. |
| Samsung | We support option 3.  For option 2: We think it is suitable for the case: independent TCI state for each RX chain and the TCI states are not required to switch simultaneously. Since in such case, if the conditions for the two TCI states are different, L1 measurement would be required in unknown TCI state switching, results in different delay requirements, and option 2 is more suitable. |
| MediaTek | Prefer option 3 with some modification. The applicability condition can be addressed in applicability requirement not in known/unknown condition. |
| Xiaomi | We support option 1 and 2.  For s-DCI, option 1 can apply. For m-DCI, option 2 can apply. |
| Huawei | We prefer option 3. And fine with MTK’s clarification. If the “known” conditions only means UE know the beam of the target TCI, it is possible that the dual TCI cannot be simultaneously received by the UE, and this is not the target scenarios for multi-RX receiving. |
| OPPO | Further discussion is needed based on option 3. |
| Nokia | Though UE may report group beams pair, it is not necessary that the UE will always be asked to switch to a dual TCI state pair which can be (known/known) only and it may be asked to switch to other possible dual TCI states (known/unknown, unknown/unknown) as well. as well.  So we prefer option 2. |
| vivo | Firstly, we think dual TCI states are independent, and each of the TCI state can be known or unknown. For the known conditions, we are open to discuss. |
| ZTE | Prefer Option 2. We prefer dual TCI state switching are independent, whether to trigger single TCI state switching or dual TCI state switching simultaneously, depending on NW decision based on UE L1 report. So regarding to the known/unknown condition, we can not see the necessity of update compared with legacy. |
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**Issue 1-2-5: Time frequency tracking requirements**

* Proposals
  + Option 1: UE with multi-Rx chain should track timing/frequency independently for each TCI state when dual TCI states are activated.
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| Qualcomm | In principle, Option 1 looks okay, but we are not really sure if “multi-Rx chain + independently” imposes something beyond RAN1 spec on UE. |
| Samsung | Agree option 1. To Qualcomm, more clarification for “RAN1 spec on UE” is needed. |
| MediaTek | We think no need to discuss this issue. UE should anyway follow the configured/activated TCI states in terms of QCL-type A/C. But, how UE achieve this is up to UE implementation. Whether to have a requirement for difference scenarios is up to RAN4 discussion. |
| Huawei | Generally fine with option 1. But it is not clear to us that the impact to RRM requirements and what it implies to the TCI switching requirements. |
| OPPO | Generally fine with option 1. More clarification on ‘independently’ is needed. |
| Nokia | Agree with Option 1.  We are not using ‘chain’ and ‘panel’ but we need to somehow find a terminology to describe reception by use of two different spatial setting on UE side. Otherwise, the discussion may become more complicated.  We earlier use common/independent BM (CBM/IBM) but this was for FR2 inter-CA discussions  This is also related to the discussion on thread 211 on architecture. UE should be tracking time and frequency tracking for each TCI state independently. |
| vivo | This may need further discussion. For timing frequency tracking, it should be based on QCL type A RS. The different QCL type D RSs may associated with same QCL type A RS. |
| ZTE | General fine with Option 1. UE should perform T/F tracking if the target TCI state is not maintained in the active TCI state list no matter single TCI state switching or dual TCI state switching. |
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### Sub-topic 1-3: TCI state list update requirements

**Issue 1-3-1: TCI state pools**

* Proposals
  + Option 1: Independent candidate TCI state pool for each Rx chain/panel. Then the TCI state switching is only allowed within one candidate TCI state pool, cross-pool switching is not allowed.
  + Option 2: Cross pool switching is allowed, i.e., the target TCI state can be in any pool, same of different with the pool of current TCI state, i.e., each TCI state switching can be within panel/Rx chain or cross panels/Rx chains.
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
| Qualcomm | We are not sure if the group has a common understanding of both Options that have unclear and unspecified terms. |
| LGE | We think that “TCI state pool” would be different according to UE implementation, so it is not clear how we can capture it in the specification. |
| Intel | From our understanding, how to configure active TCI state list is up to NW. |
| Samsung | We have concerns on this new concept of “TCI state pool” since it totally depends on UE implementation. If “cross-pool switching is not allowed”, how NW can know this restriction? |
| MediaTek | Could proponent explain how “Independent candidate TCI state pool” maps to existing RAN1/2 spec? |
| Xiaomi | Similar comments on the new definition of TCI state pool which is UE implementation which should not be included in the core requirement. |
| Huawei | Similar comments on the definition of TCI pool. And it is not clear whether it is introducing something new in RAN1 spec. |
| Nokia | We don’t understand both options.  Is the TCI state pool currently linked to panel? We also have some doubts whether it would be an advantage to have this association of pool and panel, since the UE may be rotating, and the panel association may cease to make sense quite fast.  As per the ZTE response, we understand that each TCI State of the dual TCI can be switched internally within a panel (option-1) and also can be switched across the channel (Option-2). However we don’t see that connection of TCI pool and the Rx chain or panel. |
| vivo | The issue is not clear to us. It may not align with existing RAN1 design. |
| ZTE | The motivation of splitting into the two cases is to facilitate the discussion on latency identification of TCI state switching. We has the basic assumption that if the TCI state switching is internally in single panel, then simultaneous dual TCI state switching is possible. However if at least one of the TCI state switching is cross panel, dual TCI state switching can be only in sequence rather than in parallel.  Regarding to the mapping between dual candidate TCI state pools and two panels, it depends on the NW configuration, and can be indicated to UE or not. |

**Issue 1-3-2: Active TCI state list update requirements**

* Proposals
  + Proposal 1: RAN4 to discuss the active TCI states requirements for any change to the set of active TCI states used for simultaneous reception, i.e., requirements for:
    - addition of an active TCI state to the set of active TCI states for simultaneous reception,
    - removal of an active TCI state from the set of active TCI states for simultaneous reception,
    - switching/replacement of an active TCI state in the set of active TCI states for simultaneous reception.
* Recommended WF
  + Discussion needed.

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| **Company** | **Comments** |
| Samsung | Discuss the necessity first |
| MediaTek | One question for proposal 1. In current requirement, active TCI state list update is always followed by a DCI based TCI state indication. However, for removal part, it seems DCI indication will not be used for removal, then how we test it in performance part? |
| Huawei | The scenario described by proposal 1 should be clarified first. |
| Nokia | We support Proposal 1.  Yes, TCI state to be removed/replaced can be currently active and used in case of simultaneous reception too. But this issue of addition/removal/switching of the active TCI state will be applicable for legacy TCI state management too.  We assume dual TCI state management should be same as legacy TCI state management, but dual TCI states need to be independently managed. |
| vivo | Same comment as in the 1st round. As in legacy TCI state list update requirements, we think only addition of a new TCI state to the current TCI state list is needed. |
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**Issue 1-3-3: Other proposals**

* Proposals
  + Proposal 1: The new RRM requirements (e.g., measurement or beam management requirements) defined for simultaneous measurements and procedures on two chains need to apply, provided:
    - the corresponding active TCI states are configured and used for simultaneous reception during the entire measurement or evaluation period.
  + Proposal 2: RAN4 to define the necessary UE behaviour and measurement requirements for simultaneous reception when the set of active TCI states changes during the measurement or evaluation period, e.g., when:
    - A new active TCI state is added,
    - An active TCI state is removed,
    - An active TCI state is switched/replaced.
  + Proposal 3: RAN4 to discuss and decide on how to differentiate in the specification the set of active TCI states which can be used for simultaneous reception from other active TCI states which cannot be used for simultaneous reception.
* Recommended WF
  + Discussion needed.

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| **Company** | **Comments** |
| MediaTek | FFS |
| Huawei | The proposals are rather high-level. We are open to further discuss the details. |
| Nokia | FFS/Discussion is needed.  For proposal 1, we have some questions, why do we need to discuss measurement or evaluation period? Are there exceptions here that would avoid the requirements to apply? Is the proposal concerning only TCI state switching or also other RRM procedures?  For proposal 2, how is this different than the TCI switching delay we are discussing? Discussion on this proposal might be influenced by decision on Issue 1-2-1-2 and others.  For Proposal 3, we don’t think this is needed. We can use groupBasedReporting pairs to identify whether the TCI States can be enabled for simultaneous reception or not. |
| vivo | FFS |
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# Recommendations for TDocs

## 1st round

**New tdocs**

|  |  |  |  |
| --- | --- | --- | --- |
| **New Tdoc number** | **Title** | **Source** | **Comments** |
|  |  |  |  |
|  |  |  |  |
| *R4-22xxxxx* | WF on TCI state switching for multi-RX chain DL reception | Ericsson |  |

**Existing tdocs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-2215362.zip |  | Discussion on RRM impacts for TCI state switching based on FR2 multi Rx chain | Intel Corporation | Noted |  |
| R4-2215465.zip |  | on the multi-RX chain TCI state switching | Xiaomi | Noted |  |
| R4-2215762.zip |  | Discussion on simultaneous DL reception from different directions for TCI state switching | MediaTek Inc. | Noted |  |
| R4-2215806.zip |  | Discussion on TCI state switching for simultaneous DL reception from different directions | LG Electronics Inc. | Noted |  |
| R4-2215815.zip |  | Discussion on TCI state switching for FR2\_multiRX\_DL | OPPO | Noted |  |
| R4-2215870.zip |  | On TCI state switching for multi-Rx chain | vivo | Noted |  |
| R4-2216277.zip |  | Discussion RRM requirements of TCI state switching for multi-Rx | Huawei, HiSilicon | Noted |  |
| R4-2216477.zip |  | Discussion on TCI state related RRM requirements for simultaneous DL reception from different directions | ZTE Corporation | Noted |  |
| R4-2216581.zip |  | Discussion on RRM TCI State Switching for multi Rx DL in FR2 | Nokia, Nokia Shanghai Bell | Noted |  |
| R4-2216827.zip |  | Discussion on active TCI state requirements | Ericsson | Noted |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-22xxxxx |  | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-22xxxxx |  | LS on … | ZZZ | Agreeable, Revised, Noted |  |
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Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents