**3GPP TSG-RAN WG4 Meeting #102-e R4-22xxxxx**

Electronic Meeting, Feb 21- Mar 4, 2022

**Agenda item:** 10.19.3.1

**Source:** Moderator (Intel)

**Title:** Email discussion summary for [102-e][240] NR\_feMIMO\_RRM\_2

**Document for:** Information

# Introduction

This e-mail discussion summary captured the discussions for Rel-17 FeMIMO Unified TCI state in 10.19.3.1 in RAN4 #102-e meeting.

In RAN4 101bis-e meeting, WF is approved.

* **WF on FeMIMO RRM impact for unified TCI** was approved in R4-2202666

# Topic #1: Unified TCI (10.19.3.1)

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2203773**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203773.zip) | Apple | **PL-RS in UL TCI state switching**  **Proposal #1:**  **Confirm definition of beam alignment as:**   * **If PL-RS is included in UL TCI or joint TCI, PL-RS is identical to the source RS in UL or joint TCI** * **If PL-RS is associated UL TCI or joint TCI, PL-RS and source RS in UL or joint TCI is QCL-Type D.**   **Proposal #2: Confirm that requirements for unified TCI for UL and joint TCI state switching are only defined for beam alignment case**  **MAC-CE based TCI state-pair switching**  **Proposal #3: For TCI State pair switching no new requirements are introduced and the requirements for DL or UL TCI State switching are applicable for TCI states associated with the TCI state pair.**  **TCI switching delay requirement in CA for common TCI**  ***Observation #1:*** *Common TCI for CA could be associated with the same TCI state/RS or a different TCI state/RS.*  ***Observation #2:*** *For common TCI switch associated with same TCI state/ RX existing joint, DL or UL TCI state switching delay applies to all CCs.*  **Proposal #4: For common TCI switch with shared RS, the existing requirements apply to all CCs with same TCI state/RS.**  **Proposal #5: For common TCI switch with shared RS the switching delay will be based on the smallest SCS.**  ***Observation #3:*** *We need to consider command decoding time and beam application/ switching time for CCs with common TCI switch associated with different TCI state/RS.*  ***Observation #4:*** *Command decoding time would be common for CCs with common TCI switch associated with different TCI state/RS.*  **Proposal #6: The command decoding time is common for all CCs with common TCI switch associated with different TCI state/RS.**  ***Observation #5:*** *For CCs with common TCI switch associated with different TCI state/RS the target TCI state condition could be different.*  **Proposal #7: The beam switching time for all CCs with common TCI switch associated with different TCI state/RS should be considered separately.**  **Proposal #8: The command decoding time and switching time for each CC shall be based on the smallest SCS among the CCs.**  **TCI switching delay requirements for NSC**  **Proposal #9: Extend TCI state switching requirements for cell with different PCI to the case when active BWP is not within serving cell active BWP or when SCS are different.**  **Proposal #10: Extend the TCI state switching delay by active BWP switch delay for the case when active BWP is not within serving cell active BWP or when SCS are different.**  **Proposal #11: If TCI state switch to cell with different PCI includes active BWP switch, interruption requirements need to be defined.**  **DCI based TCI state switching delay**  **Proposal #12: DCI based TCI state switching delay requirements are defined when target TCI state is known, is in active TCI state list for DL and joint TCI switch, is maintained for UL and joint TCI state switch.** |
| [**R4-2204266**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204266.zip) | CMCC | ***Proposal 1: the beam alignment definition is proposed as following:***   * ***If PL-RS is included in UL TCI or joint TCI, PL-RS is identical to the source RS in UL or joint TCI*** * ***If PL-RS is associated UL TCI or joint TCI, UL TCI switch and PL-RS switch are activated in the same MAC CE, PL-RS and source RS in UL or joint TCI is QCL-Type D*** * ***If PL-RS is associated UL TCI or joint TCI, UL TCI switch and PL-RS switch are activated in different MAC CE, no need to have the beam alignment assumption for PL-RS and source RS in UL or joint TCI***   ***Proposal 2: for the case that PL-RS is associated with UL TCI state, but UL TCI switch and RL-RS switch are activated in the different MAC CE, the TCI switch delay requirement and PL-RS switch delay requirement need to be specified separately (which means there is no need to include the delay component of measuring PL-RS in the UL switch delay requirement).***  ***Proposal 3: for the case that PL-RS is associated with UL TCI state, but UL TCI switch and RL-RS switch are activated in the different MAC CE, the TCI switch delay requirements and PL-RS switch delay requirements are proposed as following:***   * ***TCI switch delay requirement is*** * ***THARQ + 3ms + 1, if TCI is known*** * ***THARQ + 3ms + TL1-RSRP + 1, if TCI is unknown*** * ***PL-RS switch delay requirement is*** * ***THARQ + 3ms + NM\*(Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms)***   + ***NM = 1, if the target PL-RS is not maintained by the UE, 0 otherwise*** |
| [**R4-2204270**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204270.zip) | Samsung | **Proposal 1: RAN4 will specify the a cell with different cell PCI from serving cell as known cell if the following condtions are met**   * **Active BWP of cell with different PCI shall be within active BWP of serving cell** * **SCS between cell with different PCI and serving cell shall the same** * **Timing offset between SC and NSC are within CP**   **Proposal 2: RAN4 will NOT specify the requirements for unknown cell case (if conditions in proposal 1 cannot be met) for TCI swtiching dealy for a cell with different PCI from serving cell in Rel-17.**  **Proposal 3: RAN4 is to introduce the known condition for cell with different cell ID in introducation section for requirements applicability.**  **Proposal 4: No additional TCI switching delay requirements for CA case if common TCI is configured.**  **Proposal 5: RAN4 can specify the DCI based TCI switching delay requirements by referring to RAN1 agreed delay, i.e., and leave the detailed determination of beam application time for CA case to RAN1 and/or RAN2 specifications.** |
| [**R4-2204339**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204339.zip) | vivo | **Proposal 1 While re-using existing MAC-CE based TCI switching delay requirements for DL TCI switching delay requirements for PDCCH and PDSCH, the TCI state list considered should not be only for PDSCH.**  **Proposal 2 From RAN4 perspective, confirm ‘beam alignment ’ definition** **as applicability scenario for uplink TCI switching requirements, which include**   * **If PL-RS is included in UL TCI or joint TCI, PL-RS is identical to the source RS in UL or joint TCI** * **If PL-RS is associated with UL TCI or joint TCI, PL-RS and source RS in UL or joint TCI is QCL-Type D.**   **Observation 1 In R17 separate TCI, for MAC-CE based TCI state list updates, one MAC CE can update a list with mixed UL TCIs and DL TCIs.**  **Observation 2 MAC-CE based joint UL and DL TCI switching delay, which is different from MAC-CE joint TCI switching delay, comprises the case of**   * **MAC-CE based joint TCI switching delay, and** * **MAC-CE based separate TCI list updates including activation of both UL and DL TCIs**   **Proposal 3 For MAC CE based TCI state list update, specify requirements for the case when not all TCI states are known.**  **Proposal 4 For MAC-CE based joint UL and DL TCI switching delay, introduce reference point in time domain for OTA testing purpose, while the reference point is the later one between endpoints for DL TCI switching delay and UL TCI switching delay, respectively.**  **Proposal 5 If there is at least one unknown DL or UL TCI in the TCI list being activated, the requirement for TCI state list update delay follow the respective unknown case, i.e. extra delay for the respective L1-RSRP measurement is considered.**  **Proposal 6 Specify requirements for common TCI state switching delay in CA scenario, i.e. the switching delay between the TCI states whose QCL-D or UL TX filter is determined by a source RS in one of the CCs, while QCL-A or QCL-C is still determined by the RS in each CC.**  **Proposal 7 If common TCI is known, UE checks TOk for DL on a per-CC basis, and the requirements for DL TCI switching delay follows TOk=1 if at least in one CC, the corresponding source RS is not tracked according to the active TCI state list.**  **Proposal 8 If common TCI is known, UE checks NM for UL on a per-CC basis, and the requirements for UL TCI switching delay follows NM=1 if at least in one CC, the corresponding PL-RS is not maintained according to the active TCI state list.**  **Proposal 9 Update the second bullet under TCIs associated with ‘NSC’ as**  **‘MAC-CE based and DCI based TCI switching delay does not have difference for a serving cell and a cell with PCI different from a serving cell, if the cell with PCI different from a serving cell meets the known condition specified for inter-cell beam measurements’**  **Proposal 10 For MAC-CE based TCI state activation, if the TCI state being activated belongs to a cell with different PCI, UE need to check whether the ‘cell with different PCI’ is known before checking whether the TCI state is known.**  **Observation 3 The L3 measurement periodicity considered for the activation requirements in ‘cell with different PCI’ can be much shorter than that for SCell activation**  **Observation 4 How does network know whether UE has successfully switched the TCI to a ‘cell with different PCI’ not is still unclear based RAN1/RAN2 conclusions.**  **Observation 5 Interruption is considered in intra-frequency DAPS HO due to the baseband and RF adjustments for the activation of another cell, but seems not needed for activation of cell with PCI different from serving cell.**  **Proposal 10 For known conditions, update bullet 2, i.e. ‘Cell detectable condition (FFS: existing intra-frequency measurement can be reused)’, as**   * **after the corresponding cells configured for L1 measurements meet the detectable condition in 9.2.2 for [X=5] seconds**   **and exact value of X can be further discussed.**  **Proposal 11 For MAC-CE based TCI state activation, no RRM requirements is specified for TCI associated to the unknown cells.**  **Proposal 12 For DL TCI state list update requirements, T\_first\_SSB should be scale by the number of cells associated with the target UL TCIs whose SSBs for tracking are overlapped.**  **Proposal 13 For UL TCI state list update requirements, T\_first\_PL-RS and T\_PL-RS should be scale by the number of cells associated with the target UL TCIs whose not-maintained PL-RSs are SSBs, and these SSBs are overlapped** |
| [**R4-2204365**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204365.zip) | MediaTek Inc. | **Proposal 1: The definition of beam alignment is as following:**   * + **If PL-RS is included in UL TCI or joint TCI, PL-RS is identical to the source RS in UL or joint TCI**   + **If PL-RS is associated UL TCI or joint TCI, PL-RS and source RS in UL or joint TCI is QCL-Type D.**   **Proposal 2: For the MAC CE based and DCI based TCI state-pair indication, the TCI state switching delay requirement can be defined for UL TCI and DL TCI switching independently.**  **Observation 1: In the last meeting, RAN4 agreed "Active BWP of cell with different PCI shall be within active BWP of serving cell". It is unclear whether the BWPs of serving cell and non-serving cell are the same or not.**  **Proposal 3: To clarify in RAN4 that the BWPs of serving cell and non-serving cell are the same.**  **Proposal 4: Non-serving cell is known if UE transmits any L1-RSRP measurement report for the non-serving cell within [X] ms before the TCI state is switched. FFS: [X] for the valid L1-RSRP report and the value can follow the conclusion in inter-cell beam management.**  **Proposal 5: For the case when the non-serving cell is known and the target TCI state is known, the same TCI state switch delay requirement as serving cell can be reused.**  **Proposal 6: For the case when the non-serving cell is known and the target TCI state is unknown, the same TCI state switch delay requirement as serving cell can be reused.**  **Proposal 7: No UE requirement applies for the case when the non-serving cell is unknown and the target TCI state is known.**  **Proposal 8: For the case when the non-serving cell is unknown and the target TCI state is unknown, two options are suggested:**   * **Option 1: To extend the TCI state switch delay requirement, i.e., add TPSS/SSS\_sync\_intra (at least 600 ms) and TSSB\_time\_index\_intra (at least 120 ms).** * **Option 2: No UE requirement applies.**   **Proposal 9: For common TCI switching delay for CA case, reuse the delay requirement as the TCI state switching for single CC, with the clarification that the first slot to apply the new TCI state is determined on the CC with the smallest SCS among the CCs which applying the beam indication.** |
| [**R4-2204396**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204396.zip) | Intel Corporation | **Proposal 1: Define UL TCI state switching delay requirement for 4 scenarios.**  **Proposal 2: For MAC-CE based TCI state-pair indication, the TCI state switching delay requirement can be defined for UL TCI and DL TCI switching respectively.**  **Proposal 3: For the case that Pathloss RS is unknown:**   * **If Pathloss RS is included in target TCI state and pathloss RS are identical to associated DL RS in target TCI state, or Pathloss RS is activated with target TCI state in the same MAC CE command and Pathloss RS is QCL-typeD with associated DL RS in target TCI state** * **The PL-RS switching delay requirement is THARQ + 3ms + TL1-RSRP+ Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms.**   **Proposal 4: For MAC-CE based DL/UL TCI switching delay for cell with different PCI, only define SSB based RX beam refinement.**  **Proposal 5: If the timing offset is larger than CP, extra delay may be expected for** **MAC-CE based UL TCI switching delay for cell with different PCI**.  **Proposal 6: If the associated RS in common TCI state provides QCL-TypeD, the known condition can only consider whether the associated RS in the reference CC is known or not.**  **Proposal 7: For intra-band CA, if the RS in the TCI state provides QCL-TypeD, re-use MAC-CE based TCI switching delay defined for single CC. The slot where new TCI state applies is determined based on the carrier with the smallest SCS in the CC set.**  **Proposal 8: For intra-band CA, if the RS in the TCI state provides QCL-TypeA or QCL-TypeB, the slot where new TCI state applies is determined based on the SCS of CC where TCI state switching is configured.** |
| [**R4-2205016**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205016.zip) | ZTE Corporation | **Proposal 1: The MAC CE based TCI state-pair switching is similar as the MAC CE based joint TCI state switching, so Option 1 is preferred by us, i.e. DL and UL MAC CE based TCI state switching requirements can be used independently for the case of TCI state-pair switching.**  **Proposal 2: Proposal 2: The beam alignment definition as applicability scenario for uplink TCI switching requirements can be:**   * **If PL-RS is included in UL TCI or joint TCI, PL-RS is identical to the source RS in UL or joint TCI** * **If PL-RS is associated UL TCI or joint TCI, PL-RS and source RS in UL or joint TCI is QCL-Type D.**   **Proposal 3: Considering for applying the unified TCI state in intra-band CA case, still reuse the existing known condition is enough, not need to update the known condition. Once the source RS of target TCI state is known for each CC in the intra-band CC group, which means the known condition is satisfied.**  **Proposal 4: We are fine with the Option 1 and Option 2.** |
| [**R4-2205039**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205039.zip) | Nokia, Nokia Shanghai Bell | **Observation 1 :** RAN1 has considered beam alignment definition that PL-RS and source RS in UL or joint TCI is QCL-Type D, but it is under FFS.  **Proposal 1 :** Beam alignment definition should include the case that PL-RS and source RS in UL or joint TCI are QCLed by QCL-Type D.  **Proposal 2 :** We propose to apply the known state UL-TCI switching requirement for PL-RS switching delay when PL-RS is identical to the source RS in UL/Joint-TCI **AND** when the target PL-RS is known.  **Proposal 3 :** We propose not to define PL-RS switching delay requirement when PL-RS is identical to the source RS in UL/Joint-TCI **AND** when the target PL-RS is unknown.  - Both the source RS in the UL-TCI and the target PL-RS are assumed unknown as consequence  **Proposal 4 :** Reuse MAC-CE based UL-TCI switching delay requirement of known UL target TCI state when PL-RS and source RS in UL or joint TCI is QCLed by Type-D **AND** when both the UL-TCI state and the target PL-RS are known .  **Proposal 5 :** Reuse MAC-CE based UL TCI switching delay requirement of known UL target TCI state, when PL-RS and source RS in UL or joint TCI is QCLed by QCL-Type-D **AND**   * when the UL target TCI state is unknown but when the target pathloss reference signal is known. * when the UL target TCI state is known but when the target pathloss reference signal is unknown.   **Proposal 6 :** Apply DCI-based UL-TCI switching delay requirement for DCI-based PL-RS switching delay requirements, when the target pathloss reference signal is known AND when the target UL TCI state is known.  **Observation 2 :** RAN1 defines beam application time (BAT) for Rel-17 DL and UL TCI switching delay. The delay refers to for both DL and UL.  **Observation 3 :** Rel-16 TCI switching delay referring to *timeDurationForQCL* cannot be reused for Rel-17 unified TCI framework.  **Proposal 7 :** Adopt DCI-based DL and UL switching requirements in Appendix 6  **Observation 4 :** Common cross-CC TCI update is about a reference CC for TCI switching across multiple CCs, it does not impact TCI switching delay requirements that RAN4 is currently discussing.  **Proposal 8 :** No need to define additional requirement on TCI switching delay requirement in CA case.  **Proposal 9 :** RAN4 may take a note in the spec for TCI switching delay requirement in CA case :   * *The requirements of Rel-17 unified TCI switching delay are applicable to CA cases based on the rule of reference BWP/CC selection in TS38.214.*   **Proposal 10 :** RAN4 studies further how to handle TCI switching delay on NSC out of the conditions for same TCI switching delay assumption between SC and NSC.  **Proposal 11 :** Rel-17 unified TCI switching delay requirement are defined by UL-TCI and DL-TCI switching requirements. We don’t see reason to define TCI state-pair indication requirement separately. |
| [**R4-2205334**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205334.zip) | Huawei, HiSilicon | ***Proposal 1: When a SSB is indicated as PL-RS in a UL TCI state, the scaling factor for beam sweeping needs to be introduced for PL-RS measurement time in FR2.***  ***Proposal 2: In FR2, the MAC-CE based UL TCI state switching delay need to be separately defined for SSB based PL-RS.***  ***Proposal 3: In FR2, when a SSB is indicated as PL-RS in a UL TCI state, the MAC-CE based UL TCI state switching delay for both known case and unknown case can be defined as:***   * ***THARQ + 3ms + NM\*(5\*TL1-RSRP\_SSB + 2ms) with the assumption of M=1.*** * ***Where NM = 1, if the target PL-RS is not maintained by the UE, 0 otherwise.***   ***Proposal 4: For MAC-CE based TCI state switching, the following is suggested to be clarified in the known condition requirements.***   * ***The associated DL-RS for target TCL state can be a SSB with a PCI different from serving cell PCI.***   ***Proposal 5: DCI based DL TCI state switching delay can be defined as:***   * ***When a UE receives the DCI triggering DL TCI state activation at slot n, UE shall be able to receive PDCCH/PDSCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n + THARQ + [Y] symbols, where, Y is configured via higher layer parameter [TBD], and THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3].***   ***Proposal 6: DCI based UL TCI state switching delay can be defined as:***   * ***When a UE receives the DCI triggering UL TCI state activation at slot n, UE shall be able to transmit PUCCH/PUSCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n + THARQ + [Y] symbols, where, Y is configured via higher layer parameter [TBD], and THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3].*** |
| [**R4-2205843**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205843.zip) | Ericsson | **Proposal 1: RAN4 to agree that NM=1 is allowed in Rel-17 and shall define requirements for non-maintained case.**  **Proposal 2: For CA cross-carrier scheduling, RAN4 to agree that, when a DCI based TCI state switch command is received at slot n, and sends ACK at slot n+TACK, it should be able to receive on the new beam at n+TACK+ TBAT. Where TBAT is signalled by the gNB based on the UE capability and the slot and beam application time are based on the carrier with smallest SCS.**  **Proposal 3: Single TCI state switching requirements shall be reused for common TCI state switching requirements.**  **Proposal 4: DCI based common TCI switch delay shall follow the RAN1 agreement. That means, when a UE receive DCI based TCI state switch command at slot n, and sends ACK at slot n+TACK, UE should be able to receive on the new beam at n+TACK+ TBAT.**  **Proposal 5: RAN4 to agree on following beam alignment definition as applicability scenario for uplink TCI switching requirements.**   * + - **If PL-RS is included in UL TCI or joint TCI, PL-RS is identical to the source RS in UL or joint TCI**     - **If PL-RS is associated with UL TCI or joint TCI, PL-RS and source RS of the UL TCI or joint TCI are QCL-Type D.** |

## Open issues summary

### Sub-topic 1-1: Definition of beam alignment

**Issue 1-1-1 Beam alignment assumption if PL-RS is included in UL TCI or joint TCI**

* Proposals
  + Option 1(Apple, vivo, MTK, ZTE, Ericsson, ZTE, CMCC, Intel, Nokia):
    - PL-RS is identical to the source RS in UL or joint TCI
* Recommended WF
  + Agree with option 1

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| **Company** | **Comments** |
| CMCC | Support recommended WF |
| Nokia | We are ok with the proposal. |

**Issue 1-1-2 Beam alignment assumption if PL-RS is associated with UL TCI or joint TCI**

* Proposals
  + Option 1(Apple, vivo, MTK, ZTE, Ericsson, Nokia):
    - PL-RS and source RS in UL or joint TCI are QCL-Type D
  + Option 2 (CMCC):
    - When UL TCI switch and PL-RS switch are activated in the same MAC CE, PL-RS and source RS in UL or joint TCI is QCL-Type D
    - When UL TCI switch and PL-RS switch are activated in different MAC CE, no need to have the beam alignment assumption for PL-RS and source RS in UL or joint TCI
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| CMCC | Option 2. For the associated scenario, it can be considered case by case.  If UL TCI switch and PL-RS switch are activated in the same MAC CE, we agree that PL-RS and source RS in UL or joint TCI need to be QCL-Type D.  But for the case that UL TCI switch and PL-RS switch are activated in different MAC CE, both switch procedures can be performed separately, and no need to have the beam alignment assumption. For example, if UE receive the MAC CE on UL TCI switch before the MAC CE on PL-RS switch, UE will perform UL TCI switch firstly, and the uplink transmission power after TCI switch can be based on the old PL-RS, which may be not QCL-type D with the source RS in UL TCI. |
| Nokia | We support option-1.  Option-2 seems like a bit specific issue. We want to understand the issue further.  As reading the CMCC Tdoc, we found :  *When UL TCI switch and PL-RS switch are activated in different MAC CE, both switch procedures can be performed separately,*  *If UE receive the MAC CE on UL TCI switch before the MAC CE on PL-RS switch, UE will perform UL TCI switch firstly, and the uplink transmission power after TCI switch can be based on the old PL-RS, which may be not QCL-type D with the source RS in UL TCI.*  We are not sure if a UE uses UL TX power based on the old PL-RS or based on a new PL-RS measurement. |

### Sub-topic 1-2 Switching delay requirements for serving cell

**Issue 1-2-1 Requirement applicability of DCI based DL and UL TCI state switching delay**

* Proposals
  + Option 1(Apple):
    - When target TCI state is known, is in active TCI state list for DL and joint TCI switch, is maintained for UL and joint TCI state switch.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | This proposal lists conditions as we understand :   1. When target TCI state is known 2. When target TCI state is in active TCI state list for DL and joint TCI switch 3. When target TCI state is maintained for UL and joint TCI state switch.   (i) and (ii) are fine, as it is same as the existing requirement.  (iii) is unclear. What does it mean “target TCI state is maintained for UL and joint TCI state switch”? This seems more related to PL-RS switching as we considered in PL-RS switching, perhaps not directly related to UL? |
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**Issue 1-2-2 Define DCI based DL and UL TCI state switching delay as**

* Proposals
  + Option 1(Nokia):
    - If the target TCI state is known, the DL TCI switching to the indicated TCI-State in the DCI format shall be completed starting from the first slot that is at least *BeamAppTime\_r17* symbols after the last symbol of the PUCCH. The first slot and the *BeamAppTime\_r17* symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. The value of *BeamAppTime\_r17* is defined in TS 38.331 [2]. The known condition for TCI state defined in clause [8.15.2] is applied.
    - If the target TCI state is known, the UL TCI switching to the indicated TCI-State in the DCI format shall be completed starting from the first slot that is at least *BeamAppTime\_r17* symbols after the last symbol of the PUCCH. The first slot and the *BeamAppTime\_r17* symbols are both determined on the carrier with the smallest SCS among the carrier(s) applying the beam indication. The value of *BeamAppTime\_r17* is defined in TS 38.331 [2]. The known condition for TCI state defined in clause [8.16.2] is applied.
  + Option 2(Huawei):
    - When a UE receives the DCI triggering DL TCI state activation at slot n, UE shall be able to receive PDCCH/PDSCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n + THARQ + [Y] symbols, where, Y is configured via higher layer parameter [TBD], and THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3].
    - When a UE receives the DCI triggering UL TCI state activation at slot n, UE shall be able to transmit PUCCH/PUSCH with target TCI state of the serving cell on which TCI state switch occurs at the first slot that is after slot n + THARQ + [Y] symbols, where, Y is configured via higher layer parameter [TBD], and THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3].
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | In RAN1/2 unified TCI framework, it has been agreed that as option-1, but option-2 seems to have different understanding.  A few points are different between option-1 and option-2 :   * [Y] symbol is not just a fixed delay after THARQ. It has some conditions as below. * The start point is from the last symbol of the PUCCH. The unified TCI switching does not consider ’slot n + THARQ’ based on RAN1 agreement. * For Rel-17 unified TCI framework, a new starting point of the delay counting is from PUCCH TX in RAN1 spec, but we are open to discuss RAN4 view.     We prefer to align with RAN1 to remove potential confusions in future. We support option-1. |
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**Issue 1-2-3 MAC CE based UL TCI state switch when UL TCI switch and RL-RS switch are activated in different MAC CE**

* Proposals
  + Option 1(CMCC):
    - The TCI switch delay requirements and PL-RS switch delay requirements are defined separately, proposed as following:
    - TCI switch delay requirement is
    - THARQ + 3ms + 1, if TCI is known
    - THARQ + 3ms + TL1-RSRP + 1, if TCI is unknown
    - PL-RS switch delay requirement is
    - THARQ + 3ms + NM\*(Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms), where NM = 1, if the target PL-RS is not maintained by the UE, 0 otherwise
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| CMCC | In general, the intention of option 1 is to clarify that for the case that PL-RS is associated with UL TCI state, UL TCI switch and RL-RS switch are activated in different MAC CE, there is no need to include PL-RS delay in the UL switch delay requirements. TCI switch delay requirement and PL-RS switch delay requirement can be specified separately.  As we commented in Issue 1-1-2, for the case that PL-RS is associated with UL TCI state, UL TCI switch and RL-RS switch are activated in different MAC CE, no need to have the beam alignment assumption, so the requirements can be specified separately. And the legacy requirements in Rel-16 can be reused. |
| Nokia | It is related with Issue 1-1-2 and Issue 1-5-1. If option-1 is adopted, the UL TCI requirements are not reused for PL-RS switching requirement. But we think that MAC-CE based known PL-RS requirement is not different from CMCC proposal, so there is a possible way to reuse it.  If UL TCI requirement is reused for PL-RS, we share the view that there is unclarity on which delay component is considered in which delay requirement (see our comment in Issue 1-5-1 option-1), since there are cases like ‘unknown and known’ state or ‘same and different’ messages of UL TCI and PL-RS switching.  In the 2nd round, we are open to discuss this option versus the RAN4#101bis agreement. |

**Issue 1-2-4 TCI state-pair indication requirement**

* Proposals
  + Option 1(Apple, MTK, Intel, ZTE, Nokia):
    - The TCI state switching delay requirement can be defined for UL TCI and DL TCI switching independently.
* Recommended WF
  + Agree with option 1.

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| **Company** | **Comments** |
| Nokia | Option-1 says no other requirements for TCI state-pair indication. If so, we agree. |
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**Issue 1-2-5 MAC-CE based UL TCI state switching delay when SSB is indicated as PL-RS in UL TCI state for FR2**

* Proposals
  + Option 1(Huawei):
    - When a SSB is indicated as PL-RS in a UL TCI state, the scaling factor for beam sweeping needs to be introduced for PL-RS measurement time in FR2.
    - In FR2, the MAC-CE based UL TCI state switching delay need to be separately defined for SSB based PL-RS.
    - In FR2, when a SSB is indicated as PL-RS in a UL TCI state, the MAC-CE based UL TCI state switching delay for both known case and unknown case can be defined as:
    - THARQ + 3ms + NM\*(5\*TL1-RSRP\_SSB + 2ms) with the assumption of M=1.
    - Where NM = 1, if the target PL-RS is not maintained by the UE, 0 otherwise.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | We understand the motivation, but this proposal combines both L1-RSRP measurements and PL-RS measurements only on the SSB resource in one procedure. Later, they can be other RSs than SSB. We think it will be good to make a generic requirement with *Ttarget\_PL-RS* . (M=1 means NM=1?) |
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**Issue 1-2-6 TCI state list for PDCCH and PDSCH**

* Proposals
  + Option 1(vivo):
    - While re-using existing MAC-CE based TCI switching delay requirements for DL TCI switching delay requirements for PDCCH and PDSCH, the TCI state list considered should not be only for PDSCH.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | Agreeable. It is applicable to both PDCCH and PDSCH.  One note : not only for PDCCH and PDSCH, but also for all DL assignments in our understanding. |
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**Issue 1-2-7 Whether NM is allowed to be equal to 1 in Rel-17 specification**

* Proposals
  + Option 1(Ericsson):
    - RAN4 to agree that NM=1 is allowed in Rel-17 and shall define requirements for non-maintained case.
* Recommended WF
  + Agree with option 1.

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| **Company** | **Comments** |
| Nokia | What is the target requirement of this proposal? At least PL-RS switching, it is fine. |
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### Sub-topic 1-3 Switching delay requirements when SSB is associated with cell with different PCI

**Issue 1-3-1 Known cell condition for TCI state switch associated with different PCI**

* Proposals
  + Option 1(Samsung):
    - Active BWP of cell with different PCI shall be within active BWP of serving cell
    - SCS between cell with different PCI and serving cell shall the same
    - Timing offset between SC and NSC are within CP
  + Option 2(vivo):
    - If the cell with PCI different from a serving cell meets the known condition specified for inter-cell beam measurements
    - UE need to check whether the ‘cell with different PCI’ is known before checking whether the TCI state is known.
    - update bullet 2 of known condition for inter-cell beam measurement as
    - after the corresponding cells configured for L1 measurements meet the detectable condition in 9.2.2 for [X=5] seconds, and exact value of X can be further discussed.
  + Option 3(MTK):
    - The BWPs of serving cell and non-serving cell are the same
    - If UE transmits any L1-RSRP measurement report for the non-serving cell within [X] ms before the TCI state is switched. FFS: [X] for the valid L1-RSRP report and the value can follow the conclusion in inter-cell beam management.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | We are fine with adding the condition below to opion-1.  *If UE transmits any L1-RSRP measurement report for the non-serving cell within [X] ms before the TCI state is switched.* |
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**Issue 1-3-2 TCI state switch delay requirement for known cell case**

* Proposals
  + Option 1 (MTK):
    - For the case when the non-serving cell is known and the target TCI state is known, the same TCI state switch delay requirement as serving cell can be reused.
    - For the case when the non-serving cell is known and the target TCI state is unknown, the same TCI state switch delay requirement as serving cell can be reused.
* Recommended WF
  + Agree with option 1.

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| **Company** | **Comments** |
| Nokia | RAN4 has agreed that the same TCI state switch delay requirement as serving cell can be reused for non-serving cell under conditions. We wonder what is a new condition from option-1. |
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**Issue 1-3-3 Whether to define TCI state switch delay requirement for unknown cell case**

* Proposals
  + Option 1(Samsung, vivo, MTK): No
    - RAN4 will NOT specify the requirements for unknown cell case for TCI swtiching dealy for a cell with different PCI from serving cell in Rel-17 (Samsung).
    - For MAC-CE based TCI state activation, no RRM requirements is specified for TCI associated to the unknown cells (vivo).
  + Option 2(Apple): Yes
    - Extend TCI state switching requirements for cell with different PCI to the case when active BWP is not within serving cell active BWP or when SCS are different.
    - Extend the TCI state switching delay by active BWP switch delay for the case when active BWP is not within serving cell active BWP or when SCS are different.
  + Option 3 (MTK): depends on condition
    - No UE requirement applies for the case when the non-serving cell is unknown and the target TCI state is known.
    - For the case when the non-serving cell is unknown (the timing offset between serving cell and non-serving cell is less than one CP) and the target TCI state is unknown, two options are suggested:
    - Option 1: To extend the TCI state switch delay requirement, i.e., add TPSS/SSS\_sync\_intra (at least 600 ms) and TSSB\_time\_index\_intra (at least 120 ms).
    - Option 2: No UE requirement applies.
  + Option 4 (Nokia):
    - RAN4 studies further how to handle TCI switching delay on NSC out of the conditions for same TCI switching delay assumption between SC and NSC
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | We prefer option-1 the first bullet.  The second bullet in option-1 includes L1-RSRP for cells under unknown condition. We can discuss it in ICBM.  Regarding Option-2/3, we agree they are valid points that RAN4 surely continues studying, but may not be in Rel-17. |
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**Issue 1-3-4 Whether introduce the interruption requirement due to TCI state switch associated with different PCI**

* Proposals
  + Option 1 (Apple):
    - If TCI state switch to cell with different PCI includes active BWP switch, interruption requirements need to be defined.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | This is a valid point that RAN4 continues studying, but we prefer to deprioritize in Rel-17. |
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**Issue 1-3-5 Whether to only consider SSB based L1-RSRP measurement for cell with different PCI**

* Proposals
  + Option 1(Intel):
    - only consider SSB based L1-RSRP measurement for RX beam refinement.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| CMCC | This is pending on RAN1 discussion. At least in our understanding, CSI-RS based L1-RSRP measurement for cell with different PCI is considered (according to our RAN1 delegates, it is supported that CSI-RS configured for a serving cell can be QCLed with a SSB from cell with different PCI). If companies have different understanding, it is suggested to send LS to RAN1. |
| Nokia | We think this is an ICBM related issue. RAN1 agreement is required first. |

**Issue 1-3-6 Update of known conditions for associated DL-RS**

* Proposals
  + Option 1(Huawei):
    - For MAC-CE based TCI state switching, it is suggested to clarify the followings in the known condition requirements.
    - The associated DL-RS for target TCL state can be a SSB with a PCI different from serving cell PCI.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | We are ok with clarification. HW seems to suggest not to capture the wording “a cell with PCI different from a serving cell” into specification. Any alternative suggestion? |
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### Sub-topic 1-4 Delay requirements for common TCI state switching in CA case

**Issue 1-4-1 Known condition in CA scenario**

* Proposals
  + Option 1(ZTE):
    - Reuse the existing known condition. Once the source RS of target TCI state is known for each CC in the intra-band CC group, which means the known condition is satisfied.
  + Option 2 (Intel):
    - If the associated RS in common TCI state provides QCL-TypeD, the known condition can only consider whether the associated RS in the reference CC is known or not.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | Support option-2. only consider whether the associated RS in the reference CC is known. |
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**Issue 1-4-2 Whether common TCI state switching delay requirement is defined for all CC or per CC**

* Proposals
  + Option 1: Defined per CC.
    - Option 1a (Apple): The beam switching time for all CCs with common TCI switch associated with different TCI state/RS should be considered separately.
    - Option 1b (vivo): If TCI states involve QCL-A or QCL-C, TCI state switch is still determined by the RS in each CC.
    - Option 1c (Intel): If the RS in the TCI state provides QCL-TypeA or QCL-TypeB, the slot where new TCI state applies is determined based on the SCS of CC where TCI state switching is configured.
  + Option 2: Defined for all CC
    - Option 2a (Apple): For common TCI switch with shared RS, the existing requirements apply to all CCs with same TCI state/RS. For common TCI switch with shared RS the switching delay will be based on the smallest SCS.
    - Option 2b (MTK, ZTE): Reuse the delay requirement as the TCI state switching for single CC, with the clarification that the first slot to apply the new TCI state is determined on the CC with the smallest SCS among the CCs which applying the beam indication.
    - Option 2c (Nokia):No need to define additional requirement on TCI switching delay requirement in CA case. RAN4 may take a note in the spec for TCI switching delay requirement in CA case:
    - The requirements of Rel-17 unified TCI switching delay are applicable to CA cases based on the rule of reference BWP/CC selection in TS38.214.
    - Option 2d (Ericsson):
    - Single TCI state switching requirements shall be reused for common TCI state switching requirements.
    - DCI based common TCI switch delay shall follow the RAN1 agreement. That means, when a UE receive DCI based TCI state switch command at slot n, and sends ACK at slot n+TACK, UE should be able to receive on the new beam at n+TACK+ TBAT.
    - Option 2e(Samsung):
    - No additional TCI switching delay requirements for CA case if common TCI is configured.
    - RAN4 can specify the DCI based TCI switching delay requirements by referring to RAN1 agreed delay, i.e., and leave the detailed determination of beam application time for CA case to RAN1 and/or RAN2 specifications.
    - Option 2f (vivo):
    - Specify requirements for common TCI state switching delay in CA scenario, i.e. the switching delay between the TCI states whose QCL-D or UL TX filter is determined by a source RS in one of the CCs.
    - If common TCI is known, UE checks TOk for DL on a per-CC basis, and the requirements for DL TCI switching delay follows TOk=1 if at least in one CC, the corresponding source RS is not tracked according to the active TCI state list.
    - If common TCI is known, UE checks NM for UL on a per-CC basis, and the requirements for UL TCI switching delay follows NM=1 if at least in one CC, the corresponding PL-RS is not maintained according to the active TCI state list.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | In principle for common TCI, we can simplify discussion into two parts (i) making requirement (ii) applying requirement.   * For (i), only a single reference CC is referred to set up a requirement. * For (ii), the requirement is applied to all CCs.   Then, we can apply the current requirements under on-going discussion to CA cases. Rules of how to select a reference CC are defined by RAN1 TS38214. RAN4 spec can refer to it, make a note in RAN4 spec :  *The requirements of Rel-17 unified TCI switching delay are applicable to all CCs in CA cases based on the rule of reference BWP/CC selection in TS38.214.* |
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### Sub-topic 1-5 Requirements for PL-RS switching delay indicated by unified TCI

**Issue 1-5-1 Whether to define MAC CE based PL-RS switching requirement when PL-RS is unknown**

* Proposals
  + Option 1(Intel): Yes
    - If Pathloss RS is included in target TCI state and pathloss RS are identical to associated DL RS in target TCI state, or Pathloss RS is activated with target TCI state in the same MAC CE command and Pathloss RS is QCL-typeD with associated DL RS in target TCI state
    - The PL-RS switching delay requirement is THARQ + 3ms + TL1-RSRP+ Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms.
  + Option 2(Nokia): No
    - Not to define PL-RS switching delay requirement when PL-RS is identical to the source RS in UL/Joint-TCI **AND** when the target PL-RS is unknown.
    - Apply MAC-CE based UL TCI switching delay requirement of **known** UL target TCI state, when target PL-RS and source RS in UL/joint TCI are QCL-Type-D **AND**
* when the UL target TCI state is known but when the target pathloss reference signal is unknown **OR**
* when the UL target TCI state is unknown but when the target pathloss reference signal is known.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | On option-1, we don’t agree. It needs further clarification why adding TL1-RSRP .again.  TL1-RSRP is considered in MAC-CE UL-TCI switching delay in TCI unknow case. If PL-RS switching additionally has TL1-RSRP again, it seems doubly consider two of TL1-RSRP.  On option-2, we propose to introduce PL-RS switching delay requirement only in known state case. Firstly, Rel-16 PL-RS switching requirement has only been defined in known state case.  Secondly, if L1-measurement has been measured on either PL-RS or source-RS in UL-TCI, then it can be assumed to be known state, so we propose the second bullets of option-2. This proposal intends to avoid a situation to consider additional TL1-RSRP. for PL-RS switching.  Alternatively, Issue 1-2-3 discussion can be a solution to remove ambiguity. |
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**Issue 1-5-3 DCI-based PL-RS switching delay requirements**

* Proposals
  + Option 1(Nokia):
    - Apply DCI-based UL TCI switching delay requirement for DCI-based PL-RS switching delay requirements, when the target pathloss reference signal is known AND when the target UL TCI state is known.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | Support |
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### Sub-topic 1-6 TCI state list update delay

**Issue 1-6-1 MAC CE based TCI state list update delay for serving cell**

* Proposals
  + Option 1(vivo):
    - For MAC CE based TCI state list update, specify requirements for the case when not all TCI states are known.
    - For MAC-CE based joint UL and DL TCI switching delay, introduce reference point in time domain for OTA testing purpose, while the reference point is the later one between endpoints for DL TCI switching delay and UL TCI switching delay, respectively.
    - If there is at least one unknown DL or UL TCI in the TCI list being activated, the requirement for TCI state list update delay follow the respective unknown case, i.e. extra delay for the respective L1-RSRP measurement is considered.
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | To manage TCI state list update, a UE is mandated to measure L1-RSRP measurement?  A UE is already allowed with L1-RSRP time when MAC-CE based TCI switching is triggered under unknown TCI state. |
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**Issue 1-6-2 MAC CE based TCI state list update delay for cell with different PCI**

* Proposals
  + Option 1(vivo):
    - For DL TCI state list update requirements, T\_first\_SSB should be scale by the number of cells associated with the target UL TCIs whose SSBs for tracking are overlapped.
    - For UL TCI state list update requirements, T\_first\_PL-RS and T\_PL-RS should be scale by the number of cells associated with the target UL TCIs whose not-maintained PL-RSs are SSBs, and these SSBs are overlapped
* Recommended WF
  + Collect companies’ view for these proposals in 1st round

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| **Company** | **Comments** |
| Nokia | As we know, the current working assumption is the number of NSC =1. We are open to discuss up to needs. |
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## Companies views’ collection for 1st round

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| **R4-2204340**  vivo | draft CR on active DL and UL TCI state list update delay requirements in R17 |
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| [**R4-2204403**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204403.zip)  Intel | DraftCR to TS 38.133: MAC-CE based downlink/uplink TCI state switch delay for unified TCI state |
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| [**R4-2204491**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204491.zip)  ZTE | Draft CR for Introduction of DL TCI state switching delay for unified TCI |
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| [**R4-2204492**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204491.zip)  ZTE | Draft CR for Introduction of UL TCI state switching delay for unified TCI |
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| [**R4-2205042**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205042.zip)  Nokia | DraftCR on DCI based DL and UL TCI switching delay requirements |
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| [**R4-2205335**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205335.zip)  Huawei | DraftCR on known condition requirements for R17 unified TCI |
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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.*

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|  | **Status summary** |
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## Discussion on 2nd round (if applicable)

# Recommendations for Tdocs

## 1st round

**New tdocs**

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| **Title** | **Source** | **Comments** |
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**Existing tdocs**

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| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
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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

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| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
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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

# Annex

Contact information

|  |  |  |
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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)