**3GPP TSG RAN WG4 Meeting #104-e R4-2213940**

**E-meeting, 15 Aug. 2022 – 26 Aug. 2022**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  |  | **CR** | **2557** | **rev** | **1** | **Current version:** | **0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network |  |

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| ***Title:***  | CR on unified TCI state switching requirements |
|  |  |
| ***Source to WG:*** |  |
| ***Source to TSG:*** |  |
|  |  |
| ***Work item code:*** | NR\_feMIMO-Core |  | ***Date:*** |  2022-08-26 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***Release:*** | Rel-17 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | Unified TCI state switching requirements needs to be fine tuned. |
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| ***Summary of change:*** | Unified TCI state swithcing requirements are corrected as per the agreements in the meeting. |
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| ***Consequences if not approved:*** | Unified TCI state switching requirements are not correct. |
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| ***Clauses affected:*** | 8.15, 8.16 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
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| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | R4-2213940 |

<Start of Change 1>

8.15 Active downlink TCI state switching delay for unified TCI

8.15.1 Introduction

The requirements in this clause apply for a UE configured with more than one *DLorJointTCIState* or *UL-TCIState* configurations for both DL and UL channels/signals on a serving cell or a cell with PCI different from a serving cell [on a CC, or serving cells on all CCs in the same CC list configured by *simultaneousU-TCI-UpdateList1, simultaneousU-TCI-UpdateList2, simultaneousU-TCI-UpdateList3, simultaneousU-TCI-UpdateList4*]in MR-DC or standalone NR. UE shall complete the switch of active downlink TCI state within the delay defined in this clause.

The requirements in this clause for a cell with different PCI from serving cell are applicable for such cell is known for a UE. A cell with different PCI from serving cell is known if the the following conditions are met

 Active BWP of the serving cell and a cell with different PCI are the same

 Center frequency, SCS and SFN offset of a cell with different PCI from serving cell are as the same as serving cell

 During the last 5s before L1-RSRP measurement is configured, the UE has sent a valid L3 measurement report for the cell with different PCI

 Timing offset between serving cell and the cell with different PCI from serving cell is within CP of the corresponding SCS

Otherwise, the cell with different PCI from serving cell is unknown.

8.15.2 Known conditions for downlink TCI state

The downlink TCI state is known if the following conditions are met:

- During the period from the last transmission of the RS resource used for the L1-RSRP measurement reporting for the target downlink TCI state to the completion of active downlink TCI state switch, where the RS resource for L1-RSRP measurement is the RS in target downlink TCI state or QCLed to the target downlink TCI state

- Downlink TCI state switch command is received within 1280 ms upon the last transmission of the RS resource for beam reporting or measurement

- The UE has sent at least 1 L1-RSRP report for the target downlink TCI state before the downlink TCI state switch command

- The target downlink TCI state remains detectable during the downlink TCI state switching period

- The SSB associated with the downlink TCI state remain detectable during the downlink TCI switching period

- SNR of the downlink TCI state ≥ -3dB

- The SSB can be associated with either the serving cell PCI or a PCI different from serving cell PCI.

Otherwise, the downlink TCI state is unknown.

8.15.3 MAC-CE based downlink TCI state switch delay

The requirements in this clause shall apply for DL TCI state switch using separate DL TCI state or joint TCI state of unified TCI state switch framework.

In case that source RS in DL TCI state or joint TCI state is associated with a PCI different from that of the serving cell, the requirements in this clause shall apply if the cell with different PCI satisfies the known cell condition defined in 8.15.1. If the known cell condition is not met, longer delay may be expected.

[In case of joint TCI state switch, UE is not expected to receive on DL before UE completes the DL and UL TCI state switch.]

If the target TCI state is known, upon receiving PDSCH carrying MAC-CE activation command in slot n, UE shall be able to receive UE-dedicated 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 + $3N\_{slot}^{subframe,µ}$+ TOk\*(Tfirst-SSB + TSSB-proc) / *NR slot length*. The UE shall be able to receive UE-dedicated PDCCH/PDSCH with the old TCI state until slot n+ THARQ + $3N\_{slot}^{subframe,µ}$ .Where THARQ is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3];

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE; The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

- TSSB-proc = 2 ms;

- TOk = 1 if target TCI state is not in the active TCI state list for PDSCH/PDCCH, 0 otherwise.

If the target TCI state is unknown, upon receiving PDSCH carrying MAC-CE activation command in slot n, UE shall be able to receive UE-dedicated 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 +$3N\_{slot}^{subframe,µ}$ + TL1-RSRP +TOuk\*(Tfirst-SSB+ TSSB-proc) / *NR slot length*. The UE shall be able to receive UE-dedicated PDCCH/PDSCH with the old TCI state until slot n+ THARQ + $3N\_{slot}^{subframe,µ}$ .

Where

- T L1-RSRP = 0 in FR1 or when the TCI state switching not involving QCL-TypeD in FR2. Otherwise,

- T L1-RSRP is the time for Rx beam refinement in FR2, defined as

- TL1-RSPR\_Measurement\_Period\_SSB for SSB as specified in clause 9.5.4.1,

- with the assumption of M=1

- with TReport = 0

- TL1-RSRP\_Measurement\_Period\_CSI-RS for CSI-RS as specified in clause 9.5.4.2

- CSI-RS based L1-RSRP measurement only apply for TCI state switch when source RS is associated with serving cell

- configured with higher layer parameter *repetition* set to ON

- with the assumption of M=1 for periodic CSI-RS

- for aperiodic CSI-RS if number of resources in resource set at least equal to *MaxNumberRxBeam*

- with TReport = 0

- TOuk = 1 for CSI-RS based L1-RSRP measurement, and 0 for SSB based L1-RSRP measurement when TCI state switching involves QCL-TypeD

- TOuk = 1 when TCI state switching involves other QCL types only

- Tfirst-SSB is time to first SSB transmission after L1-RSRP measurement when TCI state switching involves QCL-TypeD;

- Tfirst-SSB is time to first SSB transmission after MAC CE command is decoded by the UE for other QCL types;

- The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state

8.15.4 DCI based downlink TCI state switch delay

When a UE is configured with the higher layer parameter with *DLorJointTCIState* or *UL-TCIState,* activated with TCI states for downlink transmission by MAC CE indication of more than one codepoints, and receives DCI format 1\_1/1\_2 with or without DL assignment providing indicated TCI-State or TCI state pair in the active TCI list [for a CC or all CCs with a common indicated TCI-State in the same CC list configured by *simultaneousU-TCI-UpdateList1, simultaneousU-TCI-UpdateList2, simultaneousU-TCI-UpdateList3, simultaneousU-TCI-UpdateList4]*., the UE transmits a PUCCH with HARQ-ACK information corresponding to the DCI carrying the TCI-State indication.

If the target TCI state is known, the downlink TCI switching to the indicated DL TCI state or joint 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 carrying HARQ-ACK in response to the DCI triggering TCI state activation. 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.

8.15.5 Active Downlink TCI state list update delay

The requirements specified in this clause are applicable if

- higher layer configuration [‘*unifiedtci-StateType*’] is set to [‘*SeparateULDL*’], and a MAC CE activates more than one target separate TCIs, and at least one DL TCI is included, or

- higher layer configuration [‘*unifiedtci-StateType*’] is set to [‘*JointULDL*’], and a MAC CE activates more than one target joint TCI.

Upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, if all the TCI states in the active TCI state list is known, UE shall be able to receive PDCCH or PDSCH with the new target TCI states at the first slot that is after

n +$3N\_{slot}^{subframe,µ}$ + (THARQ + Tfirst-SSB\_List + TSSB-proc)) / *NR slot length*.

Where

- If the number of cells associated with the target TCIs that are not in the active TCI list is larger than 1, and SSBs associated to the TCIs are overlapped in FR2,

- Tfirst-SSB\_List = Tfirst-SSB + (Ncell -1) \* TSSB, where Ncell is the number of cells associated with the target TCIs that are not in the active TCI list, whose SSBs are overlapped. Ncell ≤Nmax + 1, where Nmax is the number of cells with PCI different from serving cell, and Nmax = 1.

*-* Otherwise,

- Tfirst-SSB\_List = Tfirst-SSB.

- THARQ, Tfirst-SSB, TSSB-proc are defined in clause 8.15.3. TSSB is the SSB periodicity.

If one or more TCI states in the active TCI state list is unknown, longer delay applies for active DL TCI state list update.

When UE receives PDSCH carrying MAC-CE for active TCI state list update, and

- higher layer configuration [‘*unifiedtci-StateType*’] is set to [‘*JointULDL*’], or

- higher layer configuration [‘*unifiedtci-StateType*’] is set to [‘*SeparateULDL*’], while the target TCI list comprises at least one DL TCIs and at least one UL TCIs,

UE is not expected to receive on DL before UE completes the DL and UL TCI state list update.

<End of Change 1>