**3GPP TSG-RAN WG4 Meeting # 109 *R4-2321644***

**Chicago, US, November 13 - 17, 2023**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.133** | **CR** | **3953** | **rev** | **-** | **Current version:** | **18.3.0** |  |
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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:***  | Big CR to TS 38.133 on NR MIMO evolution for downlink and uplink |
|  |  |
| ***Source to WG:*** | Samsung |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | NR\_MIMO\_evo\_DL\_UL-Core |  | ***Date:*** | 2023-11-20 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *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)* |
|  |  |
| ***Reason for change:*** | This Big CR includes all endorsed Draft CRs for TS 38.133 for NR\_MIMO\_evo\_DL\_UL-Core in RAN4#109 meeting:1. R4-2321500, Draft CR on L1-RSRP RRM requirements in R18 NR MIMO evolution, vivo
2. R4-2321501, Draft CR on MRTD requirements, Apple
3. R4-2321502, UL Transmit timing for MIMO Evolution, Ericsson
4. R4-2321614, DraftCR on MTTD requirements for UL multi-DCI multi-TRP with two TAs, Huawei, HiSilicon
5. R4-2321505, DraftCR on L1-RSRP measurement for cell with different PCI when actual timing offset can be larger than CP, xiaomi
6. R4-2321506, Draft CR on active downlink TCI state switching delay for unified TCI for sDCI mTRP, Samsung
7. R4-2321508, Draft CR for Active downlink TCI state switching delay for unified TCI for mDCI mTRP, Nokia, Nokia Shanghai Bell
8. R4-2321507, Draft CR on Active uplink TCI state switching delay for unified TCI for sDCI mTRP, Huawei, HiSilicon
9. R4-2321504, DraftCR on UL TCI state switching delay requirements for eUTCI for mDCI, Apple
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|  |  |
| ***Summary of change:*** | Including the changes in draft CRs:1. R4-2321500
2. R4-2321501
3. R4-2321502
4. R4-2321614
5. R4-2321505
6. R4-2321506
7. R4-2321508
8. R4-2321507
9. R4-2321504
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|  |  |
| ***Consequences if not approved:*** | The RRM requiements of Rel-18 MIMO evolusion are missing |
|  |  |
| ***Clauses affected:*** | 9.5.2 & 7.6.1 & 7.6.x & 7.1.1 & 7.1.2 & 7.5.1 & 7.5.x & 8.X4 & 9.13 & 8.X1 & 8.X3 & 8.X2 |
|  |  |
|  | **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 ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

## =====Start of change 1=====

### 9.5.2 Requirements applicability

The requirements in clause 9.5 apply, provided:

- The CSI-RS or SSB or CSI-RS and SSB resources configured for L1-RSRP measurements are measurable.

An SSB resource configured for L1-RSRP shall be considered measurable when for each relevant SSB the following conditions are met:

- L1-RSRP related side conditions given in clauses 10.1.19.1 and 10.1.20.1 for FR1 and FR2, respectively, for a corresponding band,

- SSB\_RP and SSB Ês/Iot according to Annex B.2.4.1 for a corresponding band.

A CSI-RS resource configured for L1-RSRP shall be considered measurable when for each relevant CSI-RS the following conditions are met:

- L1-RSRP related side conditions given in clauses 10.1.19.2 and 10.1.20.2 for FR1 and FR2, respectively, for a corresponding band,

- CSI-RS\_RP and CSI-RS Ês/Iot according to Annex B.2.4.2 for a corresponding band.

A CSI-RS and SSB resource configured for L1-RSRP shall be considered measurable when the measurable resource conditions are met for both CSI-RS resource and SSB resource.

Requirements are defined for periodic, semi-persistent and aperiodic resources.

In case the SSB resources configured for L1-RSRP measurements outside SMTCs are overlapped with the PDSCH/PDCCH that is associated to a PCI different from serving cell, L1-RSRP measurement performance degradation is expected.

For a UE supports [two TAs and RTD > CP capability], the requirements apply when Rx timing difference is up to MRTD as specified in clause [7.X1.X].

For a UE which do not support [two TAs and RTD > CP capability], the requirements apply when Rx timing difference is less than CP.

## =====End of change 1=====

## =====Start of change 2=====

### 7.6.1 Introduction

A UE shall be capable of handling a relative receive timing difference between subframe timing boundary of an E-UTRA cell belonging to the MCG and the closest slot timing boundary of a cell belonging to SCG to be aggregated for EN-DC operation.

A UE shall be capable of handling a relative receive timing difference between subframe timing boundary of an E-UTRA cell belonging to the SCG to be aggregated for NE-DC operation and the closest slot timing boundary of a cell belonging to MCG.

A UE shall be capable of handling a relative receive timing difference between slot timing boundary of a cell belonging to MCG in FR1 or FR2-1 and the closest slot timing boundary of a cell belonging to the SCG FR1 or FR2-1 to be aggregated for NR DC operation.

A UE shall be capable of handling a relative receive timing difference between subframe timing boundary of a cell belonging to MCG in FR1 and the closest subframe timing boundary of a cell belonging to the SCG in FR2-2 to be aggregated for NR DC operation.

A UE shall be capable of handling a relative receive timing difference among the closest slot timing boundaries of different carriers in FR1 and/or FR2-1 to be aggregated in NR carrier aggregation.

A UE shall be capable of handling a relative receive timing difference among the closest subframe timing boundaries of different carriers to be aggregated in FR1 and FR2-2 NR inter-band carrier aggregation.

An FR2-1 PC6 UE supporting [*simultaneousReceptionFR2HST-r18]* shall be capable of handling a relative receive timing difference between the subframe boundaries of signals on the same CC received using two different Rx chains simultaneously in HST FR2 bidirectional deployment.

A UE supporting [*FG 40-2-1 or FG 40-2-2*] shall be capable of handling a relative receive timing difference between the slot boundaries of signals on the same CC received from two TRPs.

The requirements defined in clause 7.6 are also applicable when UE is configured to receive multiple PDSCH transmission occasions from one or more QCL sources on any one of the aggregated NR carriers.

### 7.6.x Minimum Requirements for Multi-TRPs

A UE supporting [*FG 40-2-1 or FG 40-2-2*] shall be capable of handling at least a relative receive timing difference between slot timing of different TRPs on the same carrier at the UE receiver as shown in Table 7.6.x-1 below.

A UE supporting [*FG 40-2-1 or FG 40-2-2*] shall be capable of handling at least a relative receive timing difference between slot timing of different TRPs on the same carrier at the UE receiver as shown in Table 7.6.x-2 below, provided that the UE indicates that it is capable of [*FG 40-2-6*].

Table 7.6.x-1: Maximum receive timing difference requirement for multi-TRPs with two TAs for UE not capable of [*FG 40-2-6*]

|  |  |
| --- | --- |
| Frequency Range | Maximum receive timing difference  |
| FR1 | CP lengthnote 1 |
| FR2-1 | CP lengthnote 1 |
| Note 1: CP length of the maximum SCS on the carrier. |

Table 7.6.4-2: Maximum receive timing difference requirement for multi-TRPs with two TAs for UE capable of [*FG 40-2-6*]

|  |  |
| --- | --- |
| Frequency Range of the pair of carriers | Maximum receive timing difference (µs)  |
| FR1 | 33 |
| FR2-1 | 8 |

## =====End of change 2=====

## =====Start of change 3=====

## 7.1 UE transmit timing

### 7.1.1 Introduction

The UE shall have capability to follow the frame timing change of the reference cell in connected state or when transmiting PUSCH on CG resources for SDT in RRC\_Inactive. The uplink frame transmission takes place before the reception of the first detected path (in time) of the corresponding downlink frame from the reference cell. For serving cell(s) in pTAG, UE shall use the SpCell as the reference cell for deriving the UE transmit timing for cells in the pTAG. For serving cell(s) in sTAG, UE shall use any of the activated SCells as the reference cell for deriving the UE transmit timing for the cells in the sTAG. UE initial transmit timing accuracy and gradual timing adjustment requirements are defined in the following requirements.

In the requirements of clause 7.1.2, the term reference cell on a carrier frequency subject to CCA is not available at the UE refers to when at least one SSB is configured by gNB, but the first two successive candidate SSB positions for the same SSB index within the discovery burst transmission window are not available during at least one discovery burst transmission window, at the UE due to DL CCA failures at gNB during the last 1280 ms; otherwise the reference cell on the carrier frequency subject to CCA is considered as available at the UE.

For multi-DCI based multi-TRP operation with two TAs, for each TAG, the uplink transmission timing takes place before the reception of the first detected path (in time) of the corresponding downlink reference signal associated with *UL-TCIState* or *DLorJointTCIState (if unifiedTCI-StateType is indicated as Joint)* , where is commanded by the network independently for each TAG [TS 38.331].

### 7.1.2 Requirements

The UE initial transmission timing error shall be less than or equal to ±Te where the timing error limit value Te is specified in Table 7.1.2-1. This requirement applies:

- when it is the first transmission in a DRX cycle for PUCCH, PUSCH and SRS, or it is the PRACH transmission, or it is the msgA transmission, or it is the first transmission sent on the PSCell for activating the deactivated SCG without RACH.

- when it is the transmission for PUSCH on CG resources for SDT in RRC\_Inactive.

When the UL SCS is 120 kHz or smaller, the UE shall meet the Te requirement for an initial transmission provided that at least one SSB is available at the UE during the last 160 ms. When the UL SCS is 480 kHz the UE shall meet the Te requirement for an initial transmission provided that at least one SSB is available in the last 80 ms. When the UL SCS is 960 kHz the UE shall meet the Te requirement for an initial transmission provided that at least one SSB is available in the last 40 ms. The reference point for the UE initial transmit timing control requirement shall be the downlink timing of the reference cell minus . The downlink timing is defined as the time when the first path (in time) of the corresponding downlink frame used by the UE to determine downlink timing is received from the reference cell at the UE antenna. *N*TA for PRACH is defined as 0.

 (in *Tc* units) for other channels is the difference between UE transmission timing and the downlink timing immediately after when the last timing advance in clause 7.3 was applied. *N*TA for other channels is not changed until next timing advance is received. The value ofdepends on the duplex mode of the cell in which the uplink transmission takes place and the frequency range (FR). is defined in Table 7.1.2-2.

For multi-DCI based multi-TRP operation with two TAs, UE initial transmission timing error requirements specified in this clause is applicable for each TAG and shall be met for each TAG separetely. The reference point described in this clause for each TAG is the the first detected path (in time) of the corresponding downlink reference signal associated with *UL-TCIState* or *DLorJointTCIState (if unifiedTCI-StateType is indicated as Joint)* [TS 38.331].

Table 7.1.2-1: Te Timing Error Limit

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of SSB signals (kHz) | SCS of uplink signals (kHz) | Te |
| 1 | 15 | 15 | 12\*64\*Tc |
|  |  | 30 | 10\*64\*Tc |
|  |  | 60 | 10\*64\*Tc |
|  | 30 | 15 | 8\*64\*Tc |
|  |  | 30 | 8\*64\*Tc |
|  |  | 60 | 7\*64\*Tc |
| 2-1 | 120 | 60 | 3.5\*64\*Tc |
|  |  | 120 | 3.5\*64\*Tc |
|  | 240 | 60 | 3\*64\*Tc |
|  |  | 120 | 3\*64\*Tc |
| 2-2 | 120 | 120 | 3.5\*64\*Tc |
|  |  | 480 | 1.58\*64\*Tc |
|  | 480 | 120 | 2.86\*64\*Tc |
|  |  | 480 | 1.35\*64\*Tc |
|  |  | 960 | 0.90\*64\*Tc |
|  | 960 | 120 | 2.80\*64\*Tc |
|  |  | 480 | 1.13\*64\*Tc |
|  |  | 960 | 0.86\*64\*Tc |
| Note 1: Tc is the basic timing unit defined in TS 38.211 [6] |

Table 7.1.2-2: The Value of 

|  |  |
| --- | --- |
| Frequency range and band of cell used for uplink transmission | (Unit: TC) |
| FR1 FDD or TDD band with neither E-UTRA–NR nor NB-IoT–NR coexistence case  | 25600 (Note 1) |
| FR1 FDD band with E-UTRA–NR and/or NB-IoT–NR coexistence case  | 0 (Note 1) |
| FR1 TDD band with E-UTRA–NR and/or NB-IoT–NR coexistence case | 39936 (Note 1) |
| FR2 | 13792 |
| Note 1: The UE identifies  based on the information n-TimingAdvanceOffset as specified in TS 38.331 [2]. If UE is not provided with the information n-TimingAdvanceOffset, the default value of  is set as 25600 for FR1 band. In case of multiple UL carriers in the same TAG, UE expects that the same value of n-TimingAdvanceOffset is provided for all the UL carriers according to clause 4.2 in TS 38.213 [3] and the value 39936 of  can also be provided for a FDD serving cell.Note 2: Void |

When it is not the first transmission in a DRX cycle or there is no DRX cycle, and when it is the transmission for PUCCH, PUSCH and SRS transmission, the UE shall be capable of changing the transmission timing according to the received downlink frame of the reference cell except when the timing advance in clause 7.3 is applied.

Table 7.1.2-3: void

If the UE uses a reference cell on a carrier frequency subject to CCA for deriving the UE transmit timing, then the UE shall meet all the transmit timing requirements defined in clause 7.1.2 provided that the reference cell is available at the UE. If the reference cell is not available at the UE on a carrier frequency subject to CCA, then the UE is allowed to transmit in the uplink provided that the UE meets all the transmit timing requirements defined in clause 7.1.2; otherwise the UE shall not transmit any uplink signal.

If a reference cell on a carrier frequency belonging to the PTAG, which is subject to CCA, is not available at the UE then the UE is allowed to use any of available activated SCell(s) at the UE in PTAG as a new reference cell. If the SCell used as reference cell is deactivated, or becomes not available, the UE is allowed to use another active serving cell in PTAG as new reference cell.

If a reference cell on a carrier frequency belonging to the STAG, which is subject to CCA is not available at the UE then the UE is allowed to use any of available activated SCell(s) at the UE in STAG as a new reference cell.

#### 7.1.2.1 Gradual timing adjustment

Requirements in this section shall apply regardless of whether the reference cell is on a carrier frequency subject to CCA or not.

When the transmission timing error between the UE and the reference timing exceeds ±Te then the UE is required to adjust its timing to within ±Te. The reference timing shall be  before the downlink timing of the reference cell. All adjustments made to the UE uplink timing shall follow these rules:

1) The maximum amount of the magnitude of the timing change in one adjustment shall be Tq.

2) The minimum aggregate adjustment rate shall be Tp per second.

3) The maximum aggregate adjustment rate shall be Tq per 200 ms for SCS of UL signals smaller or equal to 120 kHz and 100 ms for SCS of upling signals larger or equal to 480 kHz.

 where the maximum autonomous time adjustment step Tq and the aggregate adjustment rate Tp are specified in Table 7.1.2.1-1.

For multi-DCI based multi-TRP operation with two TAs, gradual timing adjustment specified in this clause applies for each TAG and shall be met for each TAG. The reference timing described in this clause for each TAG is the the first detected path (in time) of the corresponding downlink reference signal associated with *UL-TCIState* or *DLorJointTCIState (if unifiedTCI-StateType is indicated as Joint)* [TS 38.331].

Table 7.1.2.1-1: Tq Maximum Autonomous Time Adjustment Step and Tp Minimum Aggregate Adjustment rate

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of uplink signals (kHz) | Tq | Tp  |
| 1 | 15 | 5.5\*64\*Tc | 5.5\*64\*Tc |
|  | 30 | 5.5\*64\*Tc | 5.5\*64\*Tc |
|  | 60 | 5.5\*64\*Tc | 5.5\*64\*Tc |
| 2-1 | 60 | K\*64\*Tc | 2.5\*64\*Tc |
|  | 120 | K\*64\*Tc | 2.5\*64\*Tc |
| 2-2 | 120 | 2.5\*64\*Tc | 2.5\*64\*Tc |
|  | 480 | 0.8\*64\*Tc | 0.8\*64\*Tc |
|  | 960 | 0.8\*64\*Tc | 0.8\*64\*Tc |
| NOTE 1: Tc is the basic timing unit defined in TS 38.211 [6]NOTE 2: When *highSpeedMeasFlagFR2-r17* is configured for UE supporting power class 6, K = 4.5; otherwise, K = 2.5. |

## =====End of change 3=====

## =====Start of change 4=====

### 7.5.1 Introduction

A UE shall be capable of handling a relative transmission timing difference between subframe timing boundary of E-UTRA PCell and the closest slot timing boundary of PSCell to be aggregated for EN-DC operation.

A UE shall be capable of handling a relative transmission timing difference among the closest slot timing boundaries of different carriers in FR1 and/or FR2-1 to be aggregated in NR carrier aggregation.

A UE shall be capable of handling a relative transmission timing difference among the closest subframe timing boundaries of different carriers to be aggregated in FR1 and FR2-2 NR inter-band carrier aggregation.

A UE shall be capable of handling a relative transmission timing difference between slot timing boundary of PCell and subframe timing boundary of E-UTRA PSCell to be aggregated for NE-DC operation.

A UE shall be capable of handling a relative transmission timing difference between slot timing boundaries of PCell in FR1 or FR2-1 and the closest slot timing boundary of PSCell in FR1 or FR2-1 to be aggregated in NR DC operation.

A UE shall be capable of handling a relative transmission timing difference between subframe timing boundaries of PCell in FR1 and the closest subframe timing boundary of PSCell in FR2-2 to be aggregated in NR DC operation.

A UE supporting [*FG 40-2-1 or FG 40-2-2*] shall be capable of handling a relative transmission timing difference between the closest slot timing boundaries of signals on the same CC transmitted to two TRPs.

### 7.5.x Minimum Requirements for multi-TRP

A UE supporting [*FG 40-2-1 or FG 40-2-2*] shall be capable of handling at least a relative transmission timing difference between slot timing of a pair of TAGs configured on the same carrier as shown in Tables 7.5.x-1.

A UE supporting [*FG 40-2-1 or FG 40-2-2*] shall be capable of handling at least a relative transmission timing difference between slot timing of the pair of TAGs configured on the same carrier as shown in Table 7.5.x-2, provided that the UE indicates that it is capable of [*FG 40-2-6*].

Table 7.5.x-1: Maximum uplink transmission timing difference requirement for multi-TRP for UE not supporting [*FG 40-2-6*]

|  |  |
| --- | --- |
| Frequency Range of the pair of TAGs | Maximum uplink transmission timing difference (µs)  |
| FR1 | CP lengthnote 1+1.6us |
| FR2-1 | CP lengthnote 1+0.5us |
| Note 1: CP length of the maximum SCS on the carrier.Note 2: This requirement applies to the UE capable of [STxMP]. |

Table 7.5.x-2: Maximum uplink transmission timing difference requirement for multi-TRP for UE supporting [*FG 40-2-6*]

|  |  |
| --- | --- |
| Frequency Range of the pair of TAGs | Maximum uplink transmission timing difference (µs)  |
| FR1 | 34.6 |
| FR2-1 | 8.5 |

## =====End of change 4=====

## =====Start of change 5=====

## 9.13 L1-RSRP measurements for a cell with different PCI from serving cell

### 9.13.1 Introduction

When configured by the network, the UE shall be able to perform L1-RSRP measurements of configured measurement resources from a cell with different PCI in addition to serving cell (PCI indicated in *additionalPCI-r17*), with the measurement resources configured as SSBs of the cell with different PCI.

The UE shall be able to measure all SSB resources of the cell with different PCI in *csi-SSB-ResourceSet* within the CSI-Resource*Config* settings for the active BWP, while the *additionalPCI-r17* of the SSB resources are different from serving cell PCI. The number of resources, including the number of resources configured for serving cell L1-RSRP measurement in 9.5, does not exceed the UE capability indicated by *beamManagementSSB-CSI-RS*.

The UE shall report the measurement quantity (*reportQuantity*) and send periodic, semi-persistent or aperiodic reports, according to the higher layer parameter *reportConfigType* of each reporting setting *CSI-ReportConfig* for the active BWP.

The measurement reporting delay can be longer for the measurement reporting requirements in this clause when IDC autonomous denial is configured.

### 9.13.2 Requirements Applicability

The requirements in the clause 9.13 are applicable to inter-cell beam management and inter-cell multi-TRP scenarios.

The requirements in clause 9.13 apply, provided the SSB from cell with PCI different from serving cell configured for L1-RSRP if the following conditions are met:

- the number of cells with PCI different from seving cells Nmax = 1 for FR2 and Nmax = maxNrofAdditionalPCI for FR1. Where, maxNrofAdditionalPCI is defined in TS 38.331 [2].

- The SSB from the cell with different PCI completely contained in the active BWP or associated with initial downlink BWP of the UE

- The SSB of the cell with different PCI from serving cell has the same SCS, SFN offset and center frequency as the SSB of the serving cell

- For a UE supports [two TAs and RTD>CP capability], the requirements apply when RX timing difference is up to MRTD as specified in clause [7.6.X]

- For a UE which does not support [two TAs and RTD>CP capability], the requirements apply when RX timing difference is less than CP

- The cell with different PCI from serving cell is known

- The SSB resources configured for L1-RSRP measurements are measurable

An SSB resource configured for L1-RSRP for cell with different PCI from serving cell shall be considered measurable when for each relevant SSB the following conditions are met:

- L1-RSRP related side conditions given in clauses 10.1.19.1 and 10.1.20.1 for FR1 and FR2, respectively, for a corresponding band,

- SSB\_RP and SSB Ês/Iot according to Annex B.2.4.1 for a corresponding band.

The cell with different PCI from serving cell is considered as known if the following conditions are met in this requirement:

- The UE has sent a valid L3 measurement report during the last 5 seconds, and

- The SSB from the cell with different PCI remains detectable according to the cell identification requirements specified in clause 9.2.

Otherwise, the cell is unknown.

In case the SSB resources configured for L1-RSRP measurements outside SMTCs are overlapped with PDSCH/PDCCH that is associated to serving cell, L1-RSRP measurement performance degradation is expected.

## =====End of change 5=====

## =====Start of change 6=====

## 8.X1 Active downlink TCI state switching delay for unified TCI for single-DCI mTRP

### 8.X1.1 Introduction

The requirements in this clause apply for a UE configured with *DLorJoint-TCIState* configurations for DL channels on a serving cell and UE reports its capability of S-DCI based MTRP. Further the requirements also apply for all the list of serving cells in *simultaneousU-TCI-UpdateList1, simultaneousU-TCI-UpdateList2, simultaneousU-TCI-UpdateList3, simultaneousU-TCI-UpdateList4* in MR-DC or standalone NR provided all serving cells in the list are configured with the same serving cell and BWP in *unifiedTCI-StateRef-r17*. UE shall complete the switch of active downlink TCI state within the delay defined in this clause.

8.X1.2 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 the serving cell PCI.

Otherwise, the downlink TCI state is unknown.

8.X1.3 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 of joint TCI state switch, if the target PL-RS is not maintained, UE is not expected to receive on DL based on the target TCI state before UE completes the DL and UL TCI state switch.

When a MAC CE for DL TCI state switch indicates single TCI state switch, requirements specified in clause 8.15.3 apply.

When a MAC CE for DL TCI state switch indicates dual TCI state switch,

- If both the target TCI states are 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 + + max{TOk1\*(Tfirst-SSB1 + AD1\*TSSB1 + TSSB-proc), TOk2\*(Tfirst-SSB2 + AD2\*TSSB2 + 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 + where THARQ (in slot) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3];

- Tfirst-SSB1 is time to first SSB transmission of first TCI states of the pair of TCI states after MAC CE command is decoded by the UE; The SSB shall be the QCL-TypeA or QCL-TypeC to target TCI state; Tfirst-SSB2 is time to first SSB transmission of second TCI states of the pair of TCI states 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;

- TOk1 = 1 if first target TCI state is not in the active TCI state list for PDSCH/PDCCH, 0 otherwise.

- TOk2 = 1 if second target TCI state is not in the active TCI state list for PDSCH/PDCCH, 0 otherwise.

- AD1 = 1 if SSBs are adjacent in FR2 and TSSB1 =TSSB2 ; 0 otherwise

- AD2 = 1 if SSBs are adjacent in FR2 and TSSB2 = TSSB1 ; 0 otherwise

Among the dual target TCI states indicated for switch, if the one of 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 THARQ + + TL1-RSRP1 + max {TOuk1\*(Tfirst-SSB1+ AD1\*TSSB1 + TSSB-proc), TOk2\*(Tfirst-SSB2 + 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 + .

* AD1 = 1 if SSBs are adjacent in FR2; 0 otherwise

If the both of the dual target TCI state are 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 + + max{TL1-RSRP1 +TOuk1\*(Tfirst-SSB1+ TSSB-proc), TOk2\*(Tfirst-SSB2+ 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 + .

Where

- T L1-RSRP1 = 0 for the first TCI state and T L1-RSRP2 = 0 for the second TCI state in FR1 or when the TCI state switching not involving QCL-TypeD in FR2. Otherwise,

- T L1-RSRP1 for the first TCI state and T L1-RSRP2 for the second TCI state are 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

- TOuk1 for the first TCI state and TOuk2 for the second TCI state TOuk1 = 1 and TOuk2 = 1 for CSI-RS based L1-RSRP measurement, and 0 for SSB based L1-RSRP measurement when TCI state switching involves QCL-TypeD

- TOuk1 = 1 and TOuk2 = 1when TCI state switching involves other QCL types only

- Tfirst-SSB1 is time to first SSB transmission of first TCI states of the pair of TCI states after L1-RSRP measurement when TCI state switching involves QCL-TypeD; Tfirst-SSB2 is time to second SSB transmission of first TCI states of the pair of TCI states after L1-RSRP measurement when TCI state switching involves QCL-TypeD;

- Tfirst-SSB1 is time to first SSB transmission of first TCI states of the pair of TCI states after MAC CE command is decoded by the UE for other QCL types; Tfirst-SSB2 is time to second SSB transmission of first TCI states of the pair of TCI states 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

*Editor Note: for FR2* both of the dual target TCI state are unknown *when SSB are adjacent, Longer delay is expected or one SSB period extension is needed.*

### 8.X1.4 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 two TCI-States or TCI state pair in the active TCI list for a CC, the UE transmits a PUCCH with HARQ-ACK information corresponding to the DCI carrying the TCI-State indication. Requirements in clause 8.15.4 apply.

### 8.X1.5 Active Downlink TCI state list update delay

The requirements specified in this clause are applicable if

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, 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-r17*’ is set to ‘*joint*’, and a MAC CE activates more than one target joint TCI.

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

 n + THARQ + + TOk\*(Tfirst-SSB\_List + TSSB-proc) / *NR slot length*.

If a subset of the target TCI states in the active TCI state list are unknown, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to receive UE-dedicated PDCCH or PDSCH with the new target TCI states at the first slot that is after

 n+ THARQ + + (TL1-RSRP\_list +TOuk\*(Tfirst-SSB\_List+ TSSB-proc)) / *NR slot length*.

If all target TCI states in the active TCI state list are unknown, the requirements specified in this clause are not applicable.

Where

- TL1-RSRP\_List is the longest L1 measurement time (TL1-RSRP) of the source RS among the unknown target TCI states, where TL1-RSRP is specified in clause 8.X1.3

- Tfirst-SSB\_List is the Tfirst-SSB from serving cell

- THARQ, Tfirst-SSB, TSSB-proc , TOk, TOuk are defined in clause 8.X1.3. TSSB is the SSB periodicity.

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

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*joint*’, or

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, 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 based on the target TCI state before UE completes the DL and UL TCI state list update.

## =====End of change 6=====

## =====Start of change 7=====

## 8.X2 Active downlink TCI state switching delay for unified TCI for multi-DCI mTRP

### 8.X2.1 Introduction

The requirements in this clause apply for a UE configured with two different values of *CORESETPoolIndex* in ControlResourceSet with *DLorJoint-TCIState* configurations for DL channels on a serving cell. Further the requirements also apply for all the list of serving cells in *simultaneousU-TCI-UpdateList1, simultaneousU-TCI-UpdateList2, simultaneousU-TCI-UpdateList3, simultaneousU-TCI-UpdateList4* in MR-DC or standalone NR provided all serving cells in the list are configured with the same serving cell and BWP in *unifiedTCI-StateRef-r17*. UE shall complete the switch of active downlink TCI state within the delay defined in this clause. The requirements apply when UE is not expected to receive simultaneously from two different QCL-D sources in FR2. The requirements are applicable to each TRP independently.

When the target DL TCI state refers to an additional PCI different from the serving cell PCI in which this DL TCI-State is configured, the requirements in this clause are applicable provided that following conditions are met:

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

- Center frequency, SCS and SFN offset of a cell with the additional PCI are as the same as serving cell - The cell with the additional PCI is known to the UE.

A cell with the additional PCI is known if the following conditions are met:

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

- Timing offset between serving cell and the cell with the additional PCI is within CP of the corresponding SCS, except when UE supports RTD>CP with 2 TAs

Otherwise, the cell with the additional PCI is unknown.

8.X2.2 Known conditions for downlink TCI state

The downlink TCI state is known if the conditions in section 8.15.2 are met.

8.X2.3 MAC-CE based downlink TCI state switch delay

If the MAC-CE from two TRPs indicating TCI state switch are not overlapped, requirements specified in clause 8.15.3 are applicable for each target TCI state switch.

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 of joint TCI state switch, if the target PL-RS is not maintained, UE is not expected to receive on DL based on the target TCI state before UE completes the DL and UL TCI state switch.

If the target TCI state is known,

- If the UE is not configured with 2 TAs, 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 + + TOk\*(Tfirst-SSB + TSSB-proc+ OL\*TSSB) / *NR slot length*.

- If the UE is configured with 2 TAs in FR1 or configured with 2 TAs in FR2 and doesn’t support RTD>CP, 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 + + TOk\*(Tfirst-SSB + TSSB-proc+ OL\*TSSB) / *NR slot length*.

- The UE shall be able to receive UE-dedicated PDCCH/PDSCH with the old TCI state until slot n+ THARQ + where THARQ (in slot) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3];

- Tfirst-SSB is the time to the 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  = 0 if the target TCI state have QCL relationship with a RS of a TCI state in the active list of TCI states or if the target TCI state is in the active list of TCI states, otherwise TOk = 1;

- OL =1 if SSB overlaps or adjacent to SSB from other TRP in FR2 and SSB periodicity is less than that of other TRP, 0 otherwise

If the target TCI state is unknown,

* If the UE is not configured with 2 TAs, 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 + + (TL1-RSRP +TOuk\*(Tfirst-SSB+ TSSB-proc+ OL\*TSSB)) / *NR slot length*.
* If the UE is configured with 2 TAs in FR1 or configured with 2 TAs in FR2 and doesn’t support RTD>CP, 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 + + (TL1-RSRP +TOuk\*(Tfirst-SSB+ TSSB-proc+ OL\*TSSB)) / *NR slot length*.
* The UE shall be able to receive UE-dedicated PDCCH/PDSCH with the old TCI state until slot n+ THARQ + .

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, when receive timing difference is within CP,

- 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, when receive timing difference is within CP

- 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

*Editor’s note: FFS the L1-RSRP measurement requirement when RTD>CP.*

- 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.X2.4 DCI based downlink TCI state switch delay

For DCI based downlink TCI state switch delay in m-DCI mode of operation, the requirements in section 8.15.4 apply to TCI state associated with each *CORESETpoolIndex*.

### 8.X2.5 Active Downlink TCI state list update delay

The requirements specified in this clause are applicable if

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, 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-r17*’ is set to ‘*joint*’, and a MAC CE activates more than one target joint TCI.

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

 n + THARQ + + TOk\*(Tfirst-SSB\_List + TSSB-proc) / *NR slot length*.

If a subset of the target TCI states in the active TCI state list are unknown, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to receive UE-dedicated PDCCH or PDSCH with the new target TCI states at the first slot that is after

 n+ THARQ + + (TL1-RSRP\_list +TOuk\*(Tfirst-SSB + TSSB-proc)) / *NR slot length*.

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

 n+ THARQ + + (TL1-RSRP\_list +TOuk\*(Tfirst-SSB + TSSB-proc)) / *NR slot length*.

*Editor’s note: FFS how to take into account overlapping MAC-CE based switches from two TRPs where the SSB associated to each TCI state is overlapping or adjacent to each other.*

Where

- TL1-RSRP\_List is the longest L1 measurement time (TL1-RSRP) of the source RS among the unknown target TCI states, where TL1-RSRP is specified in clause 8.X2.3

*Editor’s note: FFS the L1-RSRP measurement requirement when RTD>CP.*

- THARQ, Tfirst-SSB, TSSB-proc, TOk, TOuk are defined in clause 8.X2.3. TSSB is the SSB periodicity.

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

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*joint*’, or

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, 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 based on the target TCI state before UE completes the DL and UL TCI state list update.

## =====End of change 7=====

## =====Start of change 8=====

## 8.X3 Active uplink TCI state switching delay for unified TCI for single-DCI mTRP

### 8.X3.1 Introduction

The requirements in this clause apply for a UE configured with *DLorJoint-TCIState* (if unifiedTCI-StateType is indicated as *Joint*) or *UL-TCIState* configurations for UL channels/signals on a serving cell. Further the requirements also apply for all the list of serving cells in *simultaneousU-TCI-UpdateList1, simultaneousU-TCI-UpdateList2, simultaneousU-TCI-UpdateList3, simultaneousU-TCI-UpdateList4* in MR-DC or standalone NR. There is no requirement when the UE is requested to switch to a TCI state with the higher layer parameter *UL-TCIState* associated to SRS. UE shall complete the switch of active uplink TCI state within the delay defined in this clause when the UE is requested to switch to a TCI state with the higher layer parameter *DLorJointTCIState* or *UL-TCIState* associated to a DL RS.

PL-RS may be associated with or included in UL TCI state or joint TCI state. The requirements in this clause shall apply if the following conditions are met:

- PL-RS is identical to source RS in UL TCI state or joint TCI state

- PL-RS and source RS in UL TCI state or joint TCI state are QCL-Type D

8.X3.2 Known conditions for uplink TCI state

The uplink 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 uplink TCI state to the completion of active uplink TCI state switch, where the RS resource for L1-RSRP measurement is the RS in target uplink TCI state or QCLed to the target uplink TCI state

- Uplink 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 uplink TCI state before the uplink TCI state switch command

- The RS configured in target uplink TCI state remains detectable during the uplink TCI state switching period

- SNR of the RS configured in target uplink TCI state ≥ -3dB

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

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

- SNR of the uplink TCI state ≥ -3dB

Otherwise, the uplink TCI state is unknown.

8.X3.3 MAC-CE based uplink TCI state switch delay

The requirements in this clause shall apply for UL TCI state switch using separate UL TCI state or joint TCI state of unified TCI state switch framework and having two indicated TCI-States.

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

For separate UL TCI state switch or joint TCI state switch for PUCCH or PUSCH, or semi-persistent/aperiodic/periodic SRS, when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1, upon receiving PDSCH carrying MAC-CE activation command in slot n on serving cell,

If both target TCI states are known,

- The UE shall be able to transmit uplink signal with the target TCI state(s) in the slot n+THARQ + + max{NM1\* (Tfirst\_target-PL-RS1 + 4\*Ttarget\_PL-RS1 + 2ms), NM2\* (Tfirst\_target-PL-RS2 + 4\*Ttarget\_PL-RS 2+ 2ms) }/ *NR slot length*.

If both target TCI states are unknown,

- The UE shall be able to transmit uplink signal with the target TCI state(s) in the slot n+THARQ + *+* max{TL1-RSRP1 + Tfirst\_target-PL-RS1 + 4\*Ttarget\_PL-RS1 + 2ms, TL1-RSRP2 + Tfirst\_target-PL-RS2 + 4\*Ttarget\_PL-RS 2+ 2ms }/ *NR slot length*.

If one of the target TCI states is unknown and the other TCI state is known,

- The UE shall be able to transmit uplink signal with the target TCI state(s) in the slot n+THARQ + + max{ TL1-RSRP1 + Tfirst\_target-PL-RS1 + 4\*Ttarget\_PL-RS1 + 2ms, NM2\* (Tfirst\_target-PL-RS2 + 4\*Ttarget\_PL-RS 2+ 2ms) }/ *NR slot length*.

Where,

- THARQ (in slot) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3].

- NM1 = 1, if the target PL-RS of the first TCI state is not maintained by the UE, 0 otherwise.

- NM2 = 1, if the target PL-RS of the second first TCI is not maintained by the UE, 0 otherwise.

In FR2, in case that the target PL-RS associated with or included in the target UL or joint TCI state is SSB, the requirements in this clause shall apply when this target PL-RS is maintained by the UE.

- PL-RS is maintained provided:

- the target PL-RS is associated with or included in the UL or joint TCI states in the active TCI list for PUSCH/PUCCH/SRS transmissions

- There are no more than 4 different RS activated as PL-RS per serving cell among all active UL TCI states (UL or joint TCI state) for PUSCH/PUCCH/SRS transmissions

- The target pathloss reference signal remains detectable during TCI state switching period

- SNR of the target pathloss reference signal≥-3dB

- The associated SSBs with the target pathloss reference signal remain detectable during the TCI state switching period.

- SNR of the associated SSB ≥-3dB

- Tfirst\_target-PL-RS1 is time to first pathloss RS transmission of the first TCI state after L1-RSRP measurement when first target TCI state is unknown.

- Tfirst\_target-PL-RS2 is time to first pathloss RS transmission of the second TCI state after L1-RSRP measurement when second target TCI state is unknown.

- Tfirst\_target-PL-RS1 is time to first pathloss RS transmission of the first TCI state after MAC CE command is decoded by the UE when the first target TCI state is known.

- Tfirst\_target-PL-RS2 is time to first pathloss RS transmission of the second TCI state after MAC CE command is decoded by the UE when the first seond TCI state is known.

- Ttarget\_PL-RS1 is the periodicity of the target pathloss reference signal of the first TCI state which would SSB or NZP CSI-RS when PL-RS is associated with serving cell.

- Ttarget\_PL-RS2 is the periodicity of the target pathloss reference signal of the second TCI state which would SSB or NZP CSI-RS when PL-RS is associated with serving cell.

- T L1-RSRP1 and T L1-RSRP2 are the time for Rx beam refinement in FR2 for the first and second TCI state, 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

The requirements specified in this clause are applicable if no more than 4 different RSs are activated as PL-RS per serving cell among all active UL (or joint) TCI states.

### 8.X3.4 DCI based uplink TCI state switch delay

When a UE is configured with the higher layer parameter with *DLorJointTCIState* or *UL-TCIState,* activated with TCI states for uplink 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 two TCI-States in the active TCI list for a CC, the UE transmits a PUCCH with HARQ-ACK information corresponding to the DCI carrying the TCI-State indication. Requirements in 8.16.4 apply.

### 8.X3.5 Active uplink TCI state list update delay

The requirements specified in this clause are applicable if

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, 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-r17*’ is set to ‘*joint*’, and a MAC CE activates more than one target joint TCI.

If all the target TCI states in the active TCI state list are known, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to be able to transmit PUCCH, PUSCH or SRS with the new target TCI states at the first slot that is after

 n + THARQ + + NM \* (Tfirst\_target-PL-RS + 4 \* Ttarget\_PL-RS + 2ms) / *NR slot length*.

If a subset of the target TCI states in the active TCI state list are unknown, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to transmit PUCCH, PUSCH or SRS with the new target TCI states at the first slot that is after

 n+THARQ + *+* (TL1-RSRP\_List+ Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS+ 2ms) / *NR slot length*.

If all target TCI states in the active TCI state list are unknown, the requirements specified in this clause are not applicable.

Where

- TL1-RSRP\_List is the longest L1 measurement time (TL1-RSRP) of the source RS among the unknown target TCI states, where TL1-RSRP is specified in clause 8.X3.2

- THARQ, Tfirst\_target-PL-RS, Ttarget-PL-RS are defined in clause 8.X3.3.

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

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*joint*’, or

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, while the target TCI list comprises at least one DL TCIs and at least one UL TCIs,

UE is not expected to transmit on UL based on the target TCI before UE completes the DL and UL TCI list update.

The requirements in this clause are applicable when the source RS of the active UL TCI state is a DL-RS and this DL-RS is included as one of the source RSs in the DL active TCI list.

## =====End of change 8=====

## =====Start of change 9=====

## 8.X4 Active uplink TCI state switching delay for unified TCI for multi-DCI mTRP

### 8.X4.1 Introduction

The requirements in this clause apply for a UE configured with *DLorJoint-TCIState* (if unifiedTCI-StateType is indicated as *Joint*) or *UL-TCIState* configurations for UL channels/signals on a serving cell and when UE is configured two different values of *CORESETPoolIndex* in ControlResourceSet. Further the requirements also apply for all the list of serving cells in *simultaneousU-TCI-UpdateList1, simultaneousU-TCI-UpdateList2, simultaneousU-TCI-UpdateList3, simultaneousU-TCI-UpdateList4* in MR-DC or standalone NR provided all serving cells in the list are configured with the same serving cell and BWP in *unifiedTCI-StateRef-r17*. There is no requirement when the UE is requested to switch to a TCI state with the higher layer parameter *UL-TCIState* associated to SRS. UE shall complete the switch of active uplink TCI state within the delay defined in this clause when the UE is requested to switch to a TCI state with the higher layer parameter *DLorJointTCIState* or *UL-TCIState* associated to a DL RS. The requirements apply when UE is not expected to receive simultaneously with multi-RX in FR2. The requirements are applicable to each TRP independently.

PL-RS may be associated with or included in UL TCI state or joint TCI state. The requirements in this clause shall apply if either of the following conditions are met:

- PL-RS is identical to source RS in UL TCI state or joint TCI state

- PL-RS and source RS in UL TCI state or joint TCI state are QCL-Type D

When the target UL TCI state refers to an additional PCI different from serving cell PCI in which this UL TCI state is configured, the requirements in this clause are applicable provided that the following conditions are met:

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

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

- The cell with the additional PCI is known to the UE.

A cell with the additional PCI is known if the following conditions are met:

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

- Timing offset between serving cell and the cell with the additional PCI is within CP of the corresponding SCS, except when UE supports RTD>CP with 2 TAs

- The SSB from the cell with the additional PCI remains detectable according to the cell identification requirements specified in clause 9.2

Otherwise, the cell with the additional PCI is unknown.

8.X4.2 Known conditions for uplink TCI state

The uplink TCI state is known if the conditions in section 8.16.2 are met.

8.X4.3 MAC-CE based uplink TCI state switch delay

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

In case that source RS in UL 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.X4.1. 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 transmit on UL based on the target TCI state before UE completes the DL and UL TCI state switch.

For separate UL TCI state switch or joint TCI state switch for PUCCH or PUSCH, or semi-persistent/aperiodic/periodic SRS, when *beamCorrespondenceWithoutUL-BeamSweeping* is set to 1, upon receiving PDSCH carrying MAC-CE activation command in slot n on serving cell,

- If target TCI state is known,

- If UE is not configured with 2 TAs, the UE shall be able to transmit uplink signal with the target TCI state in the slot n+THARQ + + NM*\** (Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms) / *NR slot length*.

- If UE is configured with 2 TAs in FR1 or configured with 2TAs in FR2 and doesn’t support RTD>CP, the UE shall be able to transmit uplink signal with the target TCI state in the slot n+THARQ + + NM*\** (Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms) / *NR slot length*.

 *FFS on additional time tracking of DL Ref RS for 2TA* TOk-ref \*(Tfirst-SSB-DLRef + 2ms)

- If target TCI state is unknown,

- If UE is not configured with 2 TAs, the UE shall be able to transmit uplink signal with the target TCI state in the slot n+THARQ + *+* (TL1-RSRP+ Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms) / *NR slot length*.

- If UE is configured with 2 TAs in FR1 or configured with 2TAs in FR2 and doesn’t support RTD>CP, the UE shall be able to transmit uplink signal with the target TCI state in the slot n+THARQ + *+* (TL1-RSRP+ Tfirst\_target-PL-RS + 4\*Ttarget\_PL-RS + 2ms) / *NR slot length*.

- The UE shall be able to transmit with the old UL TCI state until slot n+ THARQ + .

 *FFS on additional time tracking of DL Ref RS for 2TA* TOuk-ref (Tfirst-SSB-DLRef + 2ms)

Where,

- THARQ (in slot) is the timing between DL data transmission and acknowledgement as specified in TS 38.213 [3].

- NM = 1, if the target PL-RS is not maintained by the UE, 0 otherwise.

In FR2, in case that the target PL-RS associated with or included in the target UL or joint TCI state is SSB, the requirements in this clause shall apply when this target PL-RS is maintained by the UE.

- PL-RS is maintained provided:

- the target PL-RS is associated with or included in the UL or joint TCI states in the active TCI list for PUSCH/PUCCH/SRS transmissions

- There are no more than 4 different RS activated as PL-RS per serving cell among all active UL TCI states (UL or joint TCI state) for PUSCH/PUCCH/SRS transmissions

- The target pathloss reference signal remains detectable during TCI state switching period

- SNR of the target pathloss reference signal≥-3dB

- The associated SSBs with the target pathloss reference signal remain detectable during the TCI state switching period.

- SNR of the associated SSB ≥-3dB

- Tfirst\_target-PL-RS is time to first pathloss RS transmission after L1-RSRP measurement when target TCI state is unknown.

- Tfirst\_target-PL-RS is time to first pathloss RS transmission after MAC CE command is decoded by the UE for known TCI State.

- Ttarget\_PL-RS is the periodicity of the target pathloss reference signal which would be SSB or NZP CSI-RS when PL-RS is associated with serving cell

- Ttarget\_PL-RS is the periodicity of the target pathloss reference signal which would be SSB when PL-RS is associated with PCI different from serving cell

- 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 or 9.13.4.1,

- 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

- TOk-ref = 1, if the target TCI state is known, and the RS of DL timing reference is not in the active TCI state list for PDSCH/PDCCH, 0 otherwise.

- Tfirst-SSB-DLRef is the time to first SSB after MAC CE command is decoded when target TCI state is known.

- Tfirst-SSB-DLRef is the time to first SSB after L1-RSRP measurement when target TCI state is unknown.

- TOuk-ref = 1, for CSI-RS based L1-RSRP measurement, and 0 for SSB based L1-RSRP measurement

The requirements specified in this clause are applicable if no more than 4 different RSs are activated as PL-RS per serving cell among all active UL (or joint) TCI states.

### 8.X4.4 DCI based uplink TCI state switch delay

When a UE is configured with the higher layer parameter with *DLorJointTCIState* or *UL-TCIState,* activated with TCI states for uplink 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, the UE transmits a PUCCH with HARQ-ACK information corresponding to the DCI carrying the TCI-State indication.

The requirements in this clause are applicable only if the DCI format indicating UL TCI state or joint TCI state switch is received by UE when,

- target TCI state is known, and

- target TCI state is in active TCI state list, and

- target PL-RS is maintained as defined in clause 8.X4.3

If the target TCI state is known, the uplink TCI switching to the indicated UL 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.X4.2 is applied.

If a PL-RS is associated with or included in UL TCI state or joint TCI state, the UL TCI switching and PL-RS switching shall be completed at the same time.

8.X4.5 Active Uplink TCI state list update delay

The requirements specified in this clause are applicable if

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, and a MAC CE activates more than one target separate TCIs, and at least one UL TCI is included, or

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*joint*’, and a MAC CE activates more than one target joint TCI.

If all the target TCI states in the active TCI state list are known, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to transmit PUCCH, PUSCH or SRS with the new target TCI states at the first slot that is after

 n + THARQ + + NM \* (Tfirst\_target-PL-RS\_List + 4 \* Ttarget\_PL-RS\_List + 2ms) / *NR slot length*,

 *FFS on additional time tracking of DL Ref RS for 2TA*

If a subset of target TCI states in the active TCI state list are unknown, upon receiving PDSCH carrying MAC-CE active TCI state list update at slot n, UE shall be able to transmit PUCCH, PUSCH or SRS with the new target TCI states at the first slot that is after

 n+THARQ + *+* (TL1-RSRP\_List+ Tfirst\_target-PL-RS\_List + 4\*Ttarget\_PL-RS\_List + 2ms) / *NR slot length*

 *FFS on additional time tracking of DL Ref RS for 2TA*

If all target TCI states in the active TCI state list are unknown, the requirements specified in this clause are not applicable.

Where

- If all TCIs are known,

- if the target PL-RS associated with or included in any UL TCI is not maintained, NM = 1; Where maintained PL-RS is defined in clause 8.16.3

- if a subset of target TCI states in the active TCI state list are unknown,

- TL1-RSRP\_List = is the longest L1 measurement time (TL1-RSRP) of the source RS among the unknown target TCI states , where TL1-RSRP is specified in clause 8.16.3

- if the number of cells associated with the target TCI states in the active TCI list is 2, and time to first PL-RS associated to the TCIs are overlapped in FR2,

- Tfirst\_target-PL-RS\_List = Tfirst\_target-PL-RS\_SC + min(Ttarget-PL-RS\_SC , Ttarget-PL-RS\_CDP) ;

- Ttarget-PL-RS\_List = 2 \* Ttarget-PL-RS\_SC, if Ttarget-PL-RS\_SC = Ttarget-PL-RS\_CDP

- Ttarget-PL-RS\_List = max(Ttarget-PL-RS\_SC , Ttarget-PL-RS\_CDP), if Ttarget-PL-RS\_SC ≠ Ttarget-PL-RS\_CDP

- if the number of cells associated with the target TCI states in the active TCI list is 2, and time to first PL-RS associated to the TCIs are not overlapped in FR2,

- Tfirst\_target-PL-RS\_List = max (Tfirst\_target-PL-RS\_SC, Tfirst\_target-PL-RS\_SC);

- Ttarget-PL-RS\_List = max(Ttarget-PL-RS\_SC , Ttarget-PL-RS\_CDP)

- Otherwise,

- Tfirst\_target-PL-RS\_List = Tfirst\_target-PL-RS\_SC

- Ttarget-PL-RS\_List = Ttarget-PL-RS\_SC.

- Tfirst\_target-PL-RS\_SC is Tfirst\_target-PL-RS for serving cell

- Tfirst\_target-PL-RS\_CDP is Tfirst\_target-PL-RS for cell with different PCI from serving cell

- Ttarget-PL-RS\_SC is Ttarget-PL-RS for serving cell

- Ttarget-PL-RS\_CDP is Ttarget-PL-RS for cell with different PCI from serving cell- THARQ, Tfirst\_target-PL-RS, Ttarget-PL-RS are defined in clause 8.16.3.

The requirements specified in this clause do not apply if more than 4 different RSs are activated as PL-RS per serving cell among all active UL (or joint) TCI states.

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

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*joint*’, or

- higher layer configuration ‘*unifiedTCI-StateType-r17*’ is set to ‘*separate*’, while the target TCI list comprises at least one DL TCIs and at least one UL TCIs,

UE is not expected to transmit on UL based on the target TCI before UE completes the DL and UL TCI list update.

The requirements in this clause are applicable when the source RS of the active UL TCI state is a DL-RS and this DL-RS is included as one of the source RSs in the DL active TCI list.

## =====End of change 9=====