**3GPP TSG-RAN WG4 Meeting # 112 R4-2411803**

**Maastricht, Netherlands, 19th ‒ 23rd August, 2024**

**Agenda item:** 5.27.4

**Source:** Moderator (Samsung)

**Title:** Topic summary for [112][208] NR\_MIMO\_evo\_DL\_UL

**Document for:** Information

# Introduction

This topic summary covers the contributions submitted under the following AI for RRM maintenance of Rel-18 MIMO evolution for downlink and uplink:

* 5.27.1 RRM core requirements
* 5.27.2 RRM performance requirements

# Topic #1: RRM core requirements maintenance

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2411384 | Apple | **2TA with multi-DCI multi-TRP****Proposal #1: For multi-DCI multi-TRP with 2TA the timing requirements are applicable to PUCCH/PUSH/SRS and PDCCH ordered RACH for CFRA****Proposal #2: The reference point for PUCCH/PUSCH/SRS for each TAG is the first detected path in the reference cell associated with the activated DL or joint TCI state having the same TAG as the UL signal.****Proposal #3: RAN4 shall define the reference point for PDCCH order RACH for CFRA for inter-cell and intra-cell scenario.** **Observation #1: For multi-DCI multi-TRP operation with 2TA the UE has gradual timing adjust requirements applicable to each TAG.****Observation #2: For multi-DCI multi-TRP operation with 2TA the UE has MTTD requirements applicable to pair of TAGs.****Observation #3: While the UE is applying gradual timing adjustment for each TAG, the TTD for the pair of TAGs could exceed the MTTD requirement.****Observation #4: Similar issue with legacy gradual timing adjustment and MTTD for CA to be discussed once RAN4 concludes on this issue for mTRP requirements.****Proposal #4: For multi-DCI multi-TRP with 2TA the gradual timing adjustment is applied until the timing error for each TAG is within ±Te or the TTD between pair of TAGs doesn’t exceed the MTTD requirement for 2TAs.** **Multi-DCI mTRP****Observation #5: For 2TA case UE has 2 TAG and 2 DL reference timing associated with each TAG.****Observation #6: In case the UL TCI state has a DL timing reference associated with the TAG, then no additional time is needed for time tracking.****Observation #7: In case both DL and UL TCI state switch, and there is DL TCI state in the active TCI state list associated with the TAG, the following options are possible:****Option 1: Additional time for time tracking is needed for UL TCI state switch.****Option 2: No requirements are applicable for this case****Proposal #5: For multi-DCI multi-TRP with 2TA for separate UL TCI state switch, if no DL TCI is in the active TCI state list associated with the TAG of the target UL TCI state choose one of the 2 options -** **Option 1: Additional time for DL timing reference tracking is needed for the UL TCI state switch** **Option 2: No requirements are applicable for this case** |
| R4-2411707 | MediaTek Inc. | **Proposal 1: For mDCI mTRP, if UE supports two TAs, do not consider additional DL RS tracking time for UL TCI state switching delay requirement.****Proposal 2: The legacy measurement restriction of RLM/BFD/CBD is applicable to RTD>CP case in FR1. The legacy RLM, BFD and CBD requirements are not applicable to RTD>CP case in FR2.** |
| R4-2412034 | Nokia | **Proposal 1: For PRACH transmission for inter-cell multi-DCI based multi-TRP operation with two TAs,*** if “PRACH association indicator” is 0, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of active DL TCI state(s) of the reference cell associated with the first TAG, where is as defined in n-TimingAdvanceOffset.
* if “PRACH association indicator” is 1, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of active DL TCI state(s) of the reference cell associated with the second TAG, where is as defined in n-TimingAdvanceOffset2.

Proposal 2: For mDCI mTRP DL TCI state switching in FR2, clarify the last meeting RAN4#111 agreement including the RAN4#109 agreement as follows:* OL = 1, if the SSB overlaps or is adjacent to the SSB from the other TRP, and
	+ the SSB periodicity is less than that of other TRP, or
	+ the SSB periodicity is the same of that of the other TRP and the SSB is associated to the TRP with the lowest coresetPoolIndex.
* Otherwise, OL = 0.

**Proposal 3: Regarding mDCI mTRP UL TCI state switching requirements for UEs supporting two TAs, we support Option 2, i.e., no need to introduce an additional DL RS tracking time.** |
| R4-2412114 | Samsung | **Proposal 1:** **Confirm the association for inter-cell scenario for PRACH. RAN4 should specify the reference timing/point of PRACH transmission. The wording is in CR stage.****Proposal 2: For joint TCI state, the UE is not expected to transmit on UL based on the target TCI state before UE completes the DL and UL TCI state switch. The DL timing can always be achieved by DL TCI. No additional DL RS tracking time for UL TCI state switching.** **For separate UL TCI state switch:*** **If the DL beams are changed as well and DL TCI is not in the active list, the previous DL timing cannot be used. Additional DL RS tracking time for UL TCI state switching is needed as:**
	+ **Known case: THARQ + + TOk-ref (Tfirst-SSB-DLRef + OL\*T SSB-DLRef + 2ms)+NM\*( Tfirst-PL-RS + 4\*Ttarget\_PL-RS + 2ms)**
	+ **Unknown case: THARQ + + TL1-RSRP + TOuk-ref (Tfirst-SSB-DLRef + OL\*T SSB-DLRef + 2ms)+ Tfirst-PL-RS + 4\*Ttarget\_PL-RS + 2ms**
	+ **TOk-ref = 1 if there is no active DL TCI-State for DL timing reference associated with the same coresetPoolIndex**
* **For other cases, no additional DL tracking is needed.**
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| R4-2412199 | Huawei, HiSilicon | **Observation 1: UE can tell the TAG to which the TA command is applied by the tag2-flag and TI filed in the TA command. And there is no differentiation between intra-cell and inter-cell.****Observation 2: For PRACH and other transmission for inter-Cell, UE determines when configured with 2 Tas as follows:*** + **n-TimingAdvanceOffset applies to transmission toward serving cell PCI**
	+ **n-TimingAdvanceOffset2 applies to transmission toward serving cell with different PCI**

**Observation 3: Timing related issues for UE supporting two TA for intra-cell and inter-cell is shown in Table I based on RAN1/2 agreements and formal spec.****Proposal 1: Update the timing requirement for multi-TRP operation with two Tas as follows:**

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| For multi-DCI based multi-TRP operation with two TAs, for each TAG, the uplink transmission timing for PUCCH/PUSCH/SRS takes place before the reception of the first detected path (in time) of [one of] the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with a coresetPoolIndex having same TAG as the uplink signal, where is commanded by the network independently for each TAG [TS 38.331].For PRACH transmission for intra-cell multi-DCI based multi-TRP operation with Two TAs,* for PRACH transmission triggered by PDCCH order associated with coresetPoolIndex value 0,
	+ if “PRACH association indicator” is 0, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with a coresetPoolIndex with value 0.
	+ if “PRACH association indicator” is 1, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with a coresetPoolIndex with value 1.
* For PRACH transmission triggered by PDCCH order associated with coresetPoolIndex value 1,
	+ if “PRACH association indicator” is 0, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with a coresetPoolIndex with value 1.
	+ if “PRACH association indicator” is 1, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with a coresetPoolIndex with value 0.

For PRACH transmission for inter-cell multi-DCI based multi-TRP operation with Two TAs,* + if “PRACH association indicator” is 0, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with the first TAG, where is as defined in n-TimingAdvanceOffset.

if “PRACH association indicator” is 1, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with the second TAG, where is as defined in n-TimingAdvanceOffset2. |

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| R4-2413009 | Ericsson | **Proposal 1: For multi-DCI based multi-TRP operation with two TAs, For PUCCH/PUSCH/SRS, the reference point for each TAG is the first detected path (in time) of the corresponding downlink reference signal (s) of the reference cell associated with one of the DLorJointTCIState [TS 38.331] having the same TAG as the uplink signal.****Proposal 2: Reference point for intra-cell PRACH transmission triggered by PDCCH order, is the first detected path (in time) of one of the downlink reference signal(s) in the active DL or joint TCI state of the reference cell associated with the same coresetPoolIndex as PDCCH carrying PDCCH order if PRACH association indicator is 0, and that of the other coresetPoolIndex if PRACH association indicator is 1.****Proposal 3: For inter-cell multi-DCI based multi-TRP operation with two TAs, the reference point for PRACH transmission triggered by PDCCH order*** **if “PRACH association indicator” is 0, reference timing is the first detected path (in time) of one of the corresponding downlink reference signal(s) of [active] DL TCI state(s) of the reference cell associated with PCI of the serving cell.**
* **if “PRACH association indicator” is 1, reference timing is the first detected path (in time) of one of the corresponding downlink reference signal(s) of [active] DL TCI state(s) of the reference cell associated with the additional PCI.**

**Proposal 4: No additional DL RS tracking time for UL TCI state switching.**  |

## Open issues summary

### Sub-topic 1-1: Timing Requiements

**Issue 1-1-1-a: For PDCCH order RACH, define uplink timing and DL timings association in inter-cell case in RAN4 spec:**

* Proposals
	+ Proposal 1: Yes (Apple, Nokia, Samsung, Huawei, Ericsson)
	+ Proposal 1a:
		- For PRACH transmission for inter-cell multi-DCI based multi-TRP operation with Two TAs,
			* If “PRACH association indicator” is 0, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of [active] DL TCI state(s) of the reference cell associated with the first TAG, where is as defined in n-TimingAdvanceOffset.
			* if “PRACH association indicator” is 1, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of [active] DL TCI state(s) of the reference cell associated with the second TAG, where is as defined in n-TimingAdvanceOffset2.
* Recommended WF
	+ Discuss based on the CR R4-2413010. The differences in proposals are whether the DL TCI states(s) is active or not.

**Issue 1-1-1-b: Reference DL timing point for PUCCH/PUCCH/SRS**

* Proposals
	+ Proposal 1: Confirm the wording in CR R4-2413010 (Apple, Ericsson)
		- For multi-DCI based multi-TRP operation with two TAs, the reference point for PUCCH/PUSCH/SRS, is the first detected path (in time) of one of the corresponding downlink reference signal(s) of the reference cell associated with one of the [activated] *DLorJointTCIState* [TS 38.331] having the same TAG as the uplink signal.
	+ Proposal 2: (Huawei)
		- The first detected path (in time) of [one of] the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with a coresetPoolIndex having same TAG as the uplink signal, where is commanded by the network independently for each TAG.
* Recommended WF
	+ Discuss based on the CR R4-2413010. The differences in proposals are whether the DL TCI states(s) is active or not to remove the square bracket

**Issue 1-1-1-c: Reference DL timing point for PDCCH order RACH for CFRA in intra-cell case.**

Last meeting, the association in RAN1 LS is confirmed to be used.

* Proposals
	+ Proposal 1: Confirm the wording in CR R4-2413010 (Apple, Ericsson)
		- For intra-cell multi-DCI based multi-TRP operation with two TAs, the reference point for PRACH transmission triggered by PDCCH order, is the first detected path (in time) of one of the downlink reference signal(s) in the [active] DL or joint TCI state of the reference cell associated with the same coresetPoolIndex as PDCCH carrying PDCCH order if PRACH association indicator is 0, and that of the other coresetPoolIndex if PRACH association indicator is 1.
	+ Proposal 2: (Huawei)
		- For PRACH transmission for intra-cell multi-DCI based multi-TRP operation with Two TAs,
			* for PRACH transmission triggered by PDCCH order associated with coresetPoolIndex value 0,
				+ if “PRACH association indicator” is 0, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with a coresetPoolIndex with value 0.
				+ if “PRACH association indicator” is 1, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with a coresetPoolIndex with value 1.
			* For PRACH transmission triggered by PDCCH order associated with coresetPoolIndex value 1,
				+ if “PRACH association indicator” is 0, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with a coresetPoolIndex with value 1.
				+ if “PRACH association indicator” is 1, the uplink transmission timing for PRACH takes place before the reception of the first detected path (in time) of one of the corresponding downlink reference signal(s) of DL TCI state(s) of the reference cell associated with a coresetPoolIndex with value 0.
* Recommended WF
	+ Discuss based on the CR R4-2413010. The differences in proposals are whether the DL TCI states(s) is active or not to remove the square bracket. NTA = 0 for PRACH.

**Issue 1-1-2: Whether to add the condition to check MTTD before applying gradual timing adjustment?**

* Proposals
	+ Option 1: (Apple)
		- For multi-DCI multi-TRP with 2TA the gradual timing adjustment is applied until the timing error for each TAG is within ±Te or the TTD between pair of TAGs doesn’t exceed the MTTD requirement for 2TAs.
* Recommended WF
	+ Discuss option 1.

### Sub-topic 1-2: Other requiements

**Issue 1-2-1: For mDCI mTRP, whether to need additional DL RS tracking time for UL TCI state switching if UE supporting two TAs (RTD<CP and RTD>CP)?**

* Proposals
	+ Proposal 1: Yes (Apple, Samsung)
	+ Proposal 1a: (Apple)
		- For multi-DCI multi-TRP with 2TA for separate UL TCI state switch, if no DL TCI is in the active TCI state list associated with the TAG of the target UL TCI state choose one of the 2 options -
			* Additional time for DL timing reference tracking is needed for the UL TCI state switch
			* No requirements are applicable for this case
	+ Proposal 1b: (Samsung)
		- For joint TCI state, the UE is not expected to transmit on UL based on the target TCI state before UE completes the DL and UL TCI state switch. The DL timing can always be achieved by DL TCI. No additional DL RS tracking time for UL TCI state switching.
		- For separate UL TCI state switch:
			* If the DL beams are changed as well and DL TCI is not in the active list, the previous DL timing cannot be used. Additional DL RS tracking time for UL TCI state switching is needed as:
				+ Known case: THARQ + + TOk-ref (Tfirst-SSB-DLRef + OL\*T SSB-DLRef + 2ms)+NM\*( Tfirst-PL-RS + 4\*Ttarget\_PL-RS + 2ms)
				+ Unknown case: THARQ + + TL1-RSRP + TOuk-ref (Tfirst-SSB-DLRef + OL\*T SSB-DLRef + 2ms)+ Tfirst-PL-RS + 4\*Ttarget\_PL-RS + 2ms
				+ TOk-ref = 1 if there is no active DL TCI-State for DL timing reference associated with the same coresetPoolIndex
			* For other cases, no additional DL tracking is needed.
	+ Proposal 2: (MediaTek, Nokia, Ericsson)
		- No. Reuse the same requirements as Rel-17
* Recommended WF
	+ TBA

**Issue 1-2-2: Update RLM/BFD/CBD requirements for restriction when RTD is larger than CP**

* Proposals
	+ Proposal 1: (MediaTek)
		- Add the measurement restriction and applicability for RLM/BFD/CBD when RTD is larger than CP
* Recommended WF
	+ Discuss Proposal 1 and CR R4-2411708

**Issue 1-2-3: Further clarification for OL definition for mDCI mTRP scenario**

[Background]

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| *In RAN4#111 agreement:*OL = 1 if the SSB overlaps or is adjacent to the SSB from the other TRP in FR2 and the SSB is associated to the TRP with the lowest corestPoolIndex, 0, otherwise.*In RAN4#109 agreement:*SSB overlaps or adjacent to SSB from other TRP in FR2 and SSB periodicity is less than that of other TRP |

* Proposals
	+ Proposal 1: (Nokia)
		- Further clarify based on previous agreement:

OL = 1, if the SSB overlaps or is adjacent to the SSB from the other TRP, and

the SSB periodicity is less than that of other TRP, or

the SSB periodicity is the same of that of the other TRP and the SSB is associated to the TRP with the lowest coresetPoolIndex.

Otherwise, OL = 0.

* Recommended WF

*[Moderator view]: According to our understanding, it is aligned with previous agreements and the current spec cover both cases. No CR. Check with companies.*

### CRs

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2411385 | Apple | CR on gradual timing adjustment for 2TA |
| R4-2411386 | Apple | CR for eUTCI state switching requirements |
| R4-2411708 | MediaTek Inc. | CR on core maintenance for R18 MIMO |
| R4-2413010 | Ericsson, Qualcomm Incorporated, Apple, Nokia, Vivo | CR to TS 38.133 on UL Transmit timing for MIMO Evolution. |

# Topic #2: RRM performance requirements maintenance

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2412035 | Nokia | Update TDCP simulation results |
| R4-2413011 | Ericsson | Proposal 1:For TC4, reported TDCP index is larger than 6, with at least 80% probability |

## Open issues summary

### Sub-topic 2-1

[Background]: In last meeting, the WF is: for this case, Reported TDCP index is [equal to or] larger than 6, with at least 80% probability

**Issue 2-1-1: For high doppler condition (300Hz) + 30kHz SCS TDD, SNR = 10dB, TDCP test requirements in the test?**

* Proposals
	+ Option 1: (Ericsson)
		- Reported TDCP index is larger than 6, with at least 80% probability. Confirm to delete “equal to 6”
* Recommended WF
	+ To check whether option 1 is agreeable

### CRs

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2411387 | Apple | CR for correcting sDCI mTRP based test cases |
| R4-2412036 | Nokia | CR corrections of RRM performance requirements for NR MIMO Evo FR2 UE transmit timing |
| R4-2412037 | Nokia | CR corrections of RRM performance requirements for NR MIMO Evo sDCI mTRP FR2 separate UL TCI state switching |
| R4-2412409 | Samsung | CR on test cases of UE transmit timing from two TRPs in FR1 |
| R4-2413012 | Ericsson | CR to TS 38.133: TC for TDCP measurements |

Suggested issues to online discussion:

Issue 1-2-1

Issue 1-1-1-a

Issue 1-2-2

Issue 2-1-1