**3GPP TSG-RAN WG4 Meeting # 112 R4-2411798**

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

**Agenda item:** 5.13.4

**Source:** Moderator (vivo)

**Title:** Topic summary for [112][203] FR2\_multiRx

**Document for:** Information

# Introduction

This email discussion summary covers following agenda for FR2 multi-Rx chain DL reception WI.

5.13 Requirement for NR FR2 multi-Rx chain DL reception

5.13.1 RRM core requirements

5.13.2 RRM performance requirements

**Recommendation of issues for online discussion:**

For Topic #1:

Issue 1-1: Measurement restriction relaxation requirements

Issue 1-3: Scheduling restriction relaxation requirements

Issue 1-4: DCI based dual TCI state switch delay for m-DCI

Issue 1-5: DCI based dual TCI state switch delay for s-DCI

Issue 1-6: Condition of multi-Rx operation for fast beam sweeping

Issue 1-7: Applicability of requirements for multi-Rx operation

Issue 1-8: MRTD for multi-Rx

For Topic #2:

Issue 2-1: 3AoAs setup 6

Issue 2-3: Test setup for dual TCI state switching for m-DCI

# Topic #1: Core requirements maintenance

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2411400 | Apple | ***Observation 1: Neither the network behavior nor UE behavior after UAI indication to the network has been defined. Therefore, it is at least unclear if the requirement would apply to the case where the network configures GBBR to the UE and then the UE indicates via UAI that it prefers to fall back from multi-RX operation to single-RX operation.******Proposal 1: It is proposed to change in “3.6.19       Applicability of requirements for multi-Rx operation in FR2-1” from “The requirements related to the support of [reducedRxBeamNum] is applicable when the network configures the UE with a CSI report containing groupBasedBeamReporting-v1710.” To “The requirements related to the support of [reducedRxBeamNum] is applicable when the network has configured the UE with a CSI report containing groupBasedBeamReporting-v1710 and the UE has not sent UAI indicating its preference of single-RX operation since it was most recently configured with such CSI reporting.”******Proposal 2: Considering that SSB SCS (120/240kHz) and date SCS (60/120kHz) can be different, it is proposed that the MRTD is smaller than the CP length corresponding to MAX (SSB SCS, data SCS). It is recognized that it is more challenging to maintain MRTD < CP length of 240kHz SCS from network deployment perspective.******Proposal 3: For sDCI mTRP case, remove the following conditions for measurement restriction relaxation:*** * ***The two CSI-RS resources and both PDSCHs are overlapped on the same OFDM symbol***

***Proposal 4: For mDCI mTRP case, conditions that measurement restriction for CSI-RS based L1 measurements can be relaxed for multi-Rx are:**** ***Both CSI-RSs are not in any CSI-RS resource set with repetition ON***
* ***The two CSI-RS resources and both PDSCHs are overlapped on the same OFDM symbol.***
* ***One CSI-RS has same QCL source as the active TCI state of one PDSCH, and the other CSI-RS has same QCL source as the active TCI state of the other PDSCH***
* ***Resources of the active TCI states for the two PDSCHs have been reported as a resource group in Rel-17 group-based RSRP report.***
* ***UE is activated with multi-Rx operation***
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| R4-2411477 | OPPO | **Proposal 1: Update one of the conditions of multi-Rx operation as: Rel-17 group-based beam reporting (GBBR) is configured and activated by the network.****Proposal 2: Update one of the conditions of scheduling and measurement restriction relaxation as: the two CSI-RS resources are overlapped on the same OFDM symbol, where at least one of the PDSCHs is scheduled simultaneously.** |
| R4-2411630 | Xiaomi | **Proposal 1: Starting point of fast beam sweeping is that UE is configured with group-based beam reporting (GBBR) report and UE is activated with dual TCI states.****Proposal 2: Ending point of fast beam sweeping can be initiated by NW or UE.** |
| R4-2411780 | MediaTek inc. | **Observation 1: It will lead to unnecessary UE power consumption if UE is mandated to operate in multi-RX mode as long as UE is configured with group-based beam reporting (GBBR) report****Proposal 1: If UE recently reported ‘Not valid’ for one of the RSRP for a beam pair, this means UE is allow to fallback to single panel for the later reception QCL-ed to that beam pair****Proposal 2: Remove the following condition of measurement restriction relaxation for CSI-RS based L1 measurements.*** **[The two CSI-RS resources and both PDSCHs are overlapped on the same OFDM symbol].**
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| R4-2412027 | Nokia | **Observation 1:** When scheduling restrictions don’t apply, the expected beam sweeping factor is N=1 for L1 FR2 measurements.**Observation 2:** When the CSI-RS for L1-RSRP has same QCL source as the active TCI state of one PDSCH, and the other CSI-RS has same QCL source as the active TCI state of the other PDSCH, the UE is expected to use Rx beam pair optimized through GBBR-r17 for simultaneous reception without further beam sweeping.**Observation 3:** When measurement restrictions apply, RAN4 requirements state that longer delay is expected and no requirements apply.**Observation 4:** A condition of PDSCH scheduling for measurement restrictions would imply that requirements change for each measurement occasion depending on the scheduling.**Proposal 1: Measurement restrictions due to multi Rx operation are enhanced when the following condition is met: The CSI-RS for L1-RSRP has same QCL source as the active TCI state of one PDSCH, and the other CSI-RS has same QCL source as the active TCI state of the other PDSCH.****Proposal 2: For Issue 2-1-1, the UE can receive simultaneously TCI 1 and TCI 2 between points C and D if they have been reported as a beam pair using GBBR-17.** |
| R4-2412192 | Huawei, HiSilicon | **Observation 1: For sTRP, regarding tci-PresentInDCI is present or not, the Rx beam for PDSCH are determined as follows:*** **When tci-PresentInDCI is disabled:**
	+ **Offset less than timeDurationForQCL (T1 in the Figure)**
		- ***QCLed with the CORESET with lowest controlResourceSetId***
	+ **Offset equal or larger than timeDurationForQCL (T2 in the Figure)**
		- ***QCLed with the CORESET used for the PDCCH transmission***
* **When tci-PresentInDCI is enabled:**
	+ **Offset less than timeDurationForQCL (T1 in the Figure)**
		- ***QCLed with the CORESET with lowest controlResourceSetId***
	+ **Offset equal or larger than timeDurationForQCL (T2 in the Figure)**
		- ***QCLed with the RS in indicated TCI states***

**Observation 2: For mTRP sDCI , regarding enableTwoDefaultTCI-States is configured or not, the Rx beam for PDSCH are determined as follows:*** **When enableTwoDefaultTCI-States is configured:**
	+ **Offset less than timeDurationForQCL (T1 in the Figure)**
		- ***QCLed with the TCI states with lowest codepoints with two different TCI states***
	+ **Offset equal or larger than timeDurationForQCL (T2 in the Figure)**
		- ***QCLed with the RS in indicated TCI states***
* **When enableTwoDefaultTCI-States is not configured:**
	+ **Offset less than timeDurationForQCL (T1 in the Figure)**
		- ***QCLed with the CORESET with lowest controlResourceSetId***
	+ **Offset equal or larger than timeDurationForQCL (T2 in the Figure)**
		- ***QCLed with the RS in indicated TCI states***

**Observation 3: For mTRP, regarding tci-PresentInDCI is present or not, the Rx beam for PDSCH are determined as follows:*** **When tci-PresentInDCI is disabled:**
	+ **Offset less than timeDurationForQCL (T1 in the Figure)**
		- ***QCLed with the CORESET with lowest controlResourceSetId with the same value of coresetPoolIndex***
	+ **Offset equal or larger than timeDurationForQCL (T2 in the Figure)**
		- ***QCLed with the CORESET used for the PDCCH transmission***
* **When tci-PresentInDCI is enabled:**
	+ **Offset less than timeDurationForQCL (T1 in the Figure)**
		- ***QCLed with the CORESET with lowest controlResourceSetId with the same value of coresetPoolIndex***
	+ **Offset equal or larger than timeDurationForQCL (T2 in the Figure)**
		- ***QCLed with the RS in indicated TCI states***

**Observation 4: When the offset between DCI and PDSCH is equal or larger than timeDurationForQCL, following conditions can be kept.*** + - **[The two CSI-RS resources and both PDSCHs are overlapped on the same OFDM symbol].**

**Observation 5: For mDCI, when the offset between DCI and PDSCH is less than the threshold of timeDurationForQCL, if the default beam for PDSCH from two TRP as defined in RAN1 spec are QCL with reported GBBR, UE shall also be able to receive PDSCH simultaneously.****Observation 6: For sDCI, when the offset between DCI and PDSCH is less than the threshold of timeDurationForQCL, if the default beams are QCLed with two different TCI states as defined in RAN1 spec, which is QCL-ed with reported GBBR, UE shall also be able to receive PDSCH simultaneously.****Observation 7: Regarding the PDSCH overlapping conditions, the PDSCH could be the actual scheduled PDSCH when the offset is equal or larger than timeDurationForQCL, or the PDSCH to be buffered using default beam when the offset is smaller than timeDurationForQCL regardless whether there is scheduled PDSCH or not.****Proposal 1: With the understanding of observation 7, the measurement restriction relaxation can be modified as follows:** **Both the CSI-RS for L1-RSRP and the other CSI-RS are not in any CSI-RS resource set configured with repetition ON, and****- Resources of the active TCI states or default QCL assumption as defined in TS38.214 for two PDSCHs have been reported as a resource group in Rel-17 group-based RSRP report, and****- [The two CSI-RSs and both PDSCHs are overlapped on the same OFDM symbol, and]****- The CSI-RS for L1-RSRP has same QCL source as the active TCI state or default QCL assumption of one [PDSCH], and the other CSI-RS has same QCL source as the active TCI state or default QCL assumption of the other [PDSCH]****Observation 8: Even if the CSI-RS from different TRPs QCLed with group via GBBR, UE may not be able to use the best beam/panel to measure CSI-RS if UE is forced to perform simultaneous measurement.****Observation 9: For sDCI TCI state switching triggered by DCI from (RS#1, RS#2) to (RS#1), the current requirements about “no TCI state switching delay allowed” are not correct for following reason:*** **Before UE decoding the DCI, UE has no idea about the TCI state change carried in PDCCH, thus UE shall only follow the delay beam.**
* **It doesn’t mean shorter scheduling delay/interruption but change the beam determination.**

**Proposal 2: Following requirements shall be removed for DCI based TCI state switching for sDCI:****“For sDCI, If TCI state switching is from dual TCI states to single TCI state and the target TCI state is one of the source TCI states, there is no TCI state switching delay allowed, provided that UE is configured with group-based RSRP report (*groupBasedBeamReporting-r17*).”** |
| R4-2412243 | vivo | ***Proposal 1: When dual TCI states are not indicated within [300] s since group-based beam reporting is configured, the UE is allowed to exit fast beam sweeping.******Proposal 2: Conditions for measurement restriction are**** ***Both CSI-RSs are not in any CSI-RS resource set with repetition ON, and***
* ***Th two CSI-RSs are QCL-ed with typeD to reference signals in a resource group in the latest Rel-17 group based beam report, and***
* ***One CSI-RS has same QCL source as the TCI state of one PDSCH, and the other CSI-RS has same QCL source as the TCI state of the other PDSCH.***

***Proposal 3: Conditions for measurement restriction are**** ***Both CSI-RSs are not in any CSI-RS resource set with repetition ON, and***
* ***Th two CSI-RSs are QCL-ed with typeD to reference signals in a resource group in the latest Rel-17 group based beam report, and***
* ***One CSI-RS has same QCL source as the active TCI state of one PDSCH, and the other CSI-RS has same QCL source as the active TCI state of the other PDSCH, when at least one of the PDSCHs is scheduled on the same OFDM symbol as both the CSI-RSs.***

***Proposal 3: Conditions for PTRP=1 for CSI-RS based TRP specific BFD requirements for multi-Rx operation is**** ***Both CSI-RSs are not in any CSI-RS resource set with repetition ON***
* ***The two CSI-RSs are QCL-ed with typeD to reference signals in a resource group in the latest Rel-17 group based beam report, and***
* ***The CSI-RS in set*** $\overbar{q}\_{0,0}$ ***has same QCL source as the TCI state of one PDSCH, and the CSI-RS in set*** $\overbar{q}\_{0,1}$ ***has same QCL source as the TCI state of the other PDSCH.***

***Proposal 4: No additional requirements are needed for DCI based dual TCI state switch delay for m-DCI.*** |
| R4-2412998 | Ericsson | **Proposal 1:** Remove the following condition from the measurement restrictions for a UE supporting multi-rx chain.* + - * The two CSI-RS resources and both PDSCH are overlapped on the same OFDM symbol.

**Proposal 2:** For mDCI based dual DCI state switch, TCI state switch on each coreset is independent without any restriction on the DCI reception. **Proposal 3:** Between point C and D, UE to receive on TCI state 0 alone, if new TCI state 0 and old TCI state 1 are not in a beam pair. |
| R4-2413074 | ZTE Corporation, Sanechips | **Proposal 1: For the condition of measurement restriction, similar as the condition of scheduling restriction, no need to mention “UE is multi-Rx operation” in the spec.****Proposal 2: For mDCI, scheduling restriction relaxation is allowed for the case of the CSI-RS and both of the PDSCHs are on the same OFDM symbol(s), or the CSI-RS and one of the PDSCHs with different QCL typeD are on the same OFDM symbol(s) when partially overlapping PDSCHs are scheduled.****Observation 1: Under mDCI, it is possible that non-overlapping PDSCHs scheduled respectively by different TRPs and dual TCI states referring to the beam pair reported in GBBR are indicated to receive the non-overlapping PDSCHs.** **Proposal 3: For mDCI, even though non-overlapping PDSCHs scheduled by different TRPs, scheduling restriction relaxation is allowed provided the CSI-RS overlapping with both PDSCHs.****Proposal 4: For sDCI, the measurement restriction relaxation is allowed for the case of CSI-RSs and both of the PDSCHs are on the same OFDM symbol(s), or one of the CSI-RSs and one of the PDSCHs with different QCL typeD are on the same OFDM symbol(s) when partially overlapping PDSCHs are scheduled.****Proposal 5: For mDCI, measurement restriction relaxation is allowed provided one of the PDSCH is overlapping with the two CSI-RS.****Proposal 6: Regarding the mDCI based dual TCI state switching, some principles should be considered:****- P1: Since the beam switching only happens within CP, so during the whole timeDurationForQCL, UE can receive other DCI or other PDSCH with different TCI state assumption. This is the general principle.****- P2: For the overlapping PDSCHs, which can only be received via beam pair reported through GBBR, no matter the dual TCI state switching happens in sequence or in parallel.** **- P3: For the non-overlapping PDSCHs, which can be received via independent beams reported through non-GBBR or beam pair reported through GBBR.****- P4: When receiving DCI 0(reported through GBBR) which scheduling PDSCH 0, since unsure whether and when any overlapping PDSCH 1 would be scheduled, the behavior of TCI state switching at UE side is same as the single TCI state swithching case.****Proposal 7: If TCI 1 and TCI 2 are in a beam pair, UE to receive on TCI 1 and TCI 2 between C and D. After D, to receive on TCI 2 and TCI 4. Between C and D, UE capable of multi-Rx can receive overlapping PDSCH 0 and PDSCH 1 simultaneously. Otherwise, UE to receive on TCI 2 alone till D. After D, UE can receive on TCI 2 and TCI 4.’** |
| R4-2413202 | Samsung | **Proposal 1: The measurement restriction is just about the measurement when the two CSI-RSs are overlapped, which is not relevant for data scheduling****Proposal 2: Remove [The two CSI-RSs and both PDSCHs are overlapped on the same OFDM symbol, and]**  |
| R4-2411401 | Apple | CR on multi-RX core performance maintenance |
| R4-2411781 | MediaTek inc. | Remove CBD RRM requirement for scheduling and measurement restriction relaxation |
| R4-2411984 | CMCC | CR on BFD and CBD for multi-RX operation |
| R4-2412193 | Huawei, HiSilicon | CR on TCI state switching requirements maintenance for R18 FR2 multi-RX |
| R4-2412194 | Huawei, HiSilicon | CR on measurement restriction requirements maintenance for R18 FR2 multi-RX |
| R4-2412244 | vivo | CR on measurement restriction requirements for multi-Rx |
| R4-2412492 | Nokia | CR for Rel-18 multi-Rx TCI state switching delay |
| R4-2412999 | Ericsson | CR to TS 38.133 on core requirement maintenance for NR FR2 multi-Rx |
| R4-2413085 | ZTE Corporation, Sanechips | CR on R18 multi-Rx L1 measurement |
| R4-2413086 | ZTE Corporation, Sanechips | CR on R18 multi-Rx link recovery procedures |

*The moderator can suggest a limited number of papers which could be presented.*

## Open issues summary

### Sub-topic 1-1: Measurement restriction

**Issue 1-1: Measurement restriction relaxation requirements**

In TS38.133 v18.6.0, the measurement relaxation requirements for CSI-RS based L1 measurements are specified as follows.

For FR2-1, there is no measurement restriction allowed for UE supporting [TBD - multi-rx capability], according to the conditions described in clause 3.6.x, and the UE is required to measure both the CSI-RS for RLM and the other CSI-RS for RLM, BFD or L1-RSRP measurement, while meeting requirements in clause 8.1.3.2, provided the following conditions are met:

- Both CSI-RSs are not in any CSI-RS resource set with repetition ON, and

- [The two CSI-RS resources and both PDSCHs are overlapped on the same OFDM symbol, and]

- One CSI-RS has same QCL source as the active TCI state of one PDSCH, and the other CSI-RS has same QCL source as the active TCI state of the other PDSCH, and

- Resources of the active TCI states for the two PDSCHs have been reported as a resource group in Rel-17 group-based RSRP report.

Editor’s note: FFS how to capture UE is activated with multi-Rx operation.

The highlighted conditions need to be addressed.

* Proposals

On the condition “The two CSI-RS resources and both PDSCHs are overlapped on the same OFDM symbol”

* + Option 1: (MTK, Nokia, Ericsson, Samsung)
		- Remove the condition.
	+ Option 2: (Apple)
		- Remove the condition for s-DCI, but keep the condition for m-DCI.
	+ Option 3: (vivo)
		- Remove the condition.
		- Modify other condition to
			* The two CSI-RSs are QCL-ed with typeD to reference signals in a resource group in the latest Rel-17 group based beam report, and
	+ Option 4: (Huawei)
		- Keep the condition.
		- Modify other conditions to
			* One CSI-RS has same QCL source as the active TCI state or default QCL assumption of one PDSCH, and the other CSI-RS has same QCL source as the active TCI state or default QCL assumption of the other PDSCH, and
			* Resources of the active TCI states or default QCL assumption for the two PDSCHs have been reported as a resource group in Rel-17 group-based RSRP report.
	+ Option 5: (OPPO)
		- Modify the condition to:
			* The two CSI-RS resources are overlapped on the same OFDM symbol, where at least one of the PDSCHs is scheduled simultaneously.
	+ Option 6: (ZTE)
		- Modify the condition to:
			* For s-DCI, CSI-RSs and both of the PDSCHs are on the same OFDM symbol(s), or one of the CSI-RSs and one of the PDSCHs with different QCL typeD are on the same OFDM symbol(s) when partially overlapping PDSCHs are scheduled.
			* For m-DCI, one of the PDSCH is overlapping with the two CSI-RS.

On the condition “FFS how to capture UE is activated with multi-Rx operation”

* + Option 1: (ZTE, vivo)
		- Remove the condition UE is activated with multi-Rx operation.
* Recommended WF
	+ Remove the condition UE is activated with multi-Rx operation.
	+ Further discuss the condition [The two CSI-RS resources and both PDSCHs are overlapped on the same OFDM symbol].

**Issue 1-2: TRP specific BFD measurement requirements**

In TS38.133 v18.6.0, the conditions for PTRP = 1 for CSI-RS based BFD measurements are specified as follows.

For FR2-1, for UE supporting [TBD - multi-rx capability], according to the conditions described in clause 3.6.x, the value of PTRP in table 8.18.3.2-2 is defined as 1, when:

- CSI-RS resources in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ are not overlapped, or

- CSI-RS resources in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ are overlapped and the following conditions are met:

- Both CSI-RSs are not in any CSI-RS resource set with repetition ON

- The two CSI-RS resources in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ for beam failure detection [and both PDSCH] are overlapped on the same OFDM symbol.

- [The CSI-RS in set $\overbar{q}\_{0,0}$ has same QCL source as the active TCI state of one PDSCH, and the CSI-RS in set $\overbar{q}\_{0,1}$ has same QCL source as the active TCI state of the other PDSCH]

- Resources of the active TCI states for the two PDSCHs have been reported as a resource group in Rel-17 group-based RSRP report.

- [FFS how to capture UE is activated with multi-Rx operation]

- else, the value of PTRP is 2.

The highlighted conditions need to be addressed.

* Proposals
	+ Option 1: (vivo)
		- Both CSI-RSs are not in any CSI-RS resource set with repetition ON
		- The two CSI-RSs are QCL-ed with typeD to reference signals in a resource group in the latest Rel-17 group based beam report, and
		- The CSI-RS in set $\overbar{q}\_{0,0}$ has same QCL source as the TCI state of one PDSCH, and the CSI-RS in set $\overbar{q}\_{0,1}$ has same QCL source as the TCI state of the other PDSCH.
* Recommended WF
	+ Follow same principle as for issue 1-1.

### Sub-topic 1-2: Scheduling restriction

**Issue 1-3: Scheduling restriction relaxation requirements**

In the RAN4#110 meeting, following agreement was reached and captured in the WF R4-2403560.

Agree the following and no further discussion on other proposals.

* The CSI-RS and both of the PDSCHs are on the same OFDM symbol(s), or the CSI-RS and one of the PDSCHs with different QCL typeD are on the same OFDM symbol(s) when partially overlapping PDSCHs are scheduled.
* Further check for mDCI case.

The conditions for highlighted m-DCI case need to be addressed.

* Proposals
	+ Option 1: (ZTE)
		- For m-DCI, CSI-RS and both of the PDSCHs are on the same OFDM symbol(s), or the CSI-RS and one of the PDSCHs with different QCL typeD are on the same OFDM symbol(s) when partially overlapping PDSCHs are scheduled.
		- For m-DCI, even though non-overlapping PDSCHs scheduled by different TRPs, scheduling restriction relaxation is allowed provided the CSI-RS overlapping with both PDSCHs.
	+ Option 2: (OPPO)
		- The two CSI-RS resources are overlapped on the same OFDM symbol, where at least one of the PDSCHs is scheduled simultaneously.
* Recommended WF
	+ Further discuss and focus on m-DCI scheduling only.

### Sub-topic 1-3: TCI state switch

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**Issue 1-4: DCI based dual TCI state switch delay for m-DCI**

* Proposals
	+ Option 1: (vivo)
		- No additional requirements are needed for DCI based dual TCI state switch delay for m-DCI.
	+ Option 2: (Nokia)
		- The UE can receive simultaneously TCI 1 and TCI 2 between points C and D if they have been reported as a beam pair using GBBR-17.
	+ Option 3: (Ericsson)
		- For m-DCI based dual DCI state switch, TCI state switch on each coreset is independent without any restriction on the DCI reception.
		- Between point C and D, UE to receive on TCI state 0 alone, if new TCI state 0 and old TCI state 1 are not in a beam pair.
	+ Option 4: (ZTE)
		- If TCI 1 and TCI 2 are in a beam pair, UE to receive on TCI 1 and TCI 2 between C and D. After D, to receive on TCI 2 and TCI 4. Between C and D, UE capable of multi-Rx can receive overlapping PDSCH 0 and PDSCH 1 simultaneously. Otherwise, UE to receive on TCI 2 alone till D. After D, UE can receive on TCI 2 and TCI 4.
* Recommended WF
	+ Further discuss.
	+ It is moderator’s understanding that proposals in options 2, 3 and 4 are the UE behaviour that is allowed or not precluded by RAN1 specification. However, it is not necessary to capture such UE behaviour in RAN4 specification further.

**Issue 1-5: DCI based dual TCI state switch delay for s-DCI**

* Proposals
	+ Option 1: (Huawei)
		- Remove the following requirements.
			* For sDCI, If TCI state switching is from dual TCI states to single TCI state and the target TCI state is one of the source TCI states, there is no TCI state switching delay allowed, provided that UE is configured with group-based RSRP report (groupBasedBeamReporting-r17).”
* Recommended WF
	+ Proponent is encouraged to offline with companies firstly.

### Sub-topic 1-4: General

**Issue 1-6: Condition of multi-Rx operation for fast beam sweeping**

In TS38.133 v18.6.0, the condition of multi-Rx operation for fast beam sweeping is specified as follows.

The UE is activated with multi-Rx operation when the UE is configured with Rel-17 group-based beam reporting

group-based beam reporting

Proposals are further provided to modify/enhance the condition.

* Proposals
	+ Option 1: (MTK)
		- Add a leaving condition: If UE recently reported ‘Not valid’ for one of the RSRP for a beam pair, this means UE is allow to fallback to single panel for the later reception QCL-ed to that beam pair.
	+ Option 2: (vivo)
		- Add a leaving condition: When dual TCI states are not indicated within [300] s since group-based beam reporting is configured, the UE is allowed to exit fast beam sweeping.
	+ Option 3: (Xiaomi)
		- UE is configured with group-based beam reporting (GBBR) report and UE is activated with dual TCI states.
		- Leaving fast beam sweeping can be initiated by NW or UE.
	+ Option 4: (OPPO)
		- Rel-17 group-based beam reporting (GBBR) is configured and activated by the network.
* Recommended WF
	+ Draw conclusion in this meeting.

**Issue 1-7: Applicability of requirements for multi-Rx operation**

In TS38.133 v18.6.0, the applicability of requirements for multi-Rx operation in FR2-1 is specified as follows.

The requirements related to the support of [*reducedRxBeamNum* and 30-1] are applicable to a PCell, PSCell, or SCell, provided the UE is configured with a single serving cell (PCell, PSCell, or SCell) in FR2-1.

The requirements related to the support of [*reducedRxBeamNum*] is applicable when the network configures the UE with a CSI report containing groupBasedBeamReporting-v1710.

Proposals are further provided to modify the applicability conditions.

* Proposals
	+ Option 1: (Apple)
		- Modify the 2nd applicability of requirements to:
			* The requirements related to the support of [reducedRxBeamNum] is applicable when the network has configured the UE with a CSI report containing *groupBasedBeamReporting-v1710* and the UE has not sent UAI indicating its preference of single-RX operation since it was most recently configured with such CSI reporting.
* Recommended WF
	+ Further discuss.

**Issue 1-8: MRTD for multi-Rx**

In TS38.133 v18.6.0, the MRTD requirements for multi-Rx operation in FR2-1 is specified as follows.

A UE supporting [*FG 30-1 or 30-2*] shall be capable of handling at least a relative receive timing difference between slot timing of different TCI states on the same carrier at the UE receiver as shown in Table 7.6.8-3.

Table 7.6.8-3: Maximum receive timing difference requirement for UE supporting multi-RX

|  |  |
| --- | --- |
| Frequency Range | Maximum receive timing difference  |
| FR2-1 | CP lengthnote 1 |
| Note 1: CP length dependency on SCS is FFS  |

The FFS part should be addressed.

* Proposals
	+ Option 1: (Apple)
		- The MRTD is smaller than the CP length corresponding to MAX (SSB SCS, data SCS).
			* It is more challenging to maintain MRTD < CP length of 240kHz SCS from network deployment perspective.
* Recommended WF
	+ Further discuss.

# Topic #2: Performance requirements maintenance

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2411402 | Apple | ***Proposal 1: It is proposed to use the wording “the AoA pairs, i.e., (AoA1, AoA2), that can support 2 AoA reception.”******Observation 1: An AoA pair, i.e., (AoA1, AoA2), where AoA1 satisfies the legacy or single AoA spherical coverage requirement, and (AoA1, AoA2) supports 2 AoA reception, can be obtained in the single AoA and 2 AoA RF tests.******Proposal 2: The Editor’s note is changed to “The chosen AoA pair in the test, i.e., (AoA1, AoA2), is up to RAN5.”*** |
| R4-2412028 | Nokia | Observation 1: Since the direction and placement of the probes in the anechoic chamber during testing is fixed, the UE can receive only those beams which are within its spherical coverageObservation 2: During the TCI state switch test, when the UE has to switch from two TCI states to two new TCI states, all three probes (AoA1, AoA2, AoA3) need to be within the UE’s spherical coverage so that it can receive from two TCI states initially and switch to the target two TCI states after the TCI state switch command without any change in its orientation.**Proposal 1: Update the 3 AoA test setup with the following “The UE positioning shall be such that the UE passes both spherical coverage requirements.**Observation 3: In test case for dual TCI state switch for m-DCI, three probes are used of which one probe will transmit two RS.**Proposal 2: When three probes are used to transmit four RS, the test probe transmitting more than one RS should emulate different DL transmit beams by transmitting different RS with different power and delay. This will ensure that the UE has done a time/frequency sychronization with the target RS before switching to the target TCI state when receiving a DCI command for a TCI state switch****Proposal 3: In m-DCI TCI state switching test case, because support of simultaneous PDCCH reception is not mandatory for a Rel-18 UE, the TE shall send the two DCIs to switch to the target TCI states in consecutive slots n and n+1. The UE shall be able to receive the target TCI states simultaneously at slot n + 1 + timeDurationForQCL.****Proposal 4: Distinguish PDCCH and PDSCH TCI states clearly in the m-DCI TCI state switching test case. The TCI states and associated probes and SSBs should be:*** **TCI states at the beginning of the test:**
	+ **For CORESETPoolIndex 0**
		- **PDCCH TCI state: TCI state 0 (probe 0, SSB0)**
		- **PDSCH TCI states: TCI state 0 (probe 0, SSB0)**
	+ **For CORESETPoolIndex 1**
		- **PDCCH TCI state: TCI state 1 (probe 1, SSB1)**
		- **PDSCH TCI states: TCI state 1 (probe 1, SSB1)**
* **TCI states at the end of the test:**
	+ **For CORESETPoolIndex 0**
		- **PDCCH TCI state: TCI state 0 (probe 0, SSB0)**
		- **PDSCH TCI states: TCI state 3 (probe 0, SSB3)**
	+ **For CORESETPoolIndex 1**
		- **PDCCH TCI state: TCI state 1 (probe 1, SSB1)**
		- **PDSCH TCI states: TCI state 2 (probe 2, SSB2)**

**Proposal 5: Add a note in test case A.7.7.X clarifying that the UE can skip the test case in A.7.7.4 if it fulfils the requirements in test case A.7.7.X** |
| R4-2413000 | Ericsson | **Proposal 1:** Specify the AoA numbering and their description in the test set up. **Proposal 2:** In the scheduling and measurement restriction test cases set CSI-RS periodicity as 80ms and CSI report periodicity as 80ms. |
| R4-2411403 | Apple | CR on multi-Rx RRM performance requirement maintenance |
| R4-2411478 | OPPO | CR on clean up TC for TRP specific BFD for multi-Rx |
| R4-2411782 | MediaTek inc. | Applicability for the test case of L1-RSRP group-based beam reporting |
| R4-2412195 | Huawei, HiSilicon | CR on TC maintenance for Rel-18 Multi-Rx |
| R4-2412245 | vivo | CR on test cases for m-DCI based TCI dual states switch for multi-Rx |
| R4-2412493 | Nokia | CR for Rel-18 multi-Rx performance part maintenance |
| R4-2413001 | Ericsson | CR to TS 38.133 on maintenance of multi-rx TC |
| R4-2413201 | vivo | CR on L1-RSRP measurement accuracy requirements for multi-Rx |
| R4-2413459 | Apple | CR on multi-RX performance requirement maintenance |

*The moderator can suggest a limited number of papers which could be presented.*

## Open issues summary

*Before f2f meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1: AoA Setup

**Issue 2-1: 3AoAs setup 6**

In TS38.133 v18.6.0, the 3 AoAs setup 6 is specified with brackets as follows.

**A.3.15.6 Setup 6:** **3 AoAs for simultaneous reception with different QCL Type-D**

There are 3 active probes in the test and the DL signals and noise are transmitted from the three active probes.

Out of the three AoA, one AoA [(AoA1)] is aligned to a direction which is from the set of directions corresponding to the EIS spherical coverage percentile of the DUT as defined in clause 7.3.4 of TS 38.101-2 [19] for UE power class 3 and other 2 AoAs [(AoA2, AoA3)] are from the set of [qualified AoA pairs] according to the spherical coverage requirement for simultaneous reception from multiple directions as defined in clause 7.3K.3 of TS 38.101-2 for power class 3 supporting simultaneous reception from multiple directions.

The relative angular offset between the directions of the AoA pair is based on the UE’s declared [AoA separation and UE] orientation as defined in clause 7.3K.3 of TS 38.101-2 and [shall not be changed for each test iteration].

* Proposals
	+ P1: (Apple)
		- [qualified AoA pairs] is replaced with “the AoA pairs, i.e., (AoA1, AoA2), that can support 2 AoA reception.
	+ P2: (Ericsson)
		- Specify the AoA numbering and their description in the test set up.
	+ P3: (Nokia)
		- The UE positioning shall be such that the UE passes both spherical coverage requirements.
* Recommended WF
	+ Discuss if the proposals are agreeable.

**Issue 2-2: 2AoAs setup 5**

In TS38.133 v18.6.0, the 2 AoAs setup 5 is specified with FFS as follows.

A.3.15.5 Setup 5: 2 AoAs for simultaneous reception with QCL Type-D

Editor’s note: FFS how single AoA RF test and 2 AoA RF test could ensure this.

* Proposals
	+ Option 1: (Apple)
		- Change the Editor’s note to “The chosen AoA pair in the test, i.e., (AoA1, AoA2), is up to RAN5.
* Recommended WF
	+ Further discuss

### Sub-topic 2-2: Test setup

*Sub-topic description:*

*Open issues and candidate options before f2f meeting:*

**Issue 2-3: Test setup for dual TCI state switching for m-DCI**

In the last meeting, following agreements on Test case(s) for dual TCI state switching for m-DCI.

* Introduce one test case for DCI-based dual TCI state switching for m-DCI
* From [RS1, RS2] (Probe 1 and 2, no simultaneous transmission) to [RS3, RS4] (Probe 1 and 3) with 3 active probes.
	+ Side conditions
		- Probe 1 & 3 shall fulfill the mRx spherical coverage EIS requirement (angular offset as declared by the UE). Note: Aligned with 2AoA selected as we agreed.
		- In addition, Probe 1 & 2 shall fulfill individually the legacy spherical coverage EIS requirement and angular offset from the legacy 2AoA table, i.e. selection is equivalent to a single pair from Setup 3
	+ Signal mapping
		- RS1 & RS3 are mapped to Probe 1
		- RS2 is mapped to Probe 2
		- RS4 is mapped to Probe 3

Proposals are further provided to improve the test design.

* Proposals (Nokia)
	+ P1: When three probes are used to transmit four RS, the test probe transmitting more than one RS should emulate different DL transmit beams by transmitting different RS with different power and delay. This will ensure that the UE has done a time/frequency synchronization with the target RS before switching to the target TCI state when receiving a DCI command for a TCI state switch
	+ P2: In m-DCI TCI state switching test case, because support of simultaneous PDCCH reception is not mandatory for a Rel-18 UE, the TE shall send the two DCIs to switch to the target TCI states in consecutive slots n and n+1. The UE shall be able to receive the target TCI states simultaneously at slot n + 1 + *timeDurationForQCL*.
	+ P3: Distinguish PDCCH and PDSCH TCI states clearly in the m-DCI TCI state switching test case. The TCI states and associated probes and SSBs should be
		- TCI states at the beginning of the test:
			* For CORESETPoolIndex 0
				+ PDCCH TCI state: TCI state 0 (probe 0, SSB0)
				+ PDSCH TCI states: TCI state 0 (probe 0, SSB0)
			* For CORESETPoolIndex 1
				+ PDCCH TCI state: TCI state 1 (probe 1, SSB1)
				+ PDSCH TCI states: TCI state 1 (probe 1, SSB1)
		- TCI states at the end of the test:
			* For CORESETPoolIndex 0
				+ PDCCH TCI state: TCI state 0 (probe 0, SSB0)
				+ PDSCH TCI states: TCI state 3 (probe 0, SSB3)
			* For CORESETPoolIndex 1
				+ PDCCH TCI state: TCI state 1 (probe 1, SSB1)
				+ PDSCH TCI states: TCI state 2 (probe 2, SSB2)
* Recommended WF
	+ Further discuss the proposals.

**Issue 2-4: Test setup for L1-RSRP accuracy**

In the last meeting, following agreement was made for L1-RSRP accuracy test.

Define test case to verify the accuracy requirements for multi-Rx.

If the new test case is conducted, the corresponding legacy test will be skipped.

* Proposals
	+ Option 1: (Nokia)
		- Add a note in test case A.7.7.14 clarifying that the UE can skip the test case in A.7.7.4 if it fulfils the requirements in test case A.7.7.14
* Recommended WF
	+ Further discuss how the skipping is captured in the spec.

**Issue 2-5: Test setup for scheduling and measurement restriction**

* Proposals
	+ Option 1: (Ericsson)
		- In the scheduling and measurement restriction test cases, set CSI-RS periodicity as 80ms and CSI report periodicity as 80ms
* Recommended WF
	+ Further discuss.

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