**3GPP TSG-RAN WG4 Meeting #108bis R4-2317332**

**Xiamen, China, 09th ‒ 13th October, 2023**

**Title:** WF on NR FR2 multi-RX operation RRM requirements (part 1)

**Agenda Item:** 5.7.5

**Source:** vivo

**Document for:** Approval

# Topic #1: General aspect

## Sub-topic 1-2: RRM requirements impact

**Issue 1-2-5: Indication of multi-Rx operation**

* FFS
	+ Option 1:
		- For the new UE indication on UE preference on not supporting simultaneous reception with different QCL-typeD, following related UE capabilities in FR2-1 are identified to be involved:
			* simultaneousReceptionDiffTypeD-r16
			* defaultQCL-PerCORESETPoolIndex-r16
			* defaultQCL-TwoTCI-r16
			* mTRP-PDCCH-TwoQCL-TypeD-r17
			* sfn-SchemeA-r17
			* sfn-SchemeA-DynamicSwitching-r17
			* sfn-SchemeA-PDCCH-only-r17
			* sfn-SchemeA-PDSCH-only-r17
			* sfn-SchemeB-r17
			* sfn-SchemeB-DynamicSwitching-r17
			* sfn-SchemeB-PDSCH-only-r17
			* sfn-SimulTwoTCI-AcrossMultiCC-r17
			* sfn-QCL-TypeD-Collision-twoTCI-r17
			* UE capabilities to be introduced in Rel-18 NR\_FR2\_multiRX\_DL which will be finalized in RAN4 feature list.
		- RAN4 to send LS to RAN1/2 to inform the involved UE capabilities related to the new UE indication on UE preference on not supporting simultaneous reception with different QCL-typeD

## Sub-topic 1-3: Applicability and conditions

**Issue 1-3-5: UE behaviour when a condition becomes violated during a measurement**

* FFS
	+ Option A: When the side conditions are violated, the corresponding requirement is not applicable, and/or no UE behavior needs to be defined.
		- Alternative wording for option A: When the side conditions are changed with a transition between multi-Rx operation and no multi-Rx operation, the corresponding requirement is not applicable, and/or no UE behavior needs to be defined.
		- The side conditions are discussed separately for each topic.
	+ Option B: UE beviour needs to be speficied.
		- Option B1:
			* When the condition of multi-Rx becomes violated during measurement, UE can continue the on-going L1 measurement but with the relaxed measurement period requirement instead of the requirement for simultaneous reception.
		- Option B2:
			* UE in multi-rx operation may need to stop and restart (in new conditions) L1 measurements or evaluations, when at least the following conditions for multi-rx operation become violated:
				+ A completely new dual TCI configuration (e.g., dual TCI swapped to another dual TCI where both active states are new).
			* UE in multi-rx operation may need to continue L1 measurements or evaluations (using a single panel), but more relaxed requirements will apply for such measurements/evaluations, when any of the following conditions for multi-rx operation become violated:
				+ Partially new dual TCI configuration (e.g., one active TCI state remains the same),
				+ Different QCL type D condition is not valid, etc.
			* RAN4 to discuss whether there are scenarios when a UE in multi-rx operation may need to complete L1 measurements or evaluations in multi-rx operation prior to switching to single-rx operation, e.g.:
				+ UE becomes configured with CA operation or with some other operation suggesting single-rx operation.

## Sub-topic 1-4: UE capability

**Issue 1-4-3: UE capability of *simultaneousRxDataSSB-DiffNumerology***

<Online agreement>

* It is RAN4 common understanding that there is no scenario of simultaneous reception of mix numerologies for: SSB (TRP1) + data (TRP2), and for SSB (TRP1) + CSI-RS (TRP2) in Rel-18.
* No new UE capability for mix numerologies is needed in Rel-18

**Issue 1-4-4: UE capability for simultaneous reception with different QCL typeD for L1 measurements**

* FFS
	+ Option 1:
		- A new UE capability of supporting simultaneous reception of RS and data from different directions with different QCL type D RSs for enhanced L1 measurements for multi-Rx is introduced.
		- A new UE capability of supporting simultaneous reception of RS and RS from different directions with different QCL type D RSs for enhanced L1 measurements for multi-Rx is introduced, if measurement restriction is enhanced for multi-Rx.
	+ Option 2:
		- To support Rel-18 multi-Rx DL simultaneous reception modes, an additional UE capability needs to be defined.
	+ Option 3:
		- specify UE capability to indicate whether the UE can support simultaneous reception of data and L1 measurement
	+ Option 4:
		- No need to define new additional UE capability to support simultaneous reception of RS+data or RS+RS.

**Issue 1-4-5: UE capability for indication of whether additional delay is needed in dual TCI state switching for multi-Rx**

* FFS
	+ Option 1:
		- Specify UE capability to indicate whether additional delay is needed in MAC CE based dual TCI state switching. By default, a UE should support MAC CE based dual TCI state switching without the additional delay.
	+ Option 2:
		- No UE capability is introduced for additional delay in dual TCI state switch.

**Issue 1-4-6: UE feature list**

* FFS
	+ Option 1:
		- UE feature for Rel-18 FR2 multi-Rx DL reception is as in Table 1 for NR\_FR2\_multiRX\_DL.
1. NR\_FR2\_multiRX\_DL

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | **Consequence if the feature is not supported by the UE** | **Type****(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| X. NR\_FR2\_multiRX\_DL | X-1 | Simultaneous reception of NR PDCCH/PDSCH overlapping with layer 1 RS with different QCL Type-D | Supports simultaneous reception of PDCCH/PDSCH with different QCL Type-D layer 1 RS for measurement on overlapping OFDM symbols. | 16-2c | Yes | N/A |  | Per band | N/A | FR2 only |  |  | Optional with capability signalling |
| X. NR\_FR2\_multiRX\_DL | X-2 | Simultaneous measurement of layer 1 RS overlapping with another layer 1 RS with different QCL Type-D | Supports Simultaneous measurement of layer 1 RS overlapping with another layer 1 RS with different QCL Type-D on overlapping OFDM symbol(s). | 16-2c | Yes | N/A |  | Per band | N/A | FR2 only |  |  | Optional with capability signalling |
| X. NR\_FR2\_multiRX\_DL | X-3 | Fast beam sweeping | Supports beam sweeping factor reduction for SSB-based layer 1 measurement. |  | Yes | N/A |  | Per band | N/A | FR2 only |  | Candidate values for Component 2: {2,4,6} for FR2-1 | Optional with capability signalling |

# Topic #2: RLM and BFD/CBD requirements

## Sub-topic 2-1: Cell specific RLM and BFD/CBD

**Issue 2-1-5: Other aspects of RLM and cell specific BFD/CBD requirements for multi-Rx**

* FFS
	+ Option 1a:
		- For m-DCI scenario, reuse RLM requirements in section 8.1 of TS 38.133, without any clarification on multi-TRP operation.
	+ Option 1b:
		- For mDCI scenario of intra-cell mTRP, no need to give any clarification or assumption on whether the RLM-RS originated from two TRPs or not.
	+ Option 1c:
		- For m-DCI scenario, reuse RLM requirements in section 8.1 of TS 38.133. No need of additional clarification that RLM-RSes for evaluating out-of-sync and in-sync may originate from two different TRPs as RAN4 agreed to specify measurement restrictions.
	+ Option 2:
		- Capture in the RLM requirements that in m-DCI scenario, RLM RS during the evaluation period for out-of-sync and in-sync may originate from one or two TRPs

## Sub-topic 2-2: TRP specific RLM and BFD/CBD

**Issue 2-2-1: Updated conditions for TRP specific BFD requirements enhancement for multi-Rx**

* Both CSI-RSs are not in any CSI-RS resource set with repetition ON
* The two CSI-RS resources in the two sets q ̅\_0,0 and q ̅\_0,1 for beam failure detection are overlapped on the same OFDM symbol.
* The CSI-RS in set q ̅\_0,0 has same QCL source as the active TCI state of one PDCCH or PDSCH, and the CSI-RS in set q ̅\_0,1 has same QCL source as the active TCI state of the other PDCCH or PDSCH
* Resources of the active TCI states for the two PDCCHs, or 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]

# Topic #3: Scheduling/Measurement restrictions

## Sub-topic 3-1: Scheduling restriction

**Issue 3-1-1: Updated conditions/cases for scheduling restriction that can be relaxed for CSI-RS based L1 measurements for multi-Rx**

* The CSI-RS is not in a CSI-RS resource set with repetition ON.
* The CSI-RS has same QCL source as the active TCI state of one of the PDSCHs and has different QCL-TypeD from the other PDSCH.
* The CSI-RS and both of the PDSCHs are on the same OFDM symbol(s).
	+ FFS: The CSI-RS and only one of the PDSCHs with different QCLed typeD are on the same OFDM symbol(s)
* 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]

**Issue 3-1-2: Cases whether scheduling restriction can be relaxed for L1 measurements for multi-Rx**

<Online agreement>

* No mixed numerology case is considered for scheduling restriction for L1 measurements with multi-Rx.

## Sub-topic 3-1: Meaurement restriction

**Issue 3-2-1: Cases whether measurement restriction for SSB based L1 measurements can be relaxed for multi-Rx**

<Online agreement>

* It is RAN4 common understanding that Measurement restriction shall be applied for SSB based L1 measurement (RLM/BFD /L1-RSRP), i.e., no relaxation, regardless of supporting mixed numerology in Rel-18.
* No mixed numerology case is considered for measurement restriction for L1 measurements (CSI-RS + CSI-RS) for multi-Rx in Rel-18.

**Issue 3-2-2: Conditions that measurement restriction for CSI-RS based L1 measurements can be relaxed for multi-Rx**

* Both CSI-RSs are not in any CSI-RS resource set with repetition ON
* The two CSI-RS resources are overlapped on the same OFDM symbol.
* One CSI-RS has same QCL source as the active TCI state of one PDCCH or PDSCH, and the other CSI-RS has same QCL source as the active TCI state of the other PDCCH or PDSCH
* Resources of the active TCI states for the two PDCCHs, or 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]

# Topic #4: RRM performance requirements

## Sub-topic 4-1: Test cases design

**Issue 4-1: Whether to consider 4-layer MIMO in RRM test cases**

* FFS
	+ Option 1:
		- 4-layer MIMO is not considered in RRM test cases

**Issue 4-2: AoA selection in RRM test cases**

<Online agreement>

* Companies to check the progress in FR2 OTA WI, and whether to define test cases for dual TCI state from dual TCI to dual TCI (e.g. [RS1, RS2] to [RS3, RS4]) is to be decided in RRM session.
* Note: The feasibility of the test with 4 active probles simulateously received by the same UE is pending on the discussion in FR2 OTA WI.

**Issue 4-3: Number of probes in RRM test cases**

* FFS
	+ Option 1:
		- RAN4 don't define test cases for dual TCI state from dual TCI to dual TCI (e.g. [RS1, RS2] to [RS3, RS4]) where 4 active probes are needed.

**Issue 4-4: Test case(s) for fast beam sweeping**

* FFS
	+ Option 1:
		- For R18 multi-Rx reception, it is suggested to introduce one test case to verify the enhancement of faster beam sweeping on each type of SSB based L1 measurements.

**Issue 4-5: Test case(s) for scheduling restriction**

* FFS
	+ Option 1:
		- For R18 multi-Rx reception, it is suggested to introduce one test case to verify the enhancement of scheduling restriction relaxation on CSI-RS based L1 measurements.

**Issue 4-6: Set of test case(s) for multi-Rx in Rel-18**

* FFS
	+ Option 1:
		- RAN4 to define test cases for multi-Rx capable UE at least for:
			* RLM (s-DCI, m-DCI: out-of-sync, in-sync, scheduling restrictions)
			* Cell specific BFD and CBD (s-DCI: BFD and CBD, scheduling restrictions)
			* TRP-specific BFD and CBD (m-DCI: BFD and CBD, scheduling restrictions)
			* TCI state switching (s-DCI, PDCCH repetition, m-DCI when applicable: MAC-CE based switch, DCI-based switch, active TCI state list update, [RRC based switch])
			* L1-RSRP measurements, GBBR-based and non-GBBR based
			* [L1-SINR measurements, non-GBBR based]
	+ Option 2:
		- At high-level, the list of test cases shall include at least test cases for:
			* Dual active TCI state switching,
			* RLM,
			* Link recovery,
			* L1-RSRP measurement period.

## Sub-topic 4-2: Accuracy requirements

**Issue 4-7: Accuracy requirements for multi-Rx in Rel-18**

* FFS
	+ Option 1:
		- The legacy accuracy requirements in section 10.1.20 of TS 38.133 apply for L1-RSRP measurements under multi-rx operation, with a clarification that multi-rx chain L1-RSRP accuracy requirements apply for FR2-1.
		- No new accuracy requirements section is created for L1-RSRP measurements under multi-rx operation.

----EoD---