**3GPP TSG-RAN WG4 Meeting # 111 R4-240x**

**Fukuoka City, Fukuoka, Japan, 20th – 24th May, 2024**

**Agenda item:** 7.3.4

**Source:** Moderator (vivo)

**Title:** Topic summary for [111][204] FR2\_multiRx\_part2

**Document for:** Information

# Introduction

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

7.3.2 RRM performance requirements [NR\_FR2\_multiRX\_DL-Perf]

7.3.2.1 RRM test case design

7.3.2.2 RRM performance requirements

**Recommendation of issues for online discussion:**

For Topic #1:

Issue 1-1: Whether to define new test case for accuracy requirements for multi-Rx measurement

Issue 1-2: Gain accuracy in tests for verifying multi-Rx L1-RSRP accuracy requirements

Issue 1-4: Test requirements for multi-Rx accuracy test

For Topic #2:

Issue 2-2: AoA selection in RRM test cases

Issue 2-2a: Whether and how to define new 2AoA setup for multi-Rx

Issue 2-3: Number of probes in RRM test cases

Issue 2-7: Test case(s) for dual TCI state switching for m-DCI

Issue 2-7a: Test case(s) for dual TCI state switching for s-DCI

# Topic #1: Accuracy requirements test cases

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407297 | Apple | **Proposal 1: It is proposed to consider some allowance Δ in test requirement, where Δ = [9dB].** |
| R4-2407697 | MediaTek inc. | **Proposal 1: No need to introduce new test cases for measurement accuracy for mRx UEs.**  **Proposal 2: Re-use the existing G value of PC3 UEs to mRx UEs.** |
| R4-2408250 | ZTE Corporation, Sanechips | **Observation 1: The range of Rx beam gain [Gmin, Gmax] in legacy L1-RSRP accuracy requirements is large enough for PC3.**  **Proposal 1: The test case for accuracy requirements of GBBR is similar as that for legacy L1-RSRP accuracy requirements.** |
| R4-2408279 | vivo | **Proposal 1: Define test case to verify the accuracy requirements for multi-Rx.**  **Proposal 2: In the accuracy test, UE gain G and rough beam gain reduction D are added as additional margin in test requirements.** |
| R4-2408562 | Huawei, HiSilicon | **Proposal 1: The existing G for PC3 is still applicable for UE supporting multi-Rx.** |
| R4-2408689 | Nokia | 1. There shall be no further relaxations on the Gain ‘G’ values. Existing G values as specified for PC3 shall apply. |
| R4-2408891 | Samsung | **Observation 1: For GBBR, differential L1-RSRP is measured from resources in different resource sets.**  **Observation 2: For GBBR, the reference signals (SSB/CSI-RS resources) are transmitted in TDM manner.**  **Observation 3: The special part of L1-RSRP with GBBR compared to legacy L1-RSRP is that at least two DL-SSB/CSI-RS resource RSRP measurements from the different Resource Set have been made with the different RX beams.**  **Observation 4: For FR2 relative accuracy requirements, provided that two RS-RSRP are measured with the same Rx beam**  **Observation 5: The Minimum Io in dBm/SCS has same value as Minimum SSB\_RP.**  **Proposal 1: The existing side condition Es/IoT can be reused for L1-RSRP measurements with Rel-17 GBBR**  **Proposal 2: The existing G for PC3 is still applicable for the TC of L1-RSRP measurements with Rel-17 GBBR**  **Proposal 3: The existing L1-RSRP absolute accuracy requirement should be applied for L1-RSRP measurements with Rel-17 group-based beam reporting**   * **The existing absolute accuracy requirements should be applied for the cases when L1-RSRP is measured with different Rx beams**   **Proposal 4: The existing relative accuracy requirements should be applied for L1-RSRP measurements with Rel-17 GBBR**   * **The existing relative accuracy requirements should be applied for the cases when L1-RSRP is measured from resources in different resource sets with different Rx beams** |
| R4-2409704 | Ericsson | 1. UE declared AoA separation value for the RF tests can be reused for RRM tests. 2. For GBBR accuracy test, RAN4 to consider 1 AoA in Rx beam peak direction, 1 AoA in non beam peak direction. 3. Once the beam pair direction is found as per proposal 2, RAN4 to agree on no change in direction among the different tests in the AoA set up for the L1-RSRP accuracy requirement. 4. RAN4 to define new test metric called the difference of absolute RSRP and difference of differential RSRP for testing the RSRP accuracy requirement.    1. Where the difference of absolute RSRP is the difference of absolute RSRP values in test n and n+1.    2. Where the difference of differential RSRP is the difference of differential RSRP values in test n and n+1. 5. difference of absolute RSRP or difference of differential RSRP shall be within 0 to 2\*accuracy value (e.g., 13 dB) over the repeated tests. 6. RAN4 not define new Gain value for GBBR L1-RSRP accuracy test. |
| R4-2408284 | vivo | **Draft CR on test cases for performance accuracy for multi-Rx** |
| R4-2408892 | Samsung, Ericsson | **Draft CR on accuracy requirements for L1-RSRP measurements with groupbasedbeamreporting** |
| R4-2409705 | Ericsson, Samsung | **Draft CR to 38.133 for AoA set up for multi-rx and TC for GBBR measurement accuracy** |

*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 1-1: Accuracy test case design

**Issue 1-1: Whether to define new test case for accuracy requirements for multi-Rx measurement**

* Proposals
  + Option 1: (Apple, vivo, Samsung, Ericsson)
    - Define test case to verify the accuracy requirements for multi-Rx.
  + Option 2: (MTK)
    - No need to introduce new test cases for measurement accuracy for mRx UEs.
* Recommended WF
  + Further discuss.

**Issue 1-2: Gain accuracy in tests for verifying multi-Rx L1-RSRP accuracy requirements**

* Proposals
  + Option 1: (Huawei, MTK, ZTE, vivo, Nokia, Samsung, Ericsson)
    - The existing G for PC3 is still applicable for UE supporting multi-Rx.
  + Option 2: (Apple)
    - It is proposed to consider some allowance **Δ** in test requirement, where **Δ** = [9dB].
  + Option 3: (vivo)
    - In the accuracy test, UE gain G and rough beam gain reduction D are added as additional margin in test requirements.
* Recommended WF
  + Agree on
    - The existing G for Rx beam peak direction for PC3 is applicable for multi-Rx UEs.
  + Discuss
    - Whether additional margin is needed in the test requirements for multi-Rx UE
      * Option 1: No additional margin
      * Option 2: Add addition margin as **Δ** = [9dB].
      * Option 3: Add addition margin as rough beam gain reduction D = 5.5dB for PC3

**Issue 1-3: AoA setup for accuracy tests**

* Proposals
  + Option 1: (Ericsson)
    - 2 AoAs, 1 AoA in Rx beam peak direction, 1 AoA in non beam peak direction.
* Recommended WF
  + Further discuss.

**Issue 1-4: Test requirements for multi-Rx accuracy test**

* Proposals
  + Option 1: (Ericsson)
    - RAN4 to define new test metric called the difference of absolute RSRP and difference of differential RSRP for testing the RSRP accuracy requirement.
      * Where the difference of absolute RSRP is the difference of absolute RSRP values in test n and n+1.
      * Where the difference of differential RSRP is the difference of differential RSRP values in test n and n+1.
    - Difference of absolute RSRP or difference of differential RSRP shall be within 0 to 2\*accuracy value (e.g., 13 dB) over the repeated tests.
  + Option 2:
    - Use similar test requirements as in legacy L1-RSRP accuracy test.
* Recommended WF
  + Further discuss.

**Issue 1-5: Accuracy requirements for multi-Rx measurement**

In the last meeting, following was agreed.

* The legacy accuracy requirements for L1-RSRP measurement in section 10.1.20 of TS 38.133 apply to L1-RSRP measurements with Rel-17 group-based beam reporting.
* Proposals
  + Option 1: (Samsung)
    - The existing side condition Es/IoT can be reused for L1-RSRP measurements with Rel-17 GBBR
    - The existing L1-RSRP absolute accuracy requirement should be applied for L1-RSRP measurements with Rel-17 group-based beam reporting
      * The existing absolute accuracy requirements should be applied for the cases when L1-RSRP is measured with different Rx beams
    - The existing relative accuracy requirements should be applied for L1-RSRP measurements with Rel-17 GBBR
      * The existing relative accuracy requirements should be applied for the cases when L1-RSRP is measured from resources in different resource sets with different Rx beams.
* Recommended WF
  + Further discuss.

# Topic #2: Core requirements test cases

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407296 | Apple | **Proposal 1: It is proposed to agree on Option 1: The AoA pair for simultaneous reception with different QCL-typeD in RRM tests is 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.**  **Proposal 2: 2AoA setup for multi-RX should focus on those AoA pairs with a UE-declared AoA separation that can meet the throughput requirement. RX beam peak direction defined for R15 single AoA reception does not need to be singled out for 2AoA setup.**  **Proposal 3: The baseline to verify UE performance of dual TCI state switching is from one TCI state to two TCI states, assuming 3 probes are used in testing.** |
| R4-2407457 | Qualcomm Incorporated | **Proposal 1: For single TCI to uual TCI state switch (RS1 to RS2, RS3), RAN4 to adopt the following test procedure for test direction and probe selection:**   * **Assumption:**    + **TE has 4 physical probes placed at {0, 30, 90, 150} deg.** * **Procedure:**   + **Step 1: Test probe selection for {RS2, RS3}**     - **A pair of directions for {RS2, RS3} is selected based on 2AoA EIS spherical coverage, which is dependent on DUT declared AoA offset as shown in Table 7.3K.3-1 of TS38.101-2.**   + **Step 2: N test iterations at different pairs of test directions with respect to DUT by rotating the DUT**     - **For i = 1: N iterations**       * **Step A: Rotate the DUT and select a pair of probe directions for {RS2, RS3} fulfilling 2AoA EIS spherical coverage percentile of the DUT**       * **Step B: Find a probe direction for RS1, from the two untaken probes for {RS2, RS3}, fulfilling EIS spherical coverage**         + **If fails to find a probe for the test, go to Step A**       * **Step C: Proceed with the test**       * **Increase i by 1, and go to Step A**     - **End**   + **At each set of test directions collected from the above procedure,**     - **RS1 is for anchor TRP**     - **{RS2, RS3} is for**        * **R17 Group-based L1-RSRP measurements**       * **TCI state switch (either CSI-RS or SSB, not mixed-type of RSs for {RS2, RS3})**       * **Scheduling/measurement restrictions**   + **The above procedure can be further simplified by RAN5, if it results in the same test coverage and suits the test purpose.** |
| R4-2407852 | Xiaomi | **Proposal 1: Don’t define testcase for MAC-CE based dual TCI state switch for s-DCI for PDCCH repetition.**  **Observation 1: there is extensive discussion in RF about AOA separation requirement. E.g. due to different UE antenna module placement, the preferred AOA separation angle may be different. The RF requirement is defined based on one of AOA separations declared by UE.**  **Observation 2: The legacy 2 AOA setup can’t be directly used where AOA separation with 30 degree is chosen. However, for simultaneous reception, AOA separation angle should be based on UE declaration.**  **Observation 3: It’s hard to know which two AOA setup can work before RF test.**  **Proposal 2: RAN4 to define RRM test with only one AOA separation angle which is declared by UE.** |
| R4-2408251 | ZTE Corporation, Sanechips | **Proposal 1: The AoA pair for simultaneous reception with different QCL-typeD in RRM tests is 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.**  **Proposal 2: It is suggested to verify the dual to dual active TCI state switching from [RS 1, RS 2] to [RS 1, RS3] under the assumption of 3 active probes.**  **Observation 1: If the UE only support one fixed AoA offset and satisfy the requirements under such AoA offset, the UE may fail to pass the test of dual to dua active TCI state switching from [RS 1, RS 3] to [RS 2, RS 4].**  **Proposal 3: It is suggested to verify the dual to single active TCI state switching from [RS 1, RS 2] to RS 1 to verify no switching delay and no interruption.** |
| R4-2408280 | vivo | **Proposal 1: The AoA pair selection for RRM tests is that the AoA pair for simultaneous reception with different QCL-typeD is from the set of AoA pairs that meets throughput requirements according to the spherical coverage requirement for simultaneous reception from multiple directions as defined in clause 7.3K.3 of TS 38.101-2.**  **Proposal 2: Define one new 2 AoAs setup for multi-Rx with AoA beams from non-Rx beam peak direction. It can be based on legacy AoA setup 3 with new AoA selection principle and angular offset.**  **Proposal 3: Define test cases for verifying m-DCI based dual TCI states switch requirements with 3 probes, i.e., from [RS1] to [RS2, RS3].**  **Proposal 4: Not to define test cases MAC-CE based dual TCI states switch with m-DCI.**  **Proposal 5: In test case for s-DCI based dual TCI states switch, it is defined with from [RS1] to [RS2, RS3].** |
| R4-2408560 | Huawei, HiSilicon | **Proposal 1: Verify the requirements (no switching delay) for [RS1, RS2] to [RS1] at the same TC for [RS1] to [RS1, RS2]. In details, TE sends the commands to DUT to change the TCI states from [RS1, RS2] to [RS1] after the TCI state switching from [RS1] to [RS1, RS2].**  **Proposal 2: The AoA pair for simultaneous reception with different QCL-typeD in RRM tests is 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.**  **Proposal 3: At least following two new AoA Setups need to be defined:**   * **New AoA Setup X1: 2 AoAs**   **There are 2 active probes in the test. The DL signals, and noise if applicable, transmitted from the two active probes, align to directions (AoAs) which are from the set of directions corresponding to the EIS spherical coverage percentile of the DUT as defined in clause 7.3K.3 of TS 38.101-2 [19]. And the DL signals, and noise if applicable, transmitted from one of the two active probes is also align to directions (AoAs) which are 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].** **The relative angular offset between the directions (AoAs) of the 2 active probes is based on the UE’s declared orientation as defined in clause 7.3K.3 of TS 38.101-2 [19].**   * **New AoA Setup X2: 3 AoAs**   **There are 3 active probes in the test. The DL signals, and noise if applicable, transmitted from the two of active probes, align to directions (AoAs) which are from the set of directions corresponding to the EIS spherical coverage percentile of the DUT as defined in clause 7.3K.3 of TS 38.101-2 [19]. And the DL signals, and noise if applicable, transmitted from the third probe is also align to directions (AoAs) which are 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]. The relative angular offset between the directions (AoAs) of the first and second active probes is based on the UE’s declared orientation as defined in clause 7.3K.3 of TS 38.101-2 [19].** |
| R4-2408893 | Samsung | **Observation 1: The declared AoA separations defined in RF Section 7.3K.3 is for the relative angular relationships between two spherical coverage directions**  **Proposal 1: The 2AoAs for FR2 RRM test case are from the set of directions corresponding to the 2AoA spherical coverage requirement for simultaneous reception from multiple directions as defined in clause 7.3K of TS 38.101-2.**  **Proposal 2: RRM need to consider the declared AoA separation and all the corresponding directions defined in RF requirements**  **Proposal 3: For 2 AoAs, 1 AoA in Rx beam peak direction, 1 in non Rx beam peak for simultaneous reception from multiple directions, the AoA in non-peak beam direction could be changed between different test iterations.**   * **The applicable set of relative angular offsets between the 2 active probes is given in Table 3.15.3-1**   **Proposal 4: RAN4 to define the following new 2AoA setups for multi-Rx**   * **AoAs, both AoAs are in non Rx beam peak directions**   + **RRM need to consider the declared AoA separation and all the corresponding directions defined in RF requirements** * **2 AoAs, 1 AoA in Rx beam peak direction, 1 in non Rx beam peak without change in direction** * **2 AoAs, 1 AoA in Rx beam peak direction, 1 in non Rx beam peak with change in direction**   + **RRM can consider the RF declared AoA separation and all directions as the priority potential selection**   **Proposal 5: RAN4 to define a new 3AoA setup for multi-Rx to test dual TCI switching case**  **Proposal 6: No DRX is configured for test setup for fast beam sweeping**  **Proposal 7: The new 2AoA setup: 2AoAs, both AoAs are in spherical coverage directions shall be applied for RLM OOS non-DRX test case**  **Proposal 8: The new 2AoA setup: both AoAs are in non Rx beam peak directions shall be applied for scheduling restriction, L1-RSRP GBBR and measurement restriction TC.**   * **Suggest to assume fine beams**   **Proposal 9: The new 3AoA setup shall be applied for** **dual TCI state switching TC.**   * **3 active probes should be announced** * **TDM’ing of transmissions from the AoA0 and AoA pair {AoA1, AoA2} should be assumed.** * **The maximum number of simultaneously active (emulating signal) AoA NMAX\_AoAs=2 is still satisfied under 3AoA setup assumption**   **Proposal 10: For multi-Rx test case that signals transmitted from the spherical coverage directions, the following test parameters shall be considered:**   * **Data RBs allocated: 24** * **PDSCH Reference measurement channel: SR.3. 2 TDD**   **Proposal 11: Prefer to use OCNG pattern 5 as the baseline for all the new TCs with 2AoA setup for multi-Rx simultaneous reception.**  **Proposal 12: RAN4 to discuss whether to add a scheduling parameter to the RMC’s to specify in which slot each AoA/AoA pair can transmit/receive for multi-Rx** |
| R4-2409138 | Nokia | [**Observation 1:** When the UE needs to switch only one TCI state while the other one is common i.e. [RS1, RS2], to [RS1, RS3] then legacy delay requirements apply. There is no need to test this scenario again.](#_Toc166512588)  [Proposal 1: Since dual to dual TCI state switch in m-DCI would be a common occurrence, test case needs to be defined for this scenario.](#_Toc166512589)  [Proposal 2: Define a dual-to-dual TCI test case for m-DCI, where the UE needs to switch both the TCI states i.e. [RS1, RS3], to [RS2, RS4], with [RS1, RS3] and [RS2, RS4] each forming beam pairs.](#_Toc166512590)  [Proposal 3: When less than four probes are used, the test equipment should emulate different DL transmit beams by transmitting different signals with different power and delay.](#_Toc166512591)  [**Observation 2:** 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 coverage.](#_Toc166512592)  [**Observation 3:** Spherical coverage for m-Rx will require the UE to pass the spherical coverage at a declared 2 AoA separation.](#_Toc166512593)  [Proposal 4: How to conduct the dual TCI state switch delay requirements using three probes which are within the UE’s spherical coverage during the test duration needs to be discussed.](#_Toc166512594)  [Proposal 5: Test cases for DCI based and MAC-CE dual TCI state switch for m-DCI need to be defined.](#_Toc166512595)  [**Observation 4:** DCI based TCI state switch test case where the UE switches from RS1 to RS1+RS2 can reuse the existing SSB configuration already specified.](#_Toc166512596)  [**Observation 5:** For 2 AoA setup, even if two AoAs are used, these need to be setup for simultaneous reception.](#_Toc166512597)  [Proposal 6: Introduce new 2 AoA setup for simultaneous reception.](#_Toc166512598)  [**Observation 6:** For dual TCI state switch test cases, where UE needs to switch from RS1+RS2 to RS1+RS3, three AoAs need to be defined and setup for simultaneous reception.](#_Toc166512599)  [Proposal 7: Introduce new 3 AoA setup for simultaneous reception in dual-to-dual TCI switching test cases.](#_Toc166512600)  [**Observation 7:** For dual TCI state switch test cases, where UE needs to switch from RS1+RS2 to RS1+RS3, three SSBs will be required. Additional SSB and corresponding TRS resource set configuration needs to be defined for testing.](#_Toc166512601) |
| R4-2409703 | Ericsson | 1. UE declared AoA separation value for the RF tests can be reused for RRM tests. 2. RAN4 to define new AoA set up with following AoA in the test set up    1. One AoA in the Rx beam peak direction and other AoA in Spherical coverage direction    2. Both the AoA in Spherical coverage direction or non-beam peak direction 3. RAN4 to agree on RS1 to (RS1, RS2) switch for DCI based TCI state switch for s-DCI and RS1 to (RS2, RS3) switch for MAC-CE based dual TCI state switch for s-DCI for PDCCH repetition 4. For TCI state switching test case, RAN4 should define a AoA setup with three active probes. Where the AoA separation between the active probes are 30, 60, 90, 120 and 150 degrees. 5. RAN4 to agree on the following AoA setup for TCI state switching  * SetupX1a:   + There are 3 active probes in the test and at any time UE needs to receive at most on two probes simultaneously. The DL signals, and noise are transmitted from the three active probes. The AoA separation between the two active probes on which UE needs to receive simultaneously is 30, 60, 90, 120 and 150 degrees. The active probes are in spherical coverage direction.  1. RAN4 to agree on the following AoA setup for RLM TC for fast beam sweeping  * SetupX1B:   + There are 2 active probes in the test. The DL signals, and noise are transmitted from the two active probes. UE need to receive on the active probes simultaneously. The AoA separation between the two active probes is 30, 60, 90, 120 and 150 degrees. The active probes are in spherical coverage direction.  1. RAN4 to agree on the following AoA setup for Scheduling restriction, measurement restriction and L1-RSRP GBBR and CSI-RS based BFD.  * Setup 1C:   + There are 2 active probes in the test. The DL signals, and noise are transmitted from the two active probes. The AoA separation between the two active probes is 30, 60, 90, 120 and 150 degrees. The active probes are in spherical coverage direction. |
| R4-2407696 | MediaTek inc. | **Draft CR on TC for scheduling and measurement restriction relaxation for L1-RSRP on FR2-1** |
| R4-2407853 | Xiaomi | **DraftCR on TC for MAC CE based TCI state activation in sDCI in Multi-RX** |
| R4-2407870 | OPPO, Xiaomi | **Draft CR on TRP specific CSI-RS based BFD measurement delay for multi-Rx** |
| R4-2408282 | vivo, Ericsson | **Big CR to TS 38.133 on performance requirements for NR FR2 multi-Rx chain DL reception** |
| R4-2408283 | vivo | **Draft CR on test cases for m-DCI based TCI dual states switch for multi-Rx** |
| R4-2408561 | Huawei, HiSilicon | **DraftCR on TC3 fast beam sweeping for R18 FR2 multi-Rx** |
| R4-2408688 | Nokia | **Draft CR for TC for mRx s-DCI DCI-based TCI state switch and related configurations** |

*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: Test cases design

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

* Proposals
  + Option 1a: (Apple, ZTE, Huawei)
    - The AoA pair for simultaneous reception with different QCL-typeD in RRM tests is 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.
  + Option 1b: (vivo)
    - The AoA pair for simultaneous reception with different QCL-typeD in RRM tests is from the set of AoA pairs that meets throughput requirements according to the spherical coverage requirement for simultaneous reception from multiple directions as defined in clause 7.3K.3 of TS 38.101-2.
  + Option 1c: (Samsung)
    - The 2AoAs for FR2 RRM test case are from the set of directions corresponding to the 2AoA spherical coverage requirement for simultaneous reception from multiple directions as defined in clause 7.3K of TS 38.101-2.
  + Option 1d (Qualcomm)
    - A pair of directions for {RS2, RS3} is selected based on 2AoA EIS spherical coverage, which is dependent on DUT declared AoA offset as shown in Table 7.3K.3-1 of TS38.101-2.
  + Option 2: (Xiaomi)
    - RAN4 to define RRM test with only one AOA separation angle which is declared by UE.
* Recommended WF
  + Discuss, if additional modification is needed, and agree on
    - The AoA pair for simultaneous reception with different QCL-typeD in RRM tests is 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.

**Issue 2-2a: Whether and how to define new 2AoA setup for multi-Rx**

* Proposals
  + Option 1: (Apple)
    - 2AoA setup for multi-RX should focus on those AoA pairs with a UE-declared AoA separation that can meet the throughput requirement.
    - RX beam peak direction defined for R15 single AoA reception does not need to be singled out for 2AoA setup.
  + Option 2: (vivo)
    - Define one new 2 AoAs setup for multi-Rx with AoA beams from non-Rx beam peak direction.
    - It can be based on legacy AoA setup 3 with new AoA selection principle and angular offset.
  + Option 3: (Nokia)
    - Introduce new 3 AoA setup for simultaneous reception in dual-to-dual TCI switching test cases.
    - Introduce new 2 AoA setup for simultaneous reception.
  + Option 4: (Huawei)
    - New AoA Setup X1: 2 AoAs
      * There are 2 active probes in the test. The DL signals, and noise if applicable, transmitted from the two active probes, align to directions (AoAs) which are from the set of directions corresponding to the EIS spherical coverage percentile of the DUT as defined in clause 7.3K.3 of TS 38.101-2 [19]. And the DL signals, and noise if applicable, transmitted from one of the two active probes is also align to directions (AoAs) which are 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]. The relative angular offset between the directions (AoAs) of the 2 active probes is based on the UE’s declared orientation as defined in clause 7.3K.3 of TS 38.101-2 [19].
    - New AoA Setup X2: 3 AoAs
      * There are 3 active probes in the test. The DL signals, and noise if applicable, transmitted from the two of active probes, align to directions (AoAs) which are from the set of directions corresponding to the EIS spherical coverage percentile of the DUT as defined in clause 7.3K.3 of TS 38.101-2 [19]. And the DL signals, and noise if applicable, transmitted from the third probe is also align to directions (AoAs) which are 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]. The relative angular offset between the directions (AoAs) of the first and second active probes is based on the UE’s declared orientation as defined in clause 7.3K.3 of TS 38.101-2 [19].
  + Option 5: (Samsung)
    - RAN4 to define the following new 2AoA setups for multi-Rx
      * 2 AoAs, both AoAs are in non Rx beam peak directions
        + RRM need to consider the declared AoA separation and all the corresponding directions defined in RF requirements
      * 2 AoAs, 1 AoA in Rx beam peak direction, 1 in non Rx beam peak without change in direction
      * 2 AoAs, 1 AoA in Rx beam peak direction, 1 in non Rx beam peak with change in direction
        + RRM can consider the RF declared AoA separation and all directions as the priority potential selection
    - RAN4 to define a new 3AoA setup for multi-Rx to test dual TCI switching case
  + Option 6: (Ericsson)
    - RAN4 to define new AoA set up with following AoA in the test set up
      * One AoA in the Rx beam peak direction and other AoA in Spherical coverage direction
      * Both the AoA in Spherical coverage direction or non-beam peak direction.
    - SetupX1a:
      * There are 3 active probes in the test and at any time UE needs to receive at most on two probes simultaneously. The DL signals, and noise are transmitted from the three active probes. The AoA separation between the two active probes on which UE needs to receive simultaneously is 30, 60, 90, 120 and 150 degrees. The active probes are in spherical coverage direction.
    - SetupX1B:
      * There are 2 active probes in the test. The DL signals, and noise are transmitted from the two active probes. UE need to receive on the active probes simultaneously. The AoA separation between the two active probes is 30, 60, 90, 120 and 150 degrees. The active probes are in spherical coverage direction.
    - Setup 1C:
      * There are 2 active probes in the test. The DL signals, and noise are transmitted from the two active probes. The AoA separation between the two active probes is 30, 60, 90, 120 and 150 degrees. The active probes are in spherical coverage direction.
  + Option 7: (Qualcomm)
    - Step 1: Test probe selection for {RS2, RS3}
      * A pair of directions for {RS2, RS3} is selected based on 2AoA EIS spherical coverage, which is dependent on DUT declared AoA offset as shown in Table 7.3K.3-1 of TS38.101-2.
    - Step 2: N test iterations at different pairs of test directions with respect to DUT by rotating the DUT
      * For i = 1: N iterations
        + Step A: Rotate the DUT and select a pair of probe directions for {RS2, RS3} fulfilling 2AoA EIS spherical coverage percentile of the DUT
        + Step B: Find a probe direction for RS1, from the two untaken probes for {RS2, RS3}, fulfilling EIS spherical coverage

If fails to find a probe for the test, go to Step A

* + - * + Step C: Proceed with the test
        + Increase i by 1, and go to Step A
      * End
    - At each set of test directions collected from the above procedure,
      * RS1 is for anchor TRP
      * {RS2, RS3} is for
        + R17 Group-based L1-RSRP measurements
        + TCI state switch (either CSI-RS or SSB, not mixed-type of RSs for {RS2, RS3})
        + Scheduling/measurement restrictions
    - The above procedure can be further simplified by RAN5, if it results in the same test coverage and suits the test purpose.
    - Assumption: TE has 4 physical probes placed at {0, 30, 90, 150} deg.
* Recommended WF
  + Discuss and agree on the following
    - Introduce new AoA Setup X1: 3 AoAs, 1 AoA in Rx beam peak direction, 2 AoAs in non Rx beam peak directions
      * The single AoA is aligned to the UE Rx beam peak direction as defined in TS 38.101-2.
      * The AoA pair for simultaneous reception with different QCL-typeD is 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].
      * The relative angular offset between the directions of the AoA pair is based on the UE’s declared orientation as defined in clause 7.3K.3 of TS 38.101-2.
    - Introduce new AoA Setup X2: 2 AoAs, both AoAs are in non Rx beam peak directions
      * The 2 AoAs for simultaneous reception with different QCL-typeD is 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].
      * The relative angular offset between the directions of the 2 AoAs is based on the UE’s declared orientation as defined in clause 7.3K.3 of TS 38.101-2.
    - FFS introduce new AoA Setup X3: 2 AoAs, 1 AoA in Rx beam peak direction, 1 AoA in non Rx beam peak without change in direction
    - FFS introduce new AoA Setup X4: 1 AoA in Rx beam peak direction, 1 AoA in non Rx beam peak with change in direction

**Issue 2-3: Number of probes in RRM test cases**

* Proposals
  + Option 1: (Apple)
    - The baseline to verify UE performance of dual TCI state switching is from one TCI state to two TCI states, assuming 3 probes are used in testing.
  + Option 2: (ZTE)
    - It is suggested to verify the dual to dual active TCI state switching from [RS 1, RS 2] to [RS 1, RS3] under the assumption of 3 active probes.
  + Option 3: (vivo)
    - Define test cases for verifying m-DCI based dual TCI states switch requirements with 3 probes, i.e., from [RS1] to [RS2, RS3].
  + Option 4: (Nokia)
    - Define a dual-to-dual TCI test case for m-DCI, where the UE needs to switch both the TCI states i.e. [RS1, RS3], to [RS2, RS4], with [RS1, RS3] and [RS2, RS4] each forming beam pairs.
    - When less than four probes are used, the test equipment should emulate different DL transmit beams by transmitting different signals with different power and delay.
* Recommended WF
  + Discuss and agree on the following.
    - RRM test cases for multi-Rx are defined with at most 3 active probes needed in the tests.

**Issue 2-7: Test case(s) for dual TCI state switching for m-DCI**

* Proposals
  + Option 1: (ZTE)
    - It is suggested to verify the dual to dual active TCI state switching from [RS 1, RS 2] to [RS 1, RS3] under the assumption of 3 active probes.
  + Option 2: (vivo)
    - Define test cases for verifying m-DCI based dual TCI states switch requirements with 3 probes, i.e., from [RS1] to [RS2, RS3].
    - Not to define test cases MAC-CE based dual TCI states switch with m-DCI.
  + Option 3: (Nokia)
    - Test cases for DCI based and MAC-CE dual TCI state switch for m-DCI need to be defined.
* Recommended WF
  + Discuss and agree on the following.
    - Introduce one test case for DCI based dual TCI state switch for m-DCI. Discuss following setup
      * Option 1: from [RS1] to [RS2, RS3]
      * Option 2: from [RS 1, RS 2] to [RS 1, RS3]
      * Option 3: from [RS1, RS2] to [RS3, RS4] with 3 active probes.
    - Discuss test case for MAC-CE based dual TCI state switch for m-DCI

**Issue 2-7a: Test case(s) for dual TCI state switching for s-DCI**

Agreements in the last meeting:

* TC1: DCI based TCI state switch for s-DCI
  + As starting point: [RS1] to [RS1, RS2].
  + FFS [RS1, RS2] to [RS1, RS3].
  + FFS [RS1, RS2] to [RS1]
  + Active TCI state list update is included during the test
* TC2: MAC-CE based dual TCI state switch for s-DCI for PDCCH repetition
  + [RS1] to [RS2, RS3]
* Proposals
  + Option 1: (Xiaomi)
    - Don’t define testcase for MAC-CE based dual TCI state switch for s-DCI for PDCCH repetition.
  + Option 2: (ZTE)
    - It is suggested to verify the dual to single active TCI state switching from [RS 1, RS 2] to RS 1 to verify no switching delay and no interruption.
  + Option 3: (vivo)
    - In test case for s-DCI based dual TCI states switch, it is defined with from [RS1] to [RS2, RS3].
  + Option 4: (Huawei)
    - Verify the requirements (no switching delay) for [RS1, RS2] to [RS1] at the same TC for [RS1] to [RS1, RS2].
    - In details, TE sends the commands to DUT to change the TCI states from [RS1, RS2] to [RS1] after the TCI state switching from [RS1] to [RS1, RS2].
  + Option 5: (Ericsson)
    - RS1 to (RS1, RS2) switch for DCI based TCI state switch for s-DCI
    - RS1 to (RS2, RS3) switch for MAC-CE based dual TCI state switch for s-DCI for PDCCH repetition
* Recommended WF
  + Discuss whether this is any issue on defining test case for MAC-CE based dual TCI state switch for s-DCI for PDCCH repetition.
  + Discuss whether to define test case for DCI based dual TCI state switch for s-DCI with dual to single active TCI state switching from [RS 1, RS 2] to RS 1.
    - It may be combined in the same test case for [RS1] to [RS1, RS2].
  + Discuss whether to change setup from [RS1] to [RS1, RS2] to [RS1] to [RS2, RS3] for DCI based dual TCI state switch for s-DCI.

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

*Sub-topic description:*

*Open issues and candidate options before f2f meeting:*

**Issue 2-12: Test setup for fast beam sweeping**

* Proposals
  + Option 1: (Samsung)
    - No DRX is configured for test setup for fast beam sweeping
    - The new 2AoA setup: 2AoAs, both AoAs are in spherical coverage directions shall be applied for RLM OOS non-DRX test case
* Recommended WF
  + Discuss and agree on the following.
    - Setup X2 is used in test case for fast beam sweeping.

**Issue 2-13: Test setup for dual TCI state switching**

* Proposals
  + Option 1: (Samsung)
    - The new 3AoA setup shall be applied for dual TCI state switching TC.
      * 3 active probes should be announced
      * TDM’ing of transmissions from the AoA0 and AoA pair {AoA1, AoA2} should be assumed.
      * The maximum number of simultaneously active (emulating signal) AoA NMAX\_AoAs=2 is still satisfied under 3AoA setup assumption
  + Option 2: (Nokia)
    - For dual TCI state switch test cases, where UE needs to switch from RS1+RS2 to RS1+RS3, three AoAs need to be defined and setup for simultaneous reception.
    - Introduce new 3 AoA setup for simultaneous reception in dual-to-dual TCI switching test cases.
    - For dual TCI state switch test cases with 3 AoA setup, where UE needs to switch from RS1+RS2 to RS1+RS3, three SSBs will be required. Additional SSB and corresponding TRS resource set configuration need to be defined for testing.
* Recommended WF
  + Discuss and agree on the following.
    - Setup X1 is used in the test case for dual TCI state switching.

**Issue 2-14: Test setup for scheduling restriction, L1-RSRP GBBR and measurement restriction**

* Proposals
  + Option 1: (Samsung)
    - The new 2AoA setup: both AoAs are in non Rx beam peak directions shall be applied for scheduling restriction, L1-RSRP GBBR and measurement restriction TC.
      * Suggest to assume fine beams
* Recommended WF
  + Discuss and agree on the following.
    - Setup X2 is used in the test case for dual TCI state switching.

**Issue 2-16: Test parameters setup**

* Proposals
  + Option 1: (Samsung)
    - For multi-Rx test case that signals transmitted from the spherical coverage directions, the following test parameters shall be considered:
      * Data RBs allocated: 24
      * PDSCH Reference measurement channel: SR.3. 2 TDD
    - Prefer to use OCNG pattern 5 as the baseline for all the new TCs with 2AoA setup for multi-Rx simultaneous reception.
    - RAN4 to discuss whether to add a scheduling parameter to the RMC’s to specify in which slot each AoA/AoA pair can transmit/receive for multi-Rx
* Recommended WF
  + Further discuss.

---EoD---