**3GPP TSG-RAN WG4 Meeting # 107 R4-23xxxxx**

**Incheon, KR, May 22nd – May 26th , 2023**

**Agenda item:** 8.3.6

**Source:** Qualcomm Incorporated

**Title:** Ad-hoc minutes for [107][331] FS\_NR\_FR2\_OTA\_enh

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

The summary is to summarize the open issues for Rel-18 SI on NR FR2 OTA testing enhancements and up to Rel-16 OTA maintenance. The summary covers the contributions submitted under the following agendas:

* 4.6 OTA and TRP/TRS test aspects (R4-2307504)
* 8.3 Study on NR FR2 OTA testing enhancements

# Topic #1: Test method for UE RF

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2307933 | Samsung | **Observation 1: multi-RX DL 2AoA spherical coverage test result in not in dBm unit but in percentage.**  **Observation 2: UE orientation itself is part of Multi-RX core-requirement and hence deviation analysis based on numerous random orientation may be not doable.**  **Proposal 1: RAN4 further discuss how the measurement grid analysis could be done for multi-RX DL 2AoA spherical coverage.**  **Proposal 2: companies are encouraged to compare the simulation results difference between fine grids and coarse grids. Fine grids are suggested with <=2deg step size, and course grids are suggested to be 15deg step size.**  **Proposal 3: Both sin θ weighting and Clenshaw-Curtis weighting should be included in the measurement grid analysis.** |
| R4-2308235 | vivo | **Observation: Finer test grid requires higher UE capability and also enlarges the test time.**  **Proposal: The step size of the test grid for multi-Rx verification should be 15°.** |
| R4-2308980 | OPPO | **Proposal: It is proposed to adopt the coordinate (θ, ϕ, ω) to represent the AoA pair on the measurement grid to eliminate the test point expression ambiguity, where ω demonstrates AoA1-AoA2 DL Orientation Vector.** |
| R4-2309300 | Huawei, HiSilicon | **Proposal 1: The Far-field criteria defined for the IFF UE RF test method described in clause 5.2.1 of TR 38.810 can be reused for IFF based multi-AoA test system.**  **Proposal 2: The Far-field criteria defined for the DFF UE RF test method described in clause 5.2.3 of TR 38.810 can be reused for DFF based multi-AoA test system.** |
| R4-2309435 | Rohde & Schwarz | **Proposal 1: continue progressing in the definition of the non-parametric test approach for spherical coverage using the diagram in Figure 2 1 as baseline** |
| R4-2309469 | Keysight Technologies UK Ltd | **Proposal 1: Consider the previous agreement for absolute probe locations for UE RF testing unnecessary for multi-Rx UE RF testing using the proposed test system and testing methodology.**  **Proposal 2: Consider any 2 AoA RRM test system with probes in the *xz* plane and the required relative angular offsets for Multi-Rx testing suitable for Multi-Rx OTA spherical coverage test cases.** |
| R4-2309287 | Qualcomm Incorporated | **TP to TR 38.871 on 3-axis positioner considerations** |

## Open issues summary

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

### Sub-topic 1-1: Measurement grid

*Sub-topic description:*

*Open issues and candidate options before meeting:*

**Issue 1-1-1: Measurement grid analysis for preliminary MU**

* Proposals
  + Option 1 (R4-2307933): RAN4 further discuss how the measurement grid analysis could be done for multi-RX DL 2AoA spherical coverage. Both sin θ weighting and Clenshaw-Curtis weighting should be included in the measurement grid analysis.
  + Option 2 (R4-2307933): Companies are encouraged to compare the simulation results difference between fine grids and coarse grids. Fine grids are suggested with <=2deg step size, and course grids are suggested to be 15deg step size.
* Recommended WF
  + TBA

**Issue 1-1-2: Constant step size**

* Proposals
  + Option 1 (R4-2308235): The step size of the test grid for multi-Rx verification should be 15°
* Recommended WF
  + TBA

**Issue 1-1-3: How to represent AoA pair in the measurement grid**

* Proposals
  + Option 1 (R4-2308980): Adopt the coordinate (θ, ϕ, ω) to represent the AoA pair on the measurement grid to eliminate the test point expression ambiguity, where ω demonstrates AoA1-AoA2 DL Orientation Vector.

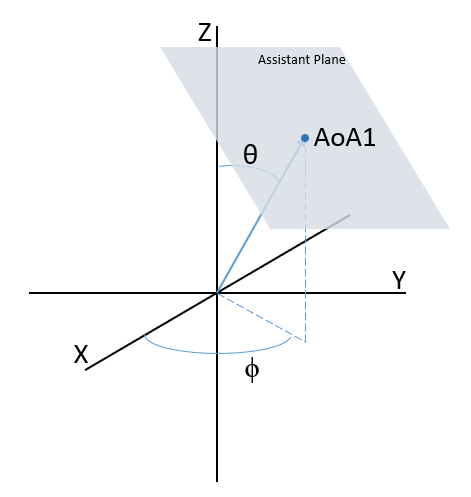
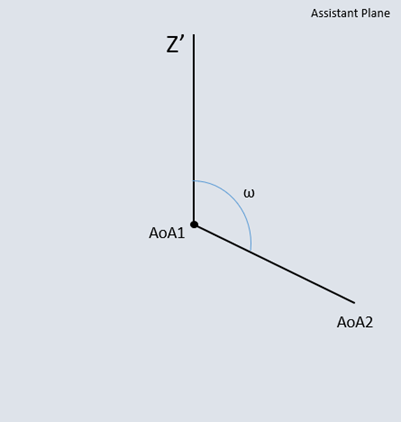
 

Figure 1.2.1-1: Illustration of representation of AoA1-AoA2 pair (R4-2308980)

* + Option 2: TBA
* Recommended WF
  + TBA

### Sub-topic 1-2: Far-field criteria

*Sub-topic description*

*Open issues and candidate options before meeting:*

**Issue 1-2-1: Far-field criteria for IFF**

* Proposals
  + Option 1(R4-2309300): The Far-field criteria defined for the IFF UE RF test method described in clause 5.2.3 of TR 38.810 can be reused for IFF based multi-AoA test system.
  + Option 2: TBA
* Recommended WF
  + TBA

**Issue 1-2-2: Far-field criteria for DFF**

* Proposals
  + Option 1(R4-2309300): The Far-field criteria defined for the DFF UE RF test method described in clause 5.2.1 of TR 38.810 can be reused for DFF based multi-AoA test system
  + Option 2: TBA
* Recommended WF
  + TBA

### Sub-topic 1-3: Test procedure

**Issue 1-3: Test procedure**

* Proposals
  + Option 1(R4-2309435): Continue progressing in the definition of the non-parametric test approach for spherical coverage using the diagram in as baseline.



Figure 1.2.3-1: Test procedure for non-parametric test approach (R4-2309435)

* + Option 2: TBA
* Recommended WF
  + TBA

### Sub-topic 1-4: Probe locations

**Issue 1-4-1: Absolute probe locations**

* Proposals
  + Option 1 (R4-2309469): Consider the previous agreement for absolute probe locations for UE RF testing unnecessary for multi-Rx UE RF testing using the proposed test system and testing methodology.
  + Option 2: TBA
* Recommended WF
  + TBA

**Issue 1-4-2: Example of measurement setup implementation**

* Proposals
  + Option 1 (R4-2309469): Consider any 2 AoA RRM test system with probes in the xz plane and the required relative angular offsets for Multi-Rx testing suitable for Multi-Rx OTA spherical coverage test cases.
  + Option 2: TBA
* Recommended WF
  + TBA

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Title of TP** |
| R4-2309287 | TP to TR 38.871 on 3-axis positioner considerations |

# Topic #2: Test method for UE RRM

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2309245 | Qualcomm Incorporated | **Observation 1: With fine beams from AoA1 and AoA2, the lower bound of G1/G2 can be derived based on the case when AoA1 is from beam peak direction and AoA2 is from the direction at 50% of legacy EIS spherical coverage CDF, and vice versa.**  **Proposal 1: For fine beam, the lower bound of G1/G2 is the gain different from legacy REFSENS and legacy EIS spherical coverage.**  **Proposal 2: For rough beam, the lower bound of G1/G2 is smaller than that for fine beam. FFS on the difference of lower bound of G1/G2 between fine and rough beams.**  **Observation 2: Legacy RRM test system could be reused for scenario 1 and the only difference is SINR control for simultaneous transmission from 2AoAs need to be studied.**  **Observation 3: At least 3 probes need to be supported by test system to achieve the switching from probe 2 to probe 3 in scenario 2. The SINR control for simultaneous transmission from 2AoAs needs to be studied.**  **Observation 4: At least 4 probes need to be supported by test system to achieve the switching from probe 2 to probe 3 and switching from probe 0 to probe 4 in scenario 3. The SINR control for simultaneous transmission from 2AoAs needs to be studied.**  **Proposal 3: It is encouraged TE vendors provide input on the testability of scenario 1/2/3. The conclusion of SINR control for simultaneous transmission from 2AoAs can be applied for all three scenarios.** |
| R4-2309305 | Huawei, HiSilicon | **Proposal 1: For TCI switching case from dual TCI to dual TCI case, RAN4 to consider 4 AoAs rather 2 AoAs.**  **Observation1: Since the performance test cases for TCI switching case from dual TCI to dual TCI have not been discussed in multi-RX RRM part at this stage, it is difficult to confirm the feasible without the input on required SINR and side condition from multi-RX RRM part.**  **Proposal 2: Feasibility of TCI switching case from dual TCI to dual TCI is deprioritized and postponed until RRM has some conclusions on it.** |
| R4-2309246 | Qualcomm Incorporated | **TP to TR 38.871 on RRM test method** |

## Open issues summary

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

### Sub-topic 2-1: Scenarios of multi-Rx RRM testing

*Sub-topic description*

*Open issues and candidate options before meeting:*

**Issue 2-1-1: Testability analysis for the RRM testing scenarios**

* Proposals
  + Option 1: RAN4 consider the following 3 scenarios to study the testability issue. Input from TE vendors are encouraged.
    - Scenario 1(R4-2309245): probe number for multiple AoA test system is at least 2



Figure 2.2.2-1: Illustration of scenario 1 (R4-2309245)

* + - Scenario 2 (R4-2309245): probe number for multiple AoA test system is at least 3



Figure 2.2.2-2: Illustration of scenario 2 (R4-2309245)

* + - Scenario 3 (R4-2309245, R4-2309305): probe number for multiple AoA test system is at least 4 (e.g., TCI switching case from dual TCI to dual TCI case)



Figure 2.2.2-3: Illustration of scenario 3 (R4-2309245)

* + Option 2 (R4-2309305): Feasibility/testability of Scenario 3, e.g., TCI switching case from dual TCI to dual TCI is deprioritized and postponed until RRM has some conclusions on it
* Recommended WF
  + TBA

**Issue 2-1-2: SINR control for the RRM testing scenarios**

* Proposals
  + Option 1 (R4-2309245): The conclusion of SINR control for simultaneous transmission from 2AoAs can be applied for all three scenarios in Issue 2-1-1.
  + Option 2: TBA

### Sub-topic 2-2: SINR control

*Sub-topic description:*

*Open issues and candidate options before meeting:*

**Issue 2-2-1: SINR control for fine beam**

* Proposals
  + Option 1 (R4-2309245): For fine beam, the lower bound of G1/G2 is the gain different from legacy REFSENS and legacy EIS spherical coverage.
  + Option 2: TBA
* Recommended WF
  + TBA

**Issue 2-2-2: SINR control for rough beam**

* Proposals
  + Option 1 (R4-2309245): For rough beam, the lower bound of G1/G2 is smaller than that for fine beam. FFS on the difference of lower bound of G1/G2 between fine and rough beams.
  + Option 2: TBA
* Recommended WF
  + TBA

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Title of TP** |
| R4-2309246 | TP to TR 38.871 on RRM test method |

# Topic #3: Test method for UE Demodulation

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2309244 | Qualcomm Incorporated | **Observation 1: In the legacy FR2 demodulation testing, Noc level configured in TE transmitter should guarantee no larger than 1dB difference between Reference point SNR and Baseband SNR.**  **Observation 2: In legacy FR2 demodulation testing, to achieve 1dB different between reference SNR and baseband SNR, Noc value is set based on the side condition that the test direction shall pass the legacy REFSENS requirement.**  **Observation 3: The testable SNR for legacy FR2 demodulation testing is also derived based on the criterion that the test direction satisfies the REFSENS requirement.**  **Observation 4: If minimum isolation can be achieved between all the branches, there is no difference between legacy and multi-Rx demodulation test per branch for the procedure configuring the Noc level.**  **Proposal 1: RAN4 to confirm the test direction should guarantee 1dB difference between Reference point SNR and Baseband SNR in multi-Rx demodulation test.**  **Proposal 2: RAN4 to agree the wanted noise, i.e., Noc level is set by the below equation for multi-Rx demodulation test on band Y:**  **Noc = REFSENSPC3, band Y, 50MHz -10log10(SCSREFSENS x PRBREFSENS x 12) - SNRREFSENS + ∆thermal + X**  **where:**  **- REFSENSPC3, band Y, 50MHz is the REFSENS value in dBm specified for Power Class 3 UE in band Y for 50MHz channel bandwidth in TS 38.101-2 Table 7.3.2.3-1, [dBm/Hz]**  **- SCSREFSENS is a subcarrier spacing associated with NRB for 50MHz in TS 38.101-2 Table 5.3.2-1, chosen as 120kHz.**  **- PRBREFSENS is NRB associated with subcarrier spacing 120kHz for 50MHz in TS 38.101-2 Table 5.3.2-1 and is 32.**  **- 12 is the number of subcarriers in a PRB**  **- SNRREFSENS = -1 dB is the SNR used for simulation of REFSENS**  **- ∆thermal is the amount of dB that the wanted noise is set above UE thermal noise, giving a rise in total noise of ∆BB. ∆thermal = 6dB, giving a rise in total noise of 1dB.**  **- X is the allowable degradation in sensitivity from legacy REFSENS requirements in dB**  **Proposal 3: There is no testability issue for TE to quantify legacy REFSENS requirement + XdB. There is no testability challenge for TE to identify directions with sensitivity better than REFSENS + X dB.**  **Observation 5: X = 2 dB implies 1/5th of all legacy spherical coverage directions (or 10% of all directions) will qualify for ‘standard’ UEs used for UE RF requirement simulation (i.e those that just meet the legacy spherical coverage requirements).**  **Observation 6: With 2dB, the number of AoA paris with at least 12dB isolation is at least 6 even with a very coarse grid, i.e., 15⁰ step size grid.**  **Observation 7: With a small value of X, it is easier to achieve the minimum isolation between polarizations.**  **Proposal 4: As a baseline, RAN4 to use X = 2 for multi-Rx demodulation test directions selection.**  **Observation 8: The number of AoA pairs for a given step size of grid and with at least 12 dB isolation depends on UE implementation. The test directions and AoA separations for demodulation test could be declared by manufacturer.**  **Observation 9: It is not enough to choose the minimum isolation (strictly SIR based) as the only criterion, which will lead to the selected test direction cannot achieve the desired SINR at the baseband.**  **Proposal 5: The test directions and AoA separation for multi-Rx demodulation test can be declared by UE. The UE declared test directions should satisfy the following 3 criteria:**   * **Minimum isolation shall be at least [12dB]** * **Rank number shall be higher or same as intended rank for a given test case** * **Each direction of AoA pair shall pass legacy REFSENS requirements with X=2dB degradation.**   **Proposal 6: If the UE declared test directions and AoA separation cannot satisfy the criteria in Proposal 5. The test directions which can satisfy the criteria should be searched by TE as the fallback approach.**  **Proposal 7: It is encouraged companies provide the simulation results to verify the minimum isolation requirements of [12dB] for multi-Rx demodulation test.** |
| R4-2309307 | Huawei, HiSilicon | **Proposal 1: RAN4 to specify SNR at the reference point per angle of arrival.** |

## Open issues summary

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

### Sub-topic 3-1: Test directions selection

*Sub-topic description:*

*Open issues and candidate options before meeting:*

**Issue 3-1-1: DL SNR reference point**

* Proposals
  + Option 1 (R4-2309307): RAN4 to specify SNR at the reference point per angle of arrival.
  + Option 2: TBA
* Recommended WF
  + TBA

**Issue 3-1-2: Difference between reference point SNR and baseband SNR**

* Proposals
  + Option 1 (R4-2309244): RAN4 to confirm the test direction should guarantee 1dB difference between Reference point SNR and Baseband SNR in multi-Rx demodulation test.
  + Option 2: TBA
* Recommended WF
  + TBA

**Issue 3-1-3: Noc level configuration**

* Proposals
  + Option 1 (R4-2309244): RAN4 to agree the wanted noise, i.e., Noc level is set by the below equation for multi-Rx demodulation test on band Y:
    - Noc = REFSENSPC3, band Y, 50MHz -10log10(SCSREFSENS x PRBREFSENS x 12) - SNRREFSENS + ∆thermal + X, where
      * REFSENSPC3, band Y, 50MHz is the REFSENS value in dBm specified for Power Class 3 UE in band Y for 50MHz channel bandwidth in TS 38.101-2 Table 7.3.2.3-1, [dBm/Hz]
      * SCSREFSENS is a subcarrier spacing associated with NRB for 50MHz in TS 38.101-2 Table 5.3.2-1, chosen as 120kHz.
      * PRBREFSENS is NRB associated with subcarrier spacing 120kHz for 50MHz in TS 38.101-2 Table 5.3.2-1 and is 32.
      * 12 is the number of subcarriers in a PRB
      * SNRREFSENS = -1 dB is the SNR used for simulation of REFSENS
      * ∆thermal is the amount of dB that the wanted noise is set above UE thermal noise, giving a rise in total noise of ∆BB. ∆thermal = 6dB, giving a rise in total noise of 1dB.
      * X is the allowable degradation in sensitivity from legacy REFSENS requirements in dB
  + Option 2: TBA
* Recommended WF
  + TBA

**Issue 3-1-4: Testability of TE to quantify legacy REFSENS + XdB**

* Proposals
  + Option 1 (R4-2309244): No testability issue for TE to quantify legacy REFSENS requirement + XdB. There is no testability challenge for TE to identify directions with sensitivity better than REFSENS + X dB.
  + Option 2: TBA
* Recommended WF
  + TBA

**Issue 3-1-5: How to determine the parameter XdB**

* Proposals
  + Option 1 (R4-2309244): As a baseline, RAN4 to use X = 2 for multi-Rx demodulation test directions selection.
  + Option 2: TBA
* Recommended WF
  + TBA

**Issue 3-1-6: Criteria of UE declared test directions**

* Proposals
  + Option 1 (R4-2309244): The test directions and AoA separation for multi-Rx demodulation test can be declared by UE. The UE declared test directions should satisfy the following 3 criteria:
    - Minimum isolation shall be at least [12dB]
    - Rank number shall be higher or same as intended rank for a given test case
    - Each direction of AoA pair shall pass legacy REFSENS requirements with X=2dB degradation.
  + Option 2: TBA
* Recommended WF
  + TBA

**Issue 3-1-7: Fallback approach for test directions selection**

* Proposals
  + Option 1 (R4-2309244): If the UE declared test directions and AoA separation cannot satisfy the criteria in Issue 3-1-6. The test directions which can satisfy the following criteria should be searched by TE with a blind search algorithm as the fallback approach.
    - Minimum isolation shall be at least [12dB]
    - Rank number shall be higher or same as intended rank for a given test case
    - Each direction of AoA pair shall pass legacy REFSENS requirements with X=2dB degradation.
  + Option 2: TBA
* Recommended WF
  + TBA

### Sub-topic 3-2: Minimum isolation requirements

*Sub-topic description:*

*Open issues and candidate options before meeting:*

**Issue 3-2-1: Minimum isolation requirements**

* Proposals
  + Option 1 (R4-2309244): It is encouraged companies provide the simulation results to verify the minimum isolation requirements of [12dB] for multi-Rx demodulation test.



Figure 3.2.2-1: Illustration of isolation implementation in the simulation (R4-2309244)

* + Option 2: TBA
* Recommended WF
  + TBA

### Sub-topic 3-3: Test method

**Issue 3-3-1: Test method for demodulation requirements for FR2 multi-Rx (Issue 1-1-3 in thread [322] R4-2310459)**

* Observations
  + Observation 1 (Qualcomm):
    - Real OTA testing may include impairment due to RF, hence demod requirements may not be truly tested in the presence of such impairments.
  + Observation 2 (MediaTek):
    - The split to emulator and simulator channels has not been captured in the earlier proposals
    - In OTA testing, we employ channel model Hemulator (4x4) between TRPs and TX-probes
    - Chamber channel Hchamber is not fading, but rather constant and deterministic for a given physical TX-probe and UE-panel setup (depending on AoA).
* Proposals
  + Option 1 (Qualcomm): RAN4 to adopt virtual cable setup to test the FR2 multi-Rx demodulation requirements as discussed in NR FR2 OTA enhancements.
  + Option 2 (MediaTek):
    - * Confirm understanding of test setup in chamber
      * Option 1: Install probes in test chamber according to defined AoA and keep emulator channel independent of the AoA
      * Option 2: Install probes in test chamber in 90 angle and model AoA in channel emulator.
      * Other options are not precluded
      * In corresponding simulations, we employ the same model Hemulator concatenated with a model of the chamber channel Hchamber (4x4) → Hsimulator = Hchamber ∙ Hemulator.
      * We need to specify the properties of both Hchamber and Hemulator explicitly.
      * In Hemulator set H12 and H21 as all zeros, and model H11 and H22 as mutually independent 2x2 fading channels that can follow some existing 3GPP correlation model (for example 2x2 Xpol high)
      * Define , where γ depends on AoA.
* 
* Figure 3.2.3-1: Illustration of virtual cable approach for multi-Rx demodulation test (R4-2309244)
* Recommended WF:
  + TBA

# Topic #4: CR for TR38.810: Integrating simultaneously active probe concept in the NFTF method

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2307504 | Chosun University, National Radio Research Agency | **CR for TR38.810: Integrating simultaneouly active probe concept in the NFTF method** |

## Open issues summary

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Title of TP** |
| R4-2307504 | CR for TR38.810: Integrating simultaneouly active probe concept in the NFTF method |

Moderator’s note: WF on Integrating simultaneously active probe concept in the NFTF method was approved in R4-2302921 in RAN4#106.