3GPP TSG-RAN WG4 Meeting # 112 R4-24xxxxx

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

**Agenda item:** 8.13.3

**Source:** Qualcomm Incorporated

**Title:** Topic summary for [112][334] NR\_FR2\_OTA

**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-19 SI on NR FR2 OTA testing Phase 3. The summary covers the contributions submitted under the following agendas:

* 8.13 Study on NR FR2 OTA (Over the Air) testing enhancement Phase 3
  + 10.5.1 General aspects
  + 10.5.2 RF testing methodology for FR2 non-handheld UE that can transmit simultaneously with multi-panel

# Topic #1: Test method for STxMP

*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** |
| R4-2411531 | Rohde & Schwarz | **Observation 1:** No synchronisation errors are observed for up to 40 dB difference in signal power.  **Proposal 1:** RAN4 shall conclude that the test of the STxMP is feasible up to a power difference of 40 dB.  **Observation 2:** MU needs further investigation especially for in case of a large power imbalance.  **Observation 3:** Channel estimation of the TE based on the DMRS of the signal under test can be used to measure the power of the signal under test.  **Proposal 2:** Detailed MU analysis can be left to RAN5 to take into account the exact Test Case parameters. |
| R4-2411698 | Samsung | **Proposal 1: confirm the feasibility and agree on the configuration of rank 2 PUSCH transmission in EIRP measurement of STxMP under SDM scheme.**  **Proposal 2: for PUMAX,f,c,k (peak EIRP per TCI), re-use the UE declared AoA separation and orientation of Multi-RX.**  **Observation 1: the mapping relationship “panel1-TCI1-probe1, panel2-TCI2-probe2” need to be kept unchanged and no swap during the whole 3D scan**  **Proposal 3: further study how to keep the mapping relationship between panels and probes unchanged (no swap) during 3D scan**  **Proposal 4: consider 0.5dB as additional margin for EIRPmax and TRPmax test skipping rule,** **i.e., “If the peak EIRP and TRP of single carrier is no greater than EIRPmax – 3.5dB or TRPmax – 3.5dB, the corresponding EIRPmax or TRPmax verification can be skipped”** |
| R4-2412072 | vivo | **Observation 1:** The configured transmission power is verified by testing MOP, MPR, A-MPR respectively.  **Observation 2:** The MPR requirement is relaxed by 3dB in RF spec to ensure the total radiated power of UE will not exceed the situation when only one antenna module is activated, so the UE can meet MPR of single carrier without any additional effort.  **Proposal 1:** The MPR/A-MPR is not need to be verified during the test of the configured transmission power.  **Observation 3:**   * Even with peak search of sTxMP, the peak direction always aligns with peak direction of single antenna module. * Due to the TE can only implemented with several fixed AoA offset, it is impossible to ensure TE can find two peak directions from arbitrary AoAs. For example, the case above require AoA offset =155° * Under proper UE orientation and AoA offset, a AoA pair that close to the peak for each antenna module can be found, as the green part above.   **Proposal 2:** The following method is agreed to be used for sTxMP testing: For the selection of AoA pair, one of AoA is at the beam peak direction of single CC operation without STxMP enable (from Beam Peak Search for MOP in 6.2 of TS 38.101-2), another AoA is decided by UE declared orientation (listed in TS38.101-2) and AoA pair from set of {30deg, 60deg, 90deg, 120deg, 150deg} |
| R4-2412919 | Qualcomm Incorporated | **Observation 1: For multi-Tx UL measurement, since rank 2 PUSCH transmission under SDM scheme (i.e., one layer per TCI) is configured and DMRS resources are orthogonal for TCI1 and TCI2, TE should be able to decode and measure EIRP per TCI.**  **Proposal 1: RAN4 concludes not to specify signal level conditions and assumes EIRP can be distinguished per TCI in STxMP testing.**  **Proposal 2: RAN4 further study the feasibility of Option 2 assuming that test system defined in TR 38871 is used.**  **Proposal 3: Legacy PC1 and PC5 constant step size measurement grid for beam peak search defined in Annex M.2 of TS38.521-2 can be reused for Option 1 and Option 2.**  **Proposal 4: RAN4 to consider UE declaration on the peak directions, i.e., no beam peak search procedure.**  **Proposal 5: If the DUT cannot pass the skipping rule, i.e., peak EIRP of single CC operation is larger than EIRPmax - 3dB - additional margin, the beam peak directions selected in EIRP PUMAX,f,c,k testing is reused in EIRPmax testing if Option 2 is adopted. FFS on Option 1 and Option 3.**  **Proposal 6: If the DUT cannot use the skipping rule, i.e., peak TRP of single CC operation is larger than TRPmax - 3dB - additional margin, the beam peak directions selected in EIRP PUMAX,f,c,k testing is reused if Option 2 is adopted. FFS on Option 1 and Option 3.**  **Proposal 7: The legacy PC1 and PC5 constant step size measurement grid for TRP defined in Annex M.4 of TS38.521-2 can be used in TRPmax testing.** |
| R4- 2413198 | Nokia | **Observation 1:** Record the EIRPmax and TRPmax of joint transmission based on joint TCI states for each AoA pair set for the whole spherical test is a straightforward method.  **Observation 2:** Resue of the same set up of OTA test equipment in multi-Rx is also very cost-efficient.  **Proposal 1**: Record the EIRPmax and TRPmax of joint transmission based on joint TCI states for each AoA pair set for the whole spherical test can be illustrated as a similar table compared with Multi-Rx requirement:   |  |  |  | | --- | --- | --- | | AoA separation (degrees) | EIPRmax (dBm) | TRPmax (dBm) | | 30 | highest measured value | highest calculated value | | 60 | highest measured value | highest calculated value | | 90 | highest measured value | highest calculated value | | 120 | highest measured value | highest calculated value | | 150 | highest measured value | highest calculated value |   **Observation 3**: TRPmax can be calculated based on EIRP OTA measurement data.  **Proposal 2**: No need to redefine TRP OTA tests, the TRPmax verification can be done together with EIRPmax verification.  **Observation 4**: Addition margin is agreed to be added to avoid the slightly change of antenna radiation pattern of one panel when the other panel is activated.  **Observation 5**: There is huge amount of UEs from different vendors in the market, such impact of radiation patterns between two activated antennas can vary significantly.  **Proposal 3**: Suggest the addition margin is 3dB due the variety of UE designs in the market. |

## 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: Per-TCI EIRP measuremment

*Sub-topic description*

*Open issues and candidate options before meeting:*

**Issue 1-1-1: Signal level condition for measuring/distinguishing EIRP per TCI**

* Proposals
  + Proposal 1 (R&S): The test of STxMP is feasible up to a power difference of 40dB. Detailed MU analysis can be left to RAN5 to take into account the exact Test Case parameters.
  + Proposal 2 (Samsung): Confirm the feasibility of and agree on the configuration of rank 2 PUSCH transmission in EIRP measurement of STxMP under SDM scheme.
  + Proposal 3 (Qualcomm): RAN4 concludes not to specify signal level conditions and assumes EIRP can be distinguished per TCI in STxMP testing.
* Recommended WF
  + RAN4 confirms the feasibility of di.
  + Proposal 1 seems aggregable with more clarifications.

*Moderator’s note:*

* *Agreement in RAN4#110bis:*
  + *TE vendors confirmed the capability of distinguishing EIRP per TCI with two layers transmission under SDM scheme*
  + *The feasibility of this approach under all signal level conditions (e.g. SNR, power imbalance) is FFS*

### Sub-topic 1-2: UE form factor and DUT size

*Sub-topic description*

*Open issues and candidate options before meeting:*

**Issue 1-2-1: Supported UE form factor and DUT size**

* Proposals
  + Proposal 1 (Keysight): OEMs and chipset vendors to confirm and/or update PC1&PC5 device and antenna assumptions for STxMP testing.
    - The applicability of the Enhanced IFF test methodology based on 2 AoA RRM and 2 AoA Multi-RX spherical coverage test cases so far has been limited to PC3 with a maximum device size of 30 cm only.
  + Proposal 2 (Keysight): OEMs and chipset vendors to provide device and antenna assumptions for vehicle and industrial devices.
* Recommended WF
  + For PC1 and PC5, the assumptions for UE antenna, Max DUT size, Max Weight, listed R4-2409768 need to be confirmed.
  + To discuss whether to consider vehicle and industrial devices in the SI.
  + No core requirements were defined for vehicle and industrial devices in Rel-18.

*Moderator’s note:*

*Assumptions for PC1 from (R4-2409768)*

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| *Certain assumptions need to be made to come up with MU/MTSU values. Following is the list of proposed assumptions, along with justification, that can affect the MU/MTSU for PC1 UEs:*   1. *Max number of antenna array elements – 12x12*    1. *A 12x12 array is judged to be sufficiently large to capture all practical PC1 implementations as subsets* 2. *Max DUT sizes – 30 cm* 3. *Max DUT radiating aperture – 10.6 cm*     1. *This value is derived from /2 separated elements at 24G, and assumption #1* 4. *Power supply type – AC Power Supply* 5. *Max weight of UE – 10 lbs* 6. *Single element pattern – re-use from table G.1.1-1* |

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| *Table 5.2.3.3-1: UE antenna element pattern*   |  |  | | --- | --- | | *Parameter* | *Values* | | *Antenna element vertical radiation pattern (dB)* |  | | *Antenna element horizontal radiation pattern (dB)* |  | | *Combining method for 3D antenna element pattern (dB)* |  | | *Maximum directional gain of an antenna element GE,max* | *5 dBi* | | *(Mg, Ng, M, N, P)* | *(1, 1, 12, 12, 2)* | | *(dv, dh)* | *(0.5λ, 0.5λ)* | | *UE orientation* | *Random orientation in the azimuth domain: uniformly distributed between -90 and 90 degrees\**  *Fixed elevation: 90 degrees* | | *NOTE: This is done to emulate two panels: the configuration is equivalent to 2 panels with 180 shift in horizontal orientation and UE orientation uniformly distributed in the azimuth domain between -180 and 180 degrees.* | | |

*Assumptions for PC5 from (R4-2409768) that is similar to PC1*

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| *A FWA device is expected to support PC1 and/or PC5. The device and antenna assumptions for FWA supporting PC1 is already captured in [2].*  *In this paper we propose to keep the PC5 FWA device and antenna assumption same as PC1 FWA. Proposals are captured in Table 2.1*  *Table 2.1: PC5 FWA device and antenna assumptions*   |  |  | | --- | --- | | *Number of antenna arrays* | *1* | | *Number of elements in array* | *12 x 12* | | *Max DUT size* | *40cm* | | *Max DUT radiating aperture* | *10.6 cm (diagonal), from l/2 separated elements at 24G, 12 elements per dimension* | | *Power supply* | *AC power supply* | | *Max weight of UE* | *10 lbs (4.5 Kg)* | | *Beam steering range and granularity in xz plane* | *4o beam steering granularity (from 30o to 150o)* | | *Beam steering range and granularity in xy plane* | *4o beam steering granularity (from 30o to 150o)* | |

### Sub-topic 1-3: UE beam lock test function

*Sub-topic description*

*Open issues and candidate options before meeting:*

**Issue 1-3-1: UE beam lock test function enhancement**

* Proposals
  + Proposal 1 (Qualcomm): UE beam lock test function need to support locking two antenna patterns simultaneously. Send a LS to RAN5 (see draft LS in R4-2409429).
* Recommended WF
  + Discuss whether to send LS to RAN5

### Sub-topic 1-4: Test method for EIRP PUMAX,f,c,k testing

**Issue 1-4-1: AoA separation and UE orientation for EIRP PUMAX,f,c,k testing**

* Proposals
  + Proposal 1 (Samsung, Qualcomm): Consider similar as Multi-Rx UE declaration approach for one AoA pair selection from the set of {30deg, 60deg, 90deg, 120deg, 150deg} and one proper UE orientation listed in TS38.101-2 for EIRP per TCI measurement
    - Proposal 1a(Qualcomm): FFS on whether declared AoA pair and UE orientation for STxMP and Multi-Rx are same or not.
    - Proposal 1b (Samsung): Based on beam correspondence principle, declared AoA pair and UE orientation for Multi-Rx can be reused for STxMP
  + Proposal 2 (vivo): For the selection of AoA pair, one of AoA is at the beam peak direction of single carrier, another AoA is based on the UE orientation and AoA offset. The UE orientation and AoA offset are declared by UE.
* Recommended WF
  + The candidate UE orientations from TS 38101-2, and AoA pairs for multi-Rx testing are reused.
  + Further discuss how to select the AoA pair and AoA offset.
  + Further discuss whether declared AoA pair and UE orientation for STxMP and Multi-Rx are same or not.

**Issue 1-4-2: Measurement grid for EIRP PUMAX,f,c,k testing**

* Proposals
  + Proposal 1 (Qualcomm): Constant-step measurement grid with 15deg step size should be used.
* Recommended WF
  + Further discuss whether Proposal 1 can be agreed.

### Sub-topic 1-5: Test method for EIRPmax

**Issue 1-5-1: Skipping rule for EIRPmax testing**

* Proposals
  + Proposal 1 (Samsung, Qualcomm): agree on skipping rule proposal for EIRPmax, i.e., “If the peak EIRP of single carrier is smaller than EIRPmax – 3dB, the corresponding EIRPmax verification can be skipped”.
  + Proposal 2 (Nokia): STxMP OTA test shall not be skipped in any situation because the antenna radiation pattern will be slightly different between using a single Tx only and using two Tx at the same time. The data from single Tx panel OTA test cannot be used to verify STxMP cases.
* Recommended WF
  + Discuss whether can agree on skipping rule proposal for EIRPmax, i.e., “If the peak EIRP and TRP of single carrier is smaller than EIRPmax – 3dB or TRPmax – 3dB, the corresponding EIRPmax verification can be skipped”.

**Issue 1-5-2: AoA separation and UE orientation EIRPmax testing**

* Proposals
  + Proposal 1 (Qualcomm): RAN4 to study and select worst case of AoA pair from the set of {30deg, 60deg, 90deg, 120deg, 150deg} and potential UE orientation listed in TS38101-2 for PUMAX,f,c testing.
  + Proposal 2 (Samsung): For PUMAX,f,c (aggregated EIRP), re-use the UE declared AoA separation and orientation of Multi-RX
  + Proposal 3 (vivo): Use AoA offset = 30° as starting point for EIRPmax verification.
  + Proposal 4 (Nokia): Define a few AoA separations/offsets in the OTA test for EIRPmax verification. Reuse the orientation definitions in current standards.
* Recommended WF
  + Need further discussion

**Issue 1-5-3: Measurement grid EIRPmax testing**

* Proposals
  + Proposal 1 (Qualcomm): Constant-step measurement grid with 15deg step size should be used.
* Recommended WF
  + Further discuss whether Proposal 1 can be agreed.

### Sub-topic 1-6: Test method for TRP PTMAX,f,c

**Issue 1-6-1: Skipping rule for TRPmax testing**

* Proposals
  + Proposal 1 (Samsung, Qualcomm): agree on skipping rule proposal for TRPmax, i.e., “If the peak TRP of single carrier is smaller than TRPmax – 3dB, the corresponding TRPmax verification can be skipped”.
  + Proposal 2 (Nokia): STxMP OTA test shall not be skipped in any situation because the antenna radiation pattern will be slightly different between using a single Tx only and using two Tx at the same time. The data from single Tx panel OTA test cannot be used to verify STxMP cases.
* Recommended WF
  + Discuss whether can agree on skipping rule proposal for EIRPmax, i.e., “If the peak EIRP and TRP of single carrier is smaller than EIRPmax – 3dB or TRPmax – 3dB, the corresponding EIRPmax verification can be skipped”.

**Issue 1-6-2: AoA separation and UE orientation TRPmax testing**

* Proposals
  + Proposal 1 (Samsung): For PTMAX,f,c (total radiated power), re-use the UE declared AoA separation and orientation of Multi-RX
  + Proposal 2 (vivo): The MOP, MPR, AMPR, TRPmax should be tested under same AoA pair for sTxMP.
  + Proposal 3 (Qualcomm): The worst-case conclusion for aggregated EIRP PUMAX,f,c testing should apply for aggregated TRP PTMAX,f,c,testing.
* Recommended WF
  + Need further discussion