3GPP TSG-RAN WG4 Meeting # 111 R4-24xxxxx

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

**Agenda item:** 10.5.3

**Source:** Qualcomm Incorporated

**Title:** Topic summary for [111][339] 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:

* 10.5 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** |
| R4-2407899 | Samsung | **Observation 1: The SNR deterioration issue can be resolved by intentional power imbalance configuration.****Proposal 1: confirm the feasibility and agree on the configuration of rank 2 PUSCH transmission in EIRP measurement of STxMP****Proposal 2: for PUMAX,f,c,k (peak EIRP per TCI), re-use the UE declared AoA separation and orientation of Multi-RX.****Proposal 3: agree on the skipping rule proposal for EIRPmax and TRPmax, i.e., “If the peak EIRP and TRP of single carrier is smaller than EIRPmax – 3dB or TRPmax – 3dB, the corresponding EIRPmax or TRPmax verification can be skipped”.****Observation 2: by post data processing of PUMAX,f,c,k (peak EIRP per TCI) measurement results, the PUMAX,f,c (aggregated EIRP) can also be obtained with UE declared AoA offset and orientation.****Proposal 4: for PUMAX,f,c (aggregated EIRP) and PTMAX,f,c (total radiated power), re-use the UE declared AoA separation and orientation of Multi-RX** |
| R4-2408090 | vivo | **Observation 1:** The configured transmission power is verified by testing MOP, MPR, A-MPR respectively.**Observation 2:** It is hard to find beam peak direction for each TCI state around the whole sphere, and it is also almost impossible to test UE under 2 beam peaks from arbitrary AoA simultaneously due to constrain of TE. **Observation 3:** Due the constrain of TE, only one AoA of the tested AoA pair can be placed at the beam peak direction, and the direction of another AoA depends on the UE orientation and AoA offset.**Proposal 1:** 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.**Proposal 2:** The UE orientation and AoA offset are declared by UE.**Observation 3:** The MOP, MPR, AMPR, TRPmax for single carrier are verified under the same direction, i.e., beam peak direction.**Proposal 3:** The MOP, MPR, AMPR, TRPmax should be tested under same AoA pair for sTxMP.**Proposal 4:** Use AoA offset = 30° as starting point for EIRPmax verification. |
| R4-2408690 | Nokia | **Observation 1**: There are two types of overlapping cases in STxMP: i.e., (1) overlapping of the two main beams from two TXs, and (2) overlapping of the main beam from one Tx and the side lobe from the other Tx.**Observation 2**: The AoA offset from 0-180 degrees should be in the scope of OTA test due to the risk that a sum of EIRP of the main beam of one Tx and the sidelobe of the other Tx may higher than EIRPmax in any AoA offsets. **Proposal 1**: Define a few AoA separations/offsets in the OTA test for EIRPmax verification.**Proposal 2**: Reuse the orientation definitions in current standards. **Observation 3**: TRP can be calculated based on EIRP OTA measurement data.**Proposal 3**: There is no need to redefine TRP OTA tests, the TRPmax verification can be done together with EIRPmax verification. **Observation 4**: The radiation pattern (antenna pattern) will be impacted by the current distribution around PCB and antenna feed/ground points. The current distribution is different between only one panel is working and both panels are working at the same time. **Observation 5**: The antenna gains in all direction maybe slightly different between when using single Tx panels and when using two Tx panels at the same time. The OTA test data, when only one Tx panel is active, cannot be used for STxMP OTA verification. **Proposal 4**: 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. |
| R4-2409428 | Qualcomm Incorporated | **Proposal 1: For TE’s capability on distinguishing EIRP per TCI with two layers transmission, no issue for signal level of SNR condition is identified.****Proposal 2: To clarify the definition of power imbalance condition for EIRP per TCI measurement.****Proposal 3: Send a LS to RAN5 extending current UE Beamlock test function to support locking two antenna patterns simultaneously.****Proposal 4: Consider UE declaration approach for AoA pair selection from the set of {30deg, 60deg, 90deg, 120deg, 150deg} and proper UE orientation listed in [3] for EIRP per TCI measurement for peak EIRP PUMAX,f,c,k testing.****Proposal 5: FFS on whether declared AoA pair and UE orientation for STxMP and Multi-Rx are same or not.****Proposal 6: Constant-step measurement grid should be used for peak EIRP PUMAX,f,c,k testing.** **Proposal 7: 15deg is used as step size for peak EIRP PUMAX,f,c,k testing.****Observation 1: From regulatory PoV, exhaustive search for EIRP per TCI with all the possible AoA separations and UE orientations shall be measured but it is very time consuming and infeasible as there are only several AoA pairs supported by current test setup.** **Proposal 8: 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 [3] for PUMAX,f,c testing.****Proposal 9: The test method for aggregated EIRP PUMAX,f,c testing, i.e., if the peak EIRP of single carrier is smaller than EIRPmax – 3dB, the corresponding EIRPmax verification can be skipped, can be adopted.****Proposal 10: Constant-step measurement grid should be used for aggregated EIRP PUMAX,f,c testing.** **Proposal 11: 15deg is used as step size for aggregated EIRP PUMAX,f,c testing.****Observation 2: With the worst-case conclusion in section 2.2, aggregated TRP can be calculated by integrating EIRP per TCI.****Proposal 12: The worst-case conclusion for aggregated EIRP PUMAX,f,c testing should apply for aggregated TRP PTMAX,f,c,testing.****Proposal 13: The test method for aggregated TRP PTMAX,f,c testing, i.e., if the TRP of single carrier is smaller than TRPmax – 3dB, the corresponding TRPmax verification can be skipped, can be adopted.** |
| R4-2409429 | Qualcomm Incorporated | **Draft LS on FR2 UE Beamlock test function** |
| R4-2409768 | Keysight Technologies | Observation 1: EIRPs or components of EIRP at very low signal level conditions generally do not have any noticeable contribution to TRP and/or the total component of EIRP and can be substituted with fixed, very low EIRP values.Observation 2: 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.Observation 3: Generally, there might not be an issue supporting PC1&PC5 devices with the Enhanced IFF test systems for STxMP testingProposal 1: OEMs and chipset vendors to confirm and/or update PC1&PC5 device and antenna assumptions for STxMP testingProposal 2: OEMs and chipset vendors to provide device and antenna assumptions for vehicle and industrial devices. |

## 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 (Samsung): Confirm the feasibility and agree on the configuration of rank 2 PUSCH transmission in EIRP measurement of STxMP.
		- Proposal 1a (Qualcomm): No issue for signal level of SNR condition is identified. To clarify the definition of power imbalance condition for EIRP per TCI measurement and confirm the feasibility**.**
		- Proposal 2: (Keysight): Performing UL measurements under all signal level conditions does not seem reasonable even for SISO measurements. EIRPs or components of EIRP at very low signal level conditions generally do not have any noticeable contribution
* Recommended WF
	+ To clarify the definition of power imbalance condition for EIRP per TCI measurement and understand the difference of signal level conditions between SISO UL measurement and STxMP measurement.
	+ 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*

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| *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.* |

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*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)* |

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### 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