**3GPP TSG-RAN WG4 Meeting # 97-e R4-20XXXXX**

**Electronic Meeting, 2 – 13 Nov., 2020**

**Agenda item:** 12.1.1

**Source:** Moderator (CAICT)

**Title:** Email discussion summary for [97e][330] NR\_MIMO\_OTA

**Document for:** Information

# Introduction

In the last RAN plenary meeting, NR MIMO OTA open issues were captured in the WI status report [1]:

*Remaining Open issues：*

*• Down-selecting of FR2 channel models and RMC*

*• Pass/Fail criteria for channel model validation*

*• Potential optimization of test methods for FR1 and FR2*

*• How to process the measurement data for FR2*

*• Lab alignment for performance requirements definition*

*• Specify the FR1 MIMO OTA requirements*

*• Specify the FR2 MIMO OTA requirements*

AI 12.1 NR MIMO OTA WI and 7.19.7 TR38.827 maintenance are included in this email discussion.

List of candidate target of discussion for 1st round and 2nd round

• 1st round: agree TPs and CRs, discuss the open issues for NR MIMO OTA.

• 2nd round: make decision on open issues for NR MIMO OTA based on the decisions of 1st round.

# Topic #1: General and Testing methodologies

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2016217 | vivo, CAICT | “LS on FR1 MIMO OTA”  **Observation 1: Industry fragmentation of LTE MIMO OTA test methods are shown in different SDOs.**  **Proposal 1: Send a LS on FR1 MIMO OTA to the SDOs outside of 3GPP. Aligned test methodology to minimize the industry fragmentation on FR1 MIMO OTA is encouraged.** |
| R4-2014723 | Samsung | “Discussion on FR1 and FR2 MIMO OTA”  **Observation 4: 64QAM is not feasible for FR2 high bands due to limited SNR.**  **Observation 4: 64QAM is not feasible for FR2 low bands since 95%TP is difficult to be achieved.**  **Proposal 5: For FR2 NR MIMO OTA, 16QAM is adopted as downlink modulation for all FR2 bands.** |
| R4-2016219 | vivo, CAICT | “Discussions on FR2 MIMO OTA requirements”  **Proposal 4: Select 16 QAM as the only RMC for FR2 MIMO OTA requirements.** |
| R4-2016235 | Qualcomm Incorporated | “Views on for FR2 MIMO OTA”  **Observation 1: The achievable SNR in 3D-MPAC is ~15.3dB for n260. There is still a gap between achievable and required SNR for 64QAM in CDL channel.**  **Observation 2: To make sure the selected RMC is testable in 3D-MAPC, selecting 16QAM is reasonable if no further update on achievable SNR from companies.**  **Proposal 1: RAN4 to select 16QAM RMC to define the FR2 MIMO OTA requirements at this stage. Further check the feasibility of 64QAM RMC based on the technical input from companies.**  **Proposal 2: To increase the test coverage and fully utilize the capabilities of 3D-MPAC, RAN4 to keep both InO CDL-A and UMi CDL-C for FR2 MIMO OTA testing.** |
| R4-2016589 | Huawei, HiSilicon | “Discussion on open issues of NR MIMO OTA WI”  **Proposal 3: use 16QAM with 100MHz bandwidth as FR2 MIMO OTA RMC for n257/n258/n261. For n260, consider QPSK, or reduce the bandwidth for 16QAM (e.g. 16QAM with 25 or 20MHz bandwidth).** |
| R4-2015368 | HUAWEI, HiSilicon | “Discussion on MIMO OTA test methodologies”  **Proposal 1: We prefer to keep UMi CDL-C as final requirement in NR FR2 MIMO OTA.** |
| R4-2016208 | Keysight Technologies | “On FR2 MIMO OTA channel model down selection”  **Observation 1: Given the novelty of FR2 MIMO, there is benefit to keep both InO CDL-A and UMi CDL-C, typical scenarios for FR2 deployment**  **Observation 2: CDL-A InO model incudes just one dominant spatial cluster and thus does not provide much additional test coverage compared to the single AoA demodulation conformance testing.**  **Observation 3: CDL-C UMi model provides more degrees of freedom for the DUT to steer its beam direction and allows for better differentiation in performance between different DUTs.**  **Proposal 1: If just a single channel model is required for FR2 MIMO OTA testing, select the CDL-C UMi channel model.** |
| R4-2016209 | Keysight Technologies | “On FR1 4x4 vs. 2x2 channel models”  **Proposal: It is proposed to adopt CDL-C UMa model for 4x4 testing and CDL-A UMi model for 2x2 testing.** |
| R4-2016210 | Keysight Technologies | “On Probe Configurations and Channel model vs. OTA test system coordinate systems for FR2 MIMO OTA”  **Observation 1: The new proposed probe configuration has the probes aligned towards the z axis with probe #1 along the z direction.**  **Observation 2: The QoQZ validation can readily be performed with probe #1 as the fully documented UE RF and RRM 2AoA QoQZ validation procedures are also assuming the measurement probe in the z direction.**  **Observation 3: The blocking with this probe configuration is rather limited.**  **Proposal 1: Adopt the revised probe configuration in Table 1 for NR FR2 MIMO OTA**  **Proposal 2: Define channel model coordinate axes xCM, yCM, and zCM which correspond to the OTA test system coordinate axes z, y, and -x, respectively** |
| R4-2015353 | OPPO | “The rules for 3D-MPAC system implementation”  **Proposal:**  **Two rules should be followed when implementing the 3D-MPAC system:**  **Rule One: Rotate the probes towards the z axis direction, to constraint the probe location in relation to the 2-axis turntable.**  **Rule Two: Keep the Reference Direction Indicator along the longitude line on DUT spherical surface and pointing to upper hemisphere, to constraint the probe placement in relation to the DUT orientation.** |
| R4-2015258 | Xiaomi | “on UE orientation clarification”  **Proposal 1: Apply figure 1 as probe configuration to avoid blocking effect.**  **Observation 1: The probe position and test point position defined by theta and phi are based on specific co-ordination system.**  **Observation 2: The test point positions need to be aligned when the cluster of probe position is changed.**  **Proposal 2: To rotate the co-ordination as X degree to define new test points according to the rotation of probe configuration.** |
| R4-2016561 | CAICT, Keysight, vivo | “FR1 MIMO OTA channel model validation results”  **Observation 1: Some of the theoretical reference values of the channel model verification after considering the filtering effect of the base station are currently absent.**  **Proposal 1: Theoretical values of channel model validation with base station antenna filtering effect shall be provided as reference.**  **Observation 2: The measured PDP of CDL-A UMi channel models matches well with the simulated reference.**  **Observation 3: The dynamic range of different clusters in PDP measurement results exceeds 40 dB due to the effect of BS pattern filtering. It could be difficult to measure the “weak” clusters accurately.**  **Proposal 2: Focus on the high power clusters (e.g. dynamic range within 40dB) in the follow-up WI phase for defining the channel model validation limits. Alternatively, consider relaxing the limits of “weak” clusters (e.g. below -40dB).**  **Observation 4: The measured spatial correlation of FR1 CDL-A UMi channel model matches well with the theoretical reference.** |
| R4-2014536 | Spirent Communications | “Channel Model Assumptions”  **Proposal 1. Agree on ideal curves for FR2 channel models, for PDP, Doppler Temporal Correlation.**  **Proposal 2. Agree on additional values for FR2: PSP, V/H ratio, Cross Correlation Matrix.**  **Proposal 3. Work out limits for each FR2 validation parameter.** |
| R4-2016539 | Huawei, HiSilicon | “Simulation assumptions for NR FR2 MIMO OTA”  **Proposal 2: The number of clusters shall be clearly regulated in different scenarios. We prefer Option 3.** |
| R4-2016218 | vivo, CAICT | **TP to TS 38.151 v0.0.1 on general part** |
| R4-2016221 | vivo, CAICT, Spirent | **TP to TS 38.151 v0.0.1 on FR1 Channel model and RMC** |
| R4-2016222 | vivo, CAICT | **TP to TS 38.151 v0.0.1 on FR1 test system for requirements** |
| R4-2016216  (reserved) | vivo | New version TS |
| R4-2016220  (reserved) | vivo | “Channel model simulation for FR1 performance requirement” |
| R4-2014688  Late contribution | BUPT | Effect of White Box Approach on Simple-Sectored Multi-Probe Anechoic Chamber Design  **Proposal 1: As for multiple adaptive sub-arrays that operate in spatial multiplexing mode, the spatial correlation error between sub-arrays as the metric for DUT.**  **Proposal 2: Applying the white box testing approach for NR FR2 conformance testing. It requires the declaration by the manufacturer about the detailed locations of the antenna panels within the DUT.**  **Proposal 3: To ensure accurate emulation of spatial correlation between multiple active sub-arrays on the terminal, a much more expensive setup configuration is expected, compared to single active sub-array terminal case.** |

## Open issues summary

### Sub-topic 1-1 General

**Issue 1-1-1: LS on FR1 MIMO OTA**

* Proposals
  + Proposal 1: Send a LS on FR1 MIMO OTA to the SDOs outside of 3GPP. Aligned test methodology to minimize the industry fragmentation on FR1 MIMO OTA is encouraged.
* Recommended WF
  + TBA

### Sub-topic 1-2 Testing parameters for Performance

**Issue 1-2-1: FR1 4x4 vs. 2x2 channel models**

* Proposals
  + Proposal 1: Adopt CDL-C UMa model for 4x4 testing and CDL-A UMi model for 2x2 testing.
* Recommended WF
  + Make decision on whether change of channel models mapping is needed.

**Issue 1-2-2: Down-selecting of FR2 RMC for performance requirement**

* Proposals
  + Proposal 1:
    - Option 1: Adopt 16QAM RMC as the only RMC for all FR2 bands (Samsung, vivo, CAICT, QC).
    - Option 2: Use 16QAM with 100MHz bandwidth as FR2 MIMO OTA RMC for n257/n258/n261. For n260, consider QPSK, or reduce the bandwidth for 16QAM (e.g. 16QAM with 25 or 20MHz bandwidth) (HW).
  + Proposal 2: Further check the feasibility of 64QAM RMC based on the technical input from companies.
* Recommended WF
  + Make decision on FR2 RMC down selection this meeting.

**Issue 1-2-3: Down-selecting of FR2 channel model for performance requirement**

* Proposals
  + Option 1: keep UMi CDL-C as final requirement in NR FR2 MIMO OTA.
  + Option 2: keep both InO CDL-A and UMi CDL-C for FR2 MIMO OTA testing.
* Recommended WF
  + TBA

### Sub-topic 1-3 Optimization of test methodologies

**Issue 1-3-1: System implementation of 3D-MPAC**

* Proposals
  + Proposal 1a: Adopt the revised probe configuration below (Table 1) for NR FR2 MIMO OTA

Table 1: Proposed Probe Locations

|  |  |  |
| --- | --- | --- |
| Probe Number | Theta/ZoA [deg] | Phi/AoA [deg] |
| 1 | 0.0 | 0.0 |
| 2 | 11.2 | 116.7 |
| 3 | 20.6 | -104.3 |
| 4 | 20.6 | 104.3 |
| 5 | 20.6 | 75.7 |
| 6 | 30.0 | 90.0 |

* + Proposal 1b: Define channel model coordinate axes xCM, yCM, and zCM which correspond to the OTA test system coordinate axes z, y, and -x, respectively.
  + Proposal 2a: Apply figure below (figure 1) as probe configuration to avoid blocking effect.
  + Proposal 2b: To rotate the co-ordination as X degree to define new test points according to the rotation of probe configuration.



Figure 1 Illustration of the probe position

* + Proposal 3: Two rules should be followed when implementing the 3D-MPAC system:
    - Rule One: Rotate the probes towards the z axis direction, to constraint the probe location in relation to the 2-axis turntable.
    - Rule Two: Keep the Reference Direction Indicator along the longitude line on DUT spherical surface and pointing to upper hemisphere, to constraint the probe placement in relation to the DUT orientation.
* Recommended WF
  + Make decision on system implementation of 3D-MPAC this meeting.

**Issue 1-3-2: White Box Approach on SS-MPAC**

* Proposals
  + Proposal 1: As for multiple adaptive sub-arrays that operate in spatial multiplexing mode, the spatial correlation error between sub-arrays as the metric for DUT.
  + Proposal 2: Applying the white box testing approach for NR FR2 conformance testing. It requires the declaration by the manufacturer about the detailed locations of the antenna panels within the DUT.
  + Proposal 3: To ensure accurate emulation of spatial correlation between multiple active sub-arrays on the terminal, a much more expensive setup configuration is expected, compared to single active sub-array terminal case.
* Recommended WF
  + TBA

### Sub-topic 1-4 channel model validation

**Issue 1-4-1: Channel model validation procedure**

* Proposals
  + Proposal 1: Theoretical values of channel model validation with base station antenna filtering effect shall be provided as reference.
  + Proposal 2: Focus on the high-power clusters (e.g. dynamic range within 40dB) in the follow-up WI phase for defining the channel model validation limits. Alternatively, consider relaxing the limits of “weak” clusters (e.g. below -40dB).
  + Proposal 3: For FR2 MIMO OTA, choose 3 or 4 strongest clusters, i.e. 3 for CDL-A as cluster #2, #3 ,#4, 4 for CDL-C as cluster #6, #7, #8 ,#2, for each channel model that the BS strongest beam toward to.
* Recommended WF
  + Companies are encouraged to share their views on pass/fail criteria of channel model validation.

**Issue 1-4-2: Channel model validation limits for FR2 MIMO OTA**

* Proposals
  + Proposal 1. Agree on ideal curves for FR2 channel models, for PDP, Doppler Temporal Correlation.
  + Proposal 2. Agree on additional values for FR2: PSP, V/H ratio, Cross Correlation Matrix.
  + Proposal 3. Work out limits for each FR2 validation parameter.
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Keysight | **Issue 1-2-3: Down-selecting of FR2 channel model for performance requirement**   * Given the novelty of FR2 MIMO, keeping both InO CDL-A and UMi CDL-C would be preferred and if absolutely needed, select a single channel model at a later time. If a channel model needs to be selected now, select CDL-C UMi   **Issue 1-3-1: System implementation of 3D-MPAC**   * Regarding Proposal 2a: The proposed probe location would rotate probes with the highest probe weights a bit too away far from the z axis * Regarding Proposal 2b: this proposal is not very clear * Regarding Proposal 3: those two rules do not allow the removal of ambiguities as too many degrees of freedom are still allowed. For instance, either of the following two proposals would be allowed as they both follow Rules One and Two:   Clearly, both probe configurations would be vastly different which should be avoided given the differences in results these approaches could yield. Additionally, the approach per Proposal 1a would not be allowed since Rule Two would be violated (RDI is pointing towards the lower hemisphere).  **Issue 1-3-2: White Box Approach on SS-MPAC**   * The intention of proposal 1 is not clear without studying some of the references in detail separately. It was previously agreed (in the SI) to use the PSP metric to determine the probe configurations; a more thorough explanation in the contribution would have been preferred why spatial correlation error is the better approach. We agree that spatial correlation could be one relevant metric for MIMO over the multiple simultaneously active arrays. But a more thorough investigation for comparison between PSP, spatial correlation and correlation between beamforming arrays would be required before choosing the metric. The correlation between two or multiple beamforming arrays is not directly defined by spatial correlation, and therefore it may not be relevant to take the spatial correlation as the metric. Other metrics, such as PSP may be more suitable also because spatial correlation is challenging to achieve as demonstrated in the paper. * Changing to a white box testing approach would require frequent re-positioning of the device during the testing of 36 test points as different antenna panels could be activated depending on test point/DL direction. * Increasing the test setup complexity to the 38 probes (as mentioned in Observation 6) would be cost prohibitive. A study of alternate metrics as well as acceptable spatial correlation limits would be required. Feedback from industry is requested whether and when multiple simultaneous panels should be considered.   **Issue 1-4-1: Channel model validation procedure**   * Regarding P1: we agree to provide those theoretical values * Regarding P2: we agree that 40dB might be a good starting point for the dynamic range * Regarding P3: All clusters have been considered in previous PSP simulations. We believe all clusters and rays should be included in the channel model implementation as described in 38.827. If number of clusters needs to be limited for some reason, it should be based on some power criteria, for example 40 dB   **Issue 1-4-2: Channel model validation limits for FR2 MIMO OTA**   * We would like Spirent to clarify what the Cross Correlation Matrix metric (from R4-2014536) is as no such parameter was defined in 38.827.   ….  Others: |
| Xiaomi | **Issue 1-1-1: LS on FR1 MIMO OTA:**  We agree with the intension of the LS. However, we might need some clarification of the alignment procedure as how to handle the difference between two SDOs.  **Issue 1-2-1: FR1 4x4 vs. 2x2 channel models:**  Agree with proposal 1. Consider the deployment scenario, the UMa will need large antenna gain while UMi will need relatively smaller gain.  **Issue 1-2-3: Down-selecting of FR2 channel model for performance requirement:**  We also want to check the probability to keep both, if not, then option 1 is preferred.  **Issue 1-3-1: System implementation of 3D-MPAC**  1, Firstly some reply to Keysight. As captured in TS 38.521-2 the QoQZ validation, only one antenna is used for QoQZ validation. We might need some more discussion to see whether only one probe is enough for the validation procedure?  If no, then the “one probe towards the Z-axis” is not a necessary requirement for the system.  If yes, then we think the validation can be performed with a single antenna separately so that there will be no limit to the probe configuration because of QoQZ.  Hence as the limitation on “one axis towards directly to z-aixs” is not necessary, then we can have the freedom to locate the probes to avoid the blocking issue.  2, Some clarification about proposal 2b as: Currently the 36 points are defined in a specific X-Y-Z co-ordination while the 6 test probes are specifically towards the y-axis. If we rotate the probes towards the Z-axis, then the 36 points should also be rotated accordingly. Further, if we move the probes upper, it can be assumed as a rotation in the Z-Y plane with certain degree and hence a second rotation is needed.  3, For OPPO’s rules, we think we are quite aligned. Our proposal is one of the configuration that fulfils the rules. But as Keysight points out, there might still be ambiguity by applying these two rules, hence we think to capture the rules with additional example might be a WF. |
| Samsung | Sub topic 1-1 General:  **Issue 1-1-1: LS on FR1 MIMO OTA**  We support this LS. At the early stage of NR MIMO OTA SI, there was strong desire to avoid standard fragmentations between SDOs. Now 3GPP has finished the study phase and is leading the NR MIMO OTA standardization. It is helpful to share with other SDOs outside of 3GPP and come up with aligned MIMO OTA test methods etc. for the entire industry.  Sub-topic 1-2 Testing parameters for Performance:  **Issue 1-2-2: Down-selecting of FR2 RMC for performance requirement**  We support option 1 of proposal 1, i.e. 16QAM as the only RMC for all FR2 bands as long as no critical issue could be identified. About the concern on limited SNR on FR2 high bands in option 2, besides falling back to QPSK, other methods may also be considered, e.g., only 70%TP or lower outage point for performance requirement and/or some exception points allowed for FR2 high bands, etc.  **Issue 1-2-3: Down-selecting of FR2 channel model for performance requirement**  Option 1 is preferred so that only one channel model will be adopted for performance requirement as agreed in the WF of last meeting in R4-2012707, i.e. “the goal is to select one for final requirement”. We are fine to keep both for study but finally select only one.  Sub-topic 1-3 Optimization of test methodologies:  **Issue 1-3-1: System implementation of 3D-MPAC**  About probe location, proposal 1~3 are generally aligned. Proposal 1 seems a good trade off which enables 3D scan and also minimizes blocking effect. If the X=75deg then proposal 2 is the same as proposal 1.  A question to OPPO’s rules. Rule one is already addressed by the agreement of last meeting. About rule 2, we understand the ambiguity there, but if DUT position is aligned (38.827 says “Position the DUT in the default P0 alignment option (Orientation 1)”), then there may be no ambiguity after implementing the new probe location towards z-axis?  **Issue 1-3-2: White Box Approach on SS-MPAC**  It was agreed in R4-1904160 that black box approach is adopted for both FR1 and FR2. If further study is needed on SS-MPAC, we prefer to only consider black box approach. |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2016218  (TP) | Company A |
| Company B |
|  |
| R4-2016221  (TP) | Company A |
| Company B |
|  |
| R4-2016222  (TP) | Company A |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Performance Requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2015311 | CAICT, vivo | “Framework on NR MIMO OTA requirements development”  **Proposal 1: Labs volunteer to participate in the performance requirement part shall complete the lab alignment measurements and submit the results to RAN4 for review.**  **Proposal 2: Lab alignment activities shall be divided in two independent parts. Part 1: lab alignment for FR1; Part 2: lab alignment for FR2 (if applicable). Simulation approach for FR2 requirement development is not precluded.**  **Proposal 3: Vendors or labs shall complete the channel model validation in accordance with the requirements of the above items during lab alignment activities.**  **Proposal 4: Labs shall complete the calibration and performance alignment in accordance with the requirements of the above items during lab alignment activities.**  **Proposal 5: Results for FR1 lab alignment activities shall be reported in the approved format, as specified in Table 2.4.1-1.**  **Proposal 6: Select sufficient commercial devices in the market, smartphone is the first priority. The measurement result of these selected devices shall be submitted by the aligned labs.**  **Proposal 7: Decide the minimum number of devices (e.g., at least [15]) for defining requirements in each band.** |
| R4-2016588 | Huawei, HiSilicon | “Discussion on framework for the definition of NR MIMO OTA TRMS requirements”  **Proposal 1: adopt above framework for the definition of NR MIMO OTA TRMS requirements (with track changes accepted).** |
| R4-2014723 | Samsung | “Discussion on FR1 and FR2 MIMO OTA”  **Observation 1: the precondition for defining exception points is to specify the PRS-EPRE-MAX (maximum downlink RS-ERPE) parameter.**  **Proposal 1: PRS-EPRE-MAX (maximum downlink RS-ERPE) parameter shall be specified for FR1 NR MIMO OTA. Further discussion is needed if -80dBm/15kHz or equivalent (-77dBm/30kHz) could be re-used for whole NR FR1 range.**  **Proposal 2: exception points shall be specified for FR1 NR MIMO OTA at both 70%TP and 95%TP**  **Observation 2: Option 1 (TP@90% can pass 11 of total 12 rotations) is even more stringent than the LTE exception point requirement at 70%TP (TP@70% can pass 11 of total 12 rotations).**  **Proposal 3: Option 2 (TP@95% can pass 10 of total 12 rotations) is only acceptable for below 3GHz.**  **Observation 3: if [50%] percentile value is also taken as a FoM, that means no exception points allowed for all top [50%] test points.**  **Proposal 4: For NR MIMO OTA, only middle channel shall be verified for each band.** |
| R4-2016219 | vivo, CAICT | “Discussions on FR2 MIMO OTA requirements”  **Observation 1: Throughput outage of the FR2 PMODE is not defined yet.**  **Observation 2: Limited DL power of FR2 system has impacts on throughput testing of different UE orientations.**  **Proposal 1: Align with demodulation test cases and FR1 MIMO OTA, 70% of maximum throughput as outage could be the starting point for FR1 MIMO OTA requirements.**  **Proposal 2: RAN4 should define the final outage of throughput for FR2 MIMO OTA requirements based on measurement results of real devices.**  **Proposal 3: Decision should be made on how to treat the orientations those can not reach target outage throughput in the future.** |
| R4-2016235 | Qualcomm Incorporated | “Views on for FR2 MIMO OTA”  **Observation 3: The approach of averaging MIMO sensitivity better than certain percentile of CCDF e.g. 50% for PC3, can be selected as the FoM for FR2 MIMO OTA requirement.**  **Observation 4: EIS statistics mode deviates from the orginal EIS CCDF as down sampling rate increase. Compared with orignal data and 18 samples (equivalent to 36 samples in whole sphere), the deviations are nontrivial.**  **Observation 5: Based on the EIS measurements analysis, 36 grid points will lead to ~0.77dB MU on averaging sensitivity which is much larger than TRP MU of 0.25dB.**  **Proposal 3: RAN4 to consider more test points to make sure the MU of MIMO OTA performance requirement is less than 0.25dB.** |
| R4-2016589 | Huawei, HiSilicon | “Discussion on open issues of NR MIMO OTA WI”  **Proposal 1: in addition to the agreement that *“Only one outage point of TP@ 70% is selected for the final performance metric”,* select option 2 in the WF as another check point i.e. “*TP@95% can pass 10 of total 12 rotations”.***  **Proposal 2: clarify the agreement as “select averaging all the value better than [xx%, “xx” is the %-tile of spherical coverage requirements for different power classes] percentile of CCDF as the only Figure of Merit for FR2 MIMO OTA requirement”. And not to introduce “[50%] percentile of the CCDF curve” as another FoM.** |
| R4-2015352 | OPPO | “Analysis on the impact of number of test points”  **Proposal:** **keep the agreement of 36 evenly spaced test points for FR2 MIMO OTA test.** |
| R4-2016539 | Huawei, HiSilicon | “Simulation assumptions for NR FR2 MIMO OTA”  **Proposal 1: BS beamforming configuration shall be described in more detail. We prefer to use option1 for FR2 BS beamforming configuration.**  **Proposal 2: The number of clusters shall be clearly regulated in different scenarios. We prefer Option 3.**  **Proposal 3: adopt two simplified antenna array layouts (two 2x2 patches and three 1x4 patches with the display) to evaluate on UE performance.** |
| R4-2014829 | MediaTek Inc. | “Proposal of FR2 MIMO OTA simulation approach workplan”  **Proposal 1: Approve FR2 MIMO OTA simulation approach workplan as Fig 1. i.e.**  **• RAN4#99-e (May, 2021): agree on simulation setting**  **• RAN4#100 to RAN4#101 (Aug to Nov, 2021): simulation data collection** |

## Open issues summary

### Sub-topic 2-1 Framework on performance requirements development

**Issue 2-1: Framework on performance requirements development**

* Proposal 1: Adopt framework on NR MIMO OTA TRMS performance requirements development in [R4-2015311].
* **P1**: Labs volunteer to participate in the performance requirement part shall complete the lab alignment measurements and submit the results to RAN4 for review.
* **P2**: Lab alignment activities shall be divided in two independent parts. Part 1: lab alignment for FR1; Part 2: lab alignment for FR2 (if applicable). Simulation approach for FR2 requirement development is not precluded.
* **P3**: Vendors or labs shall complete the channel model validation in accordance with the requirements of the above items during lab alignment activities.
* **P4**: Labs shall complete the calibration and performance alignment in accordance with the requirements of the above items during lab alignment activities.
* **P5**: Results for FR1 lab alignment activities shall be reported in the approved format, as specified in Table 2.4.1-1.
* **P6**: Select sufficient commercial devices in the market, smartphone is the first priority. The measurement result of these selected devices shall be submitted by the aligned labs.
* **P7**: Decide the minimum number of devices (e.g., at least [15]) for defining requirements in each band.
* Proposal 2: Adopt framework on NR MIMO OTA TRMS performance requirements development (with change tracks accepted) in [R4-2016588].
* Only aligned MIMO OTA labs can share measurement results into TRMS data pool
* **P1:** MIMO OTA TRMS requirements for FR1 are derived from measurement results of commercial devices. For FR2, simulation approach to define performance requirement is FFS.
* **P2**: The 8 bands listed in WID have highest priority:
  + - FR1: Band n41, n77, n78 and n79
    - FR2: Band n257, n258, n260 and n261
* **P3**: For a given frequency band, the requirement is defined based on the available data (≥15 TRMS points);
* **P4:** Whether joint band passing rate or per band approach is used for defining the requirements for above bands is to be determined
* **P5**: for FR1, each sample shall support at least 3 different NR bands, such that at least 1 low band (<3 GHz) and 1 high band (>= 4 GHz). For FR2, it is FFS.
* **P6**: The following percentile is picked from the overall TRMS CDFs for requirements:
  + - For FR1 TRMS at 70%TP: 85 percentile of the CDFof TRMSaverage,70
    - For FR2, it is FFS.
* **P7**: If measurements are not provided for some of the bands, the WI can finalize the requirements for those bands for which data is available according to P3
* **P8**: the number and location of all bands each UE supports shall be provided for information when TRMS data are provided
* **P9**: at RAN4#100 aim is to agree TRMS requirements for all above FR1 bands listed in WID; at RAN4#101 aim is to agree TRMS requirements for all above FR2 bands listed in WID; additional bands are not precluded
* **P10**: measurement results of SA mode are the first priority, NSA mode results are also encouraged. Information of SA or NSA mode shall be provided together with measurement data.
* Proposal 3: For NR MIMO OTA, only middle channel shall be verified for each band.
* Recommended WF
  + TBA

### Sub-topic 2-2 Performance metric for FR1 MIMO OTA

**Issue 2-2-1: Maximum downlink RS-EPRE for FR1 MIMO OTA performance metric**

* Proposals
  + Proposal 1: PRS-EPRE-MAX (maximum downlink RS-ERPE) parameter shall be specified for FR1 NR MIMO OTA.
    - Option 1: -80dBm/15kHz
    - Option 2: -77dBm/30kHz
    - Option 3: other
* Recommended WF
  + TBA

**Issue 2-2-2: Exception points for FR1 MIMO OTA performance metric**

* Proposals
  + Proposal 1: Exception points shall be specified for FR1 NR MIMO OTA at both 70%TP and 95%TP.
  + Proposal 2: Select “TP@95% can pass 10 of total 12 rotations” as another check point.
  + Proposal 3: “TP@95% can pass 10 of total 12 rotations” is only acceptable for below 3GHz.
* Recommended WF
  + TBA

### Sub-topic 2-3 Performance metric for FR2 MIMO OTA

**Issue 2-3-1: outage throughput for FR2 MIMO OTA performance metric**

* Proposals
  + Proposal 1: As starting point, adopt 70% of maximum throughput value as outage point.
  + Proposal 2: RAN4 should define the final outage of throughput for FR2 MIMO OTA requirements based on measurement results of real devices.
  + Proposal 3: Decision should be made on how to treat the orientations those can not reach target outage throughput in the future.
* Recommended WF
  + TBA

**Issue 2-3-2: averaging approaches for FR2 MIMO OTA performance metric**

* Proposals
  + Proposal 1: clarify the agreement as “select averaging all the value better than [xx%, “xx” is the %-tile of spherical coverage requirements for different power classes] percentile of CCDF as the only Figure of Merit for FR2 MIMO OTA requirement”.
  + Proposal 2: not to introduce “[50%] percentile of the CCDF curve” as another FoM.
* Recommended WF
  + TBA

**Issue 2-3-3: Number of test points for FR2 MIMO OTA performance metric**

* Proposals
  + Option 1: RAN4 to consider more test points to make sure the MU of MIMO OTA performance requirement is less than 0.25dB.
  + Option 2: Keep the agreement of 36 evenly spaced test points for FR2 MIMO OTA test.
* Recommended WF
  + TBA

### Sub-topic 2-4 Simulation issues for FR2 performance evaluation

**Issue 2-4-1: simulation approach work plan for FR2 MIMO OTA**

* Proposals
  + Proposal 1: Approve FR2 MIMO OTA simulation approach workplan as Fig 1 in R4-2014829, i.e.

• RAN4#99-e (May, 2021): agree on simulation setting

• RAN4#100 to RAN4#101 (Aug to Nov, 2021): simulation data collection.

* Recommended WF
  + TBA

**Issue 2-4-2: Simulation assumption for FR2 performance evaluation**

* Proposals
  + Option 1:
* **BS beamforming configuration:** We select the strongest beam from the codebook of 128 fixed beams, and then rotate the BS antenna array so that the direction of this beam towards the strongest cluster (Clsuter #6 in UMi CDL-C and Clsuter #2 in InO CDL-A).
* **Number of clusters:** choose 3 or 4 strongest clusters, i.e. 3 for CDL-A as cluster #2, #3 ,#4, 4 for CDL-C as cluster #6, #7, #8 ,#2, for each channel model that the BS strongest beam toward to.
* **PSP:** comparison between these above clusters(3 for CDL-A as cluster #2 #3 #4, 4 for CDL-C as cluster #6 #7 #8 #2) radiated from 6 probes and reference PAS from the above clusters defined in the channel model.
* **UE antenna array:** adopt two simplified antenna array layouts (two 2x2 patches and three 1x4 patches with the display) to evaluate on UE performance.
  + Option 2: other
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Keysight | **Issue 2-4-2: Simulation assumption for FR2 performance evaluation**  **BS beamforming configuration:** we agree that the text in 7.3: “*1 strongest transmitting beam is generated from BS, the direction of this beam towards the strongest cluster of each FR2 channel model*” should be updated. It should say “*1 strongest transmitting beam out of the 128 beam fixed beam grid is selected for each FR2 channel model*”   * **Number of clusters:** Option 2 in R4-2016539 is based on originally accepted proposal and our preference is not to make a late change as existing model and validation implementations are already based on previously agreed method unless there is a strong compelling case for this change * **UE antenna array:** Our view is not to define antenna array locations given the black box approach. Method of uniform sampling grid within the test-zone has been used so far and should be used in future as well to provide overview of all test orientations by one simulation. 2x2 and 1x4 arrays are subsets of the 4x4 array, which should be used in the simulations. 1x4 array is not suitable for PSP simulation as it reduces the channel model into 2D. Symmetrical rectangular arrays should be used in PSP simulations. |
| Xiaomi | **Issue 2-2-2: Exception points for FR1 MIMO OTA performance metric**  For FR1 we think it is quite mature now so we prefer proposal 3.  **Issue 2-3-1: outage throughput for FR2 MIMO OTA performance metric**  Prefer proposal 2 to see more results of the real devices. |
| Samsung | Sub-topic 2-1 Framework on performance requirements development  **Issue 2-1: Framework on performance requirements development**  Agree on the proposal that minimum number of devices should be guaranteed and the UE should support low and high bands (multi-band UE), e.g. FR1 UE supports both n41 and n79, FR2 UE support both 28GHz and 39GHz. Single-band UE or UE that covers narrow frequency range should be precluded.  Besides, we propose to agree on the test channel i.e. only middle channel for each band, which follows the principle of LTE MIMO OTA. It will also be beneficial for the measurement campaign afterwards.  Sub-topic 2-2 Performance metric for FR1 MIMO OTA  **Issue 2-2-1: Maximum downlink RS-EPRE for FR1 MIMO OTA performance metric**  We propose to specify PRS-EPRE-MAX (maximum downlink RS-ERPE) parameter before specify exception points requirements. We are open to each option. -80dBm/15kHz and equivalent -77dBm/30kHz may be starting point.  **Issue 2-2-2: Exception points for FR1 MIMO OTA performance metric**  We support proposal 1, i.e. exception points should be applicable for both 70%TP and 95%TP.  For proposal 2 and proposal 3, the precondition is the value of PRS-EPRE-MAX (maximum downlink RS-ERPE). At current stage, we can keep it TBD for whole FR1 range or restrict proposal 2 and proposal 3 within 3GHz.  Sub-topic 2-3 Performance metric for FR2 MIMO OTA  **Issue 2-3-1: outage throughput for FR2 MIMO OTA performance metric**  The proposals are all reasonable. 70% outage is a good starting point. Especially FR2 high bands (39GHz etc.) should be paid more attention for which achievable SNR is limited. There is also open issue on maximum downlink signal level definition and allowable exception points.  **Issue 2-3-2: averaging approaches for FR2 MIMO OTA performance metric**  We support the proposals. Agree to consider averaging approach as only metric, the clarification in proposal 1 is also meaningful.  **Issue 2-3-3: Number of test points for FR2 MIMO OTA performance metric**  We support option 2, i.e. keep the agreed 36 test points. MU larger than 0.25dB for OTA test especially receiver OTA test is acceptable. And the MIMO OTA averaging approach will provide better MU than EIS.  Sub-topic 2-4 Simulation issues for FR2 performance evaluation  **Issue 2-4-2: Simulation assumption for FR2 performance evaluation**  About UE antenna array, typical implementation for PC3 is two panels. 3 panels is possible in implementation but should be precluded in simulation assumption. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: TR 38.827 maintenance

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014289  (CR) | Spirent Communications | CR: Addition of Time Domain Alternative for Spatial Correlation Validation |
| R4-2016227 | vivo, CAICT | Number of slots for NR MIMO OTA testing  **Observation 1: Number of Slots per stream for FoM measurement is not defined for NR MIMO OTA.**  **Observation 2: minimum number of 10000 subframe is sufficient to identify the LTE MIMO OTA performance.**  **Proposal 1: Adopt 20000 as the minimum number of slots per stream for NR MIMO OTA testing.**  **Proposal 2: Further discuss whether 20000 slots is sufficient for 120kHz SCS FR2 MIMO OTA testing.**  **Proposal 3: If non-negligible variation of throughput is identified, the number of slots might be increased or new MU element named as “uncertainty associated with the number of slots” might need to be added into FR2 MU budget.**  **Proposal 4: Further study whether the minimum number of slots for FR1 MIMO OTA could be reduced to 10000, measurement results or simulation analysis for FR1 MIMO OTA performance is encouraged.** |
| R4-2016228  (CR) | vivo | CR: Number of Slots for NR MIMO OTA testing |
| R4-2016586  (CR) | Huawei, HiSilicon | CR: CR for 38.827 on corrections |
| R4-2006544  (TP) | Huawei, HiSilicon | TP to 38.827 on channel model rotations |
| R4-2016546  (TP) | Huawei, HiSilicon | TP to 38.827 on base station beamforming configuration |
| R4-2016211  (reserved) | Keysight Technologies | CR: Update of FR2 probe configuration |

## Open issues summary

### Sub-topic 3-1 Number of slots for NR MIMO OTA testing

**Issue 3-1: Number of slots for NR MIMO OTA testing**

* Proposals
  + Proposal 1: Adopt 20000 as the minimum number of slots per stream for NR MIMO OTA testing.

For FR2,

* + Proposal 2: Further discuss whether 20000 slots is sufficient for 120kHz SCS FR2 MIMO OTA testing.
  + Proposal 3: If non-negligible variation of throughput is identified, the number of slots might be increased or new MU element named as “uncertainty associated with the number of slots” might need to be added into FR2 MU budget.

For FR1,

* + Proposal 4: Further study whether the minimum number of slots for FR1 MIMO OTA could be reduced to 10000, measurement results or simulation analysis for FR1 MIMO OTA performance is encouraged.
* Related CR: R4-2016228
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Keysight | **Issue 3-1: Number of slots for NR MIMO OTA testing**   * Based on our analyses, the proposed number of slots for FR2 is acceptable. However, we believe that the emulation length should be longer than 20k slots for FR1, specifically SCS of 30kHz. We could provide such table to outline the number of slots as a function of SCS and frequency if requested. |
| Samsung | **Issue 3-1: Number of slots for NR MIMO OTA testing**  Agree to specify the exact number of slots. Generally speaking 20000 slots is a good proposal at current stage. If possible 10000 slots is also an option and we’d better be careful to further increase slots number beyond 20000. As proposal 3 mentioned, if non-negligible issue identified, new MU element named as “uncertainty associated with the number of slots” is a possible way forward. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2014289 | Keysight: Our preference would be to add more accurate instrument settings and synchronization procedure (cabling etc.) as it might not be clear to everyone |
| Company B |
|  |
| R4-2016228 | Company A |
| Company B |
|  |
| R4-2016586 | Moderator: “Postponed”  CR cover page version is not correct. WI code is not correct. Need to come back next meeting based on RAN4 Chair’s guidance:  “All CRs, for both open or closed WIs, will be automatically postponed to the next meeting if there are two or more errors on the CR coversheet”  Views on the content can be discussed |
| Company A |
| Company B |
|  |
| R4-2016544 | Moderator: “Postponed”  TDoc type should be CR, come back next meeting. Views on this topic can be discussed. |
| Keysight: The channel model rotation will change depending on revised probe locations and channel model coordinate system definition and will be double checked |
| Company B |
|  |
| R4-2016546 | Moderator: “Postponed”  TDoc type should be CR, come back next meeting. Views on this topic can be discussed. |
| Keysight: given channel model and validation implementations have been based on the previously agreed implementation, it is preferred not to make a late change unless there is a strong compelling case for this change |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Refrenece

[1] RP-201998, SR for NR\_MIMO\_OTA，RAN#89-e, Sep. 2020

[2] R4-2012707, WF on MIMO OTA, vivo, CAICT, Spirent, RAN4#96-e, Aug. 2020

[3] R4-2016539, Simulation assumptions for NR FR2 MIMO OTA, Huawei, HiSilicon, RAN4#97-e, Nov. 2020