**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-210XXXX**

**Electronic Meeting, 12th – 20th April, 2021**

**Agenda item:** 8.1.1

**Source:** Moderator (CAICT)

**Title:** Email discussion summary for [98-bis-e][326] NR\_MIMO\_OTA

**Document for:** Information

# Introduction

*Contributions submitted to AI 8.1 NR MIMO OTA WI are captured in this email discussion.*

*In the RAN4#98e meeting, next steps of NR MIMO OTA WI were captured in the WF:*

*Next steps:*

* + *Further study the proper Channel model for FR1 2x2 MIMO OTA requirements*
  + *Discuss the pass/fail limit and reference figure of channel model validation*
  + *Further discuss testing parameters for requirements (e.g. Maximum downlink power for bands>3GHz)*
  + *Further discuss the Figure of Merit for FR1 and FR2*
  + *Measurement results of FR1 or FR2 UEs are encouraged for discussion*
  + *Channel model validation results for FR2 channel models are encourages*
  + *Analysis on MU evaluation of FR2 blocking issue*
  + *FR2 simulation results of UE performance are encouraged*

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

* *1st round: agree TPs, discuss channel model validation, test parameters, FoM, simulation assumptions and other open issues for NR MIMO OTA.*
* *2nd round: make decision on open issues for NR MIMO OTA based on the decisions of 1st round.*

*Note: Given the meeting is only 7-day long and there is the RAN4 chair election, some changes in schedule are made compared to previous two-week e-meetings. Please pay close attention to the arrangements. The deadlines will be strictly enforced.*

# Topic #1: General and Testing methodologies

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2104515 | vivo, CAICT, OPPO | Updated workplan of MIMO OTA WI  **Proposal**: Approve the proposed work plan for Rel-17 NR MIMO OTA WI. |
| R4- 2105170 | Huawei, HiSilicon | On channel model for FR1 2x2 MIMO OTA requirements  **Observation 1:** for the simulated NR FR1 2x2 configurations, CDL-C channel models have better performance than CDL-A, similar trend was observed in [4].  **Observation 2:** the required SNR @ TP 95% is from ~14.5 - 18.5 dB for the 4 simulated channel models. They are all within the feasible SNR range of FR1 MIMO OTA chamber.  **Observation 3:** regarding the SNR span inside every specific channel model from TP0% to TP100%, CDLC\_UMA is the “sharpest” one, with only ~1.5dB span compared to ~2.5dB of the other three. This might make the CDLC\_UMA not be the best choice from test granularity perspective. And CDLC\_UMAhas been selected for FR1 4x4 MIMO OTA.  **Observation 4:** no significant difference between “4k slot” and “2k slot” for the simulated n78& SCS30Khz.  **Proposal 1:** the priority order for FR1 2x2 channel model is CDL-A UMi = CDL-A UMa = CDL-C UMi > CDL-C UMa. |
| R4-2105041 | Samsung | Discussion on channel model and downlink power configuration  **Observation 1:** system downlink power availability is one aspect for consideration when selecting channel model.  **Proposal 1:** the path loss induced by different channel models need to be considered. It is preferred to choose the channel model which requires least downlink power. One possible candidate is to apply UMi CDL-C for both 2x2 and 4x4 MIMO. |
| R4-2107127 | Keysight Technologies | Reference Channel Emulation Curves  **Observation 1:** Definition of BS antenna element polarization is currently missing in TR 38.827  **Proposal 1**: Apply ****polarized antenna model with 45˚ slant angle for FR1 MIMO OTA and Ë polarized antenna model for FR2 MIMO OTA  **Proposal 2**: Use polarization model-2 of section 7.3.2 of TR 38.901 for implementing the +/-45˚ slant angle for FR1 antenna model and 0˚/90˚ slant angle for FR2 antenna model |
| R4-2106902 | Spirent | Spatial Channel Model Validation Targets  **Proposal 1:** Adopt spatial channel model validation targets as presented. |
| R4-2106567 | OPPO | Consideration on Spatial Correlation with combined beam  **Observation 1**: DUT while performing MIMO OTA test receives wireless signals from all the clusters with both of the beam energy combined.  **Observation 2**: For CDL-C UMa, the coincided spatial correlation with combined beam approach reveals both of the two beams coincided well, accomplished with the PDP validation done separately for each beam.  **Proposal**: RAN4 should reconsider the baseline based on the combined beam approach to perform the spatial correlation validation. |
| R4-2105020 | CMCC | NR FR1 MIMO OTA Reference Spatial Correlation Curves based on Different Optimization Algorithm  **Observation 1:** If theoretical curve is not the objective function of optimization, simulation curve fit theoretical curve badly.  **Observation 2**: Different probe optimization algorithm makes different simulation result, and there are huge differences among them.  **Proposal:** Choose option #1 for spatial correlation reference curves. |
| R4-2104514 | vivo | Discussion on FR1 Power Validation procedure and compensation process  **Observation 1:** By using the average of 4 four orthogonal horizontal positions, the sum pattern is not flat vs angle, close to 0.5dB ripple is shown.  **Proposal 1**: If a horizontally polarized sleeve dipole is used for H component power validation, the horizontal positions should be more than 4. Recommended value is 16 to make sure the residual error is within 0.1 dB.  **Observation 2**: The reference antenna gain for dipole-based H-component power validation is the average of the theta gain pattern cut, which is missing in the spec.  **Proposal 2**: A note is needed in the power validation Measurement Procedure: “Note: in step 4, if horizontally polarized sleeve dipole is used, the reference gain correction should be the average of the theta gain pattern cut of the dipole.”  **Observation 3**: The base station setting for power validation should be identical to the measurement conditions, therefore the measured frequency needs to be the centre frequency of each band.  **Proposal 3**: The power validation should be performed per band, and the measured frequency is the centre frequency of each band.  **Proposal 4**: The power validation results should be considered as systematic offset of each band, which needs to be used to correct on the final sensitivity value to further reduce measurement uncertainty. |
| R4-2106569 | OPPO | Views on FR2 blocking issue  **Observation:** the conclusion can not be drawn that Probe 3 will not bring more blocking issue.  **Proposal:** the ripple test with Probe 3 activated can be considered to evaluate the measurement uncertainty of QoQZ and blocking effect. |
| R4-2107126 | Keysight | On Blocking MU for FR2 MIMO OTA  **Observation 1:** Blocking from Probe #1 is worse than from Probe #3.  **Observation 2:** The QoQZ validation procedure and MU element ‘Quality of quiet zone’ already captures the reflection/blocking from the positioning system.  **Observation 3**: 2 AoA RRM, which also leverages multiple probes simultaneously, is using the same QoQZ validation procedure with a single probe as FR2 MIMO OTA.  **Observation 4**: For systems that support both FR2 MIMO OTA and FR2 RRM testing, leveraging the same probe optimizes the QoQZ validation procedure.  **Observation 45**: The re-positioning concept has been incorporated in the FR2 MIMO OTA test cases and the QoQZ procedure, leveraged for all FR2 test methodologies, as optional approach.  **Observation 5**: The MTSUs for all FR2 test cases assume the re-positioning concept is applied, i.e., the optimized QoQZ MU must be used to determine the maximum acceptable MU.  **Proposal 1:** Consider the blocking issue properly captured for NR FR2 MIMO OTA. |
| R4-2107174 | CAICT | Views on MU evaluation of FR2 blocking issue  **Observation 1**: It is not clear whether the blocking effect of probe 3 is smaller than that of probe 1 based on the existing information.  **Proposal 1**: Whether the blocking issue of 3D-MPAC system has been properly covered by MU needs further analysis. |
| R4-2107293 | Huawei, HiSilicon | Discussion on bandwidth for NR FR2 MIMO OTA RMC  **Proposal 1**: We propose to at least use 200MHz CBW for 28GHz Bands. |
| R4-2104510 | vivo, CAICT | TP to TS38.151 v0.2.0 on FR1 Channel model |
| R4-2104511 | vivo, CAICT | TP to TS38.151 v0.2.0 on calibration and test procedure |
| R4-2104512  (reserved) | vivo | 3GPP TS 38.151 v0.3.0 |

## Open issues summary

### Sub-topic 1-1 General

**Issue 1-1: Updated Work Plan for NR MIMO OTA WI**

* Proposals
  + Proposal 1: Approve the proposed work plan for Rel-17 NR MIMO OTA WI in [R4-2104515].
* Recommended WF
  + Stabilize the updated Work Plan in the 1st round.

### Sub-topic 1-2 FR1 Channel model for 2x2

*Moderator: The discussion of FR1 channel model has lasted for several meetings, the group revised the previous agreement after further analysis on 4x4 channel model, and the RAN4#98e meeting conformed to adopt CDL-C UMa for FR1 4x4. In this meeting, proposal to further modify the 4x4 channel model is received in [R4-2105041]. However, in order to make progress, moderator hopes that we can focus on 2x2 channel model. It is not recommended to modify the 4x4 channel model again unless more measurement results are received to prove that the existing model is not suitable.*

**Issue 1-2: FR1 channel model for 2x2 MIMO**

* Proposal 1:
  + Option 1: CDL-A UMi (R4- 2105170)
  + Option 2: CDL-C Umi (R4- 2105170, R4-2105041)
  + Option 3: CDL-A Uma (R4- 2105170)
* Proposal 2: The path loss induced by different channel models need to be considered. It is preferred to choose the channel model which requires least downlink power.
* Recommended WF
  + TBA

### Sub-topic 1-3 Power validation procedure

**Issue 1-3-1: number of horizontal positions when using horizontally polarized sleeve dipole**

* Proposals
  + Proposal 1: If a horizontally polarized sleeve dipole is used for H component power validation, the horizontal positions should be more than 4. Recommended value is 16 to make sure the residual error is within 0.1 dB.
* Recommended WF
  + TBA.

**Issue 1-3-2: reference gain correction**

* Proposals
  + Proposal 1: A note is needed in the power validation Measurement Procedure: “Note: in step 4, if horizontally polarized sleeve dipole is used, the reference gain correction should be the average of the theta gain pattern cut of the dipole.”
* Recommended WF
  + TBA.

**Issue 1-3-3: Frequency for FR1 power validation**

* Proposals
  + Proposal 1: The power validation should be performed per band, and the measured frequency is the centre frequency of each band.
* Recommended WF
  + TBA.

**Issue 1-3-4: Compensation of power validation**

* Proposals
  + Proposal 1: The power validation results should be considered as systematic offset of each band, which needs to be used to correct on the final sensitivity value to further reduce measurement uncertainty.
* Recommended WF
  + TBA.

### Sub-topic 1-4 Channel model validation for FR1

*Power validation related topics are handled in sub-topic 1-3.*

**Issue 1-4-1: BS antenna element polarization for FR1**

* Proposals:
  + Proposal 1: Apply  polarized antenna model with 45˚ slant angle for FR1 MIMO OTA
  + Proposal 2: Use polarization model-2 of section 7.3.2 of TR 38.901 for implementing the +/-45˚ slant angle for FR1 antenna model.
* Recommended WF
  + TBA

**Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**

* Proposals:
  + Option 1: beam specific approach (agreed as baseline in RAN4#98e)
  + Option 2: combined beams (R4-2106567)
* Recommended WF
  + TBA

**Issue 1-4-3: Reference figure for spatial correlation validation**

*Previous agreement on reference figure for channel model validation in RAN4#97e are listed as follow: [R4-2017585]*

* + Reference figure for channel model validation
    - Simulated curve (channel model with BS filtering effect) with limited number of probes (16 probes for FR1 and 6 probes for FR2) is agreed as a reference, to be added into the TR to determine pass fail limits.
    - Simulated curve (channel model with BS filtering effect) with infinite number of probes is optional to be added.

*Further analysis and proposals are presented in R4-2105020:*

* Proposals:
  + Option 1: Choose theoretical curve as reference
  + Option 2: Choose simulation curve as reference: If we choose any one simulation curve as reference, the details of probe optimization algorithm must be clear.
* Recommended WF
  + TBA

**Issue 1-4-4: Reference validation targets for FR1**

*Offline discussions among CE vendors are ongoing for alignment purposes.*

* Proposals: Reference PDP/Temporal correlation/Spatial correlation data for FR1 (CDL-C UMa and CDL-A UMi model)
  + Option 1: R4-2106902
  + Option 2: R4-2107127 *(* *note: a* *revision of R4-2107127 has been uploaded to draft folder to include additional CM validation curves)*
  + Option 3: Further study is needed.
* Recommended WF
  + TBA

### Sub-topic 1-5 Channel model validation for FR2

**Issue 1-5-1: BS antenna element polarization for FR2**

* Proposals
  + Proposal 1: Apply  polarized antenna model for FR2 MIMO OTA
  + Proposal 2: Use polarization model-2 of section 7.3.2 of TR 38.901 for implementing the 0˚/90˚ slant angle for FR2 antenna model.
* Recommended WF
  + TBA.

**Issue 1-5-2: Reference validation targets for FR2**

* Proposals: Reference PDP/Temporal correlation/Spatial correlation data for FR2 (CDL-A InO and CDL-C UMi model)
  + Option 1: R4-2106902
  + Option 2: R4-2107127 *(The remaining reference PDP and autocorrelation data for FR2 models will be amended in this contribution before the start of # 98bis-e meeting. Additionally, updated spatial correlation reference curves will be provided in a revision of this contribution.)*
  + Option 3: Further study is needed
* Recommended WF
  + TBA

### Sub-topic 1-6 FR2 blocking issue

**Issue 1-6: FR2 Blocking issue**

* Proposals
  + Option 1:
    - Opt-1a: Whether the blocking issue of 3D-MPAC system has been properly covered by MU needs further analysis. [R4-2107174]
    - Opt-1b: the ripple test with Probe 3 activated can be considered to evaluate the measurement uncertainty of QoQZ and blocking effect. [R4-2106569]
  + Option 2: consider the blocking issue properly captured for NR FR2 MIMO OTA. [R4-2107126]
* Recommended WF
  + TBA.

### Sub-topic 1-7 FR2 MIMO OTA RMC

**Issue 1-7: FR2 MIMO OTA RMC**

*In RAN4#97e meeting, 16QAM RMC with 100MHz bandwidth is adopted as the only RMC for FR2 MIMO OTA.*

*In RAN4#98e, additional bandwidth of FR2 MIMO OTA RMC is proposed in [R4-2102729] and the agreement is to keep the previously agreed 100MHz.*

*In this meeting, FR2 MIMO OTA RMC with 200MHz is proposed and some feedbacks are provided in [R4-2107293].*

* Proposals
  + Proposal 1: at least use 200MHz CBW for 28GHz Bands
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

**Sub topic 1-1 General**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Support Proposal 1. |
| MediaTek | We are fine with Proposal 1 as a starting point, which reflects current WI and general Rel-17 time plan for core part and performance part well. However, just a general comment, if it is hard to achieve consensus for each checkpoint on time in the end, the exact deadline items of core part and performance part are still as shown in WID. |

**Sub topic 1-2 FR1 Channel model for 2x2**

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| **Company** | **Comments** |
| OPPO | We prefer Option 2. Actually, we believe CDL-C is more appropriate than CDL-A models. Not only because it matches with the base station features, but also two strongest beams in CDL-C models give UE more flexibility to design MIMO antenna than only one strongest beam in CDL-A models. |
| Keysight | Regarding Proposal 1: Prefer Option 1 as CM implementation/validation has progressed.  Regarding the results in R4-2105170: The correct beam direction is az: **-**7.27 deg and El: -10 deg for CDL-A Umi and CDL-C UMa for > 3.5 GHz. It seems that az: **+**7.27 was used in the simulations, which can also be seen in Figure 2. The results might be different if -7.27 beam direction was used.  Regarding Proposal 2: Our assumption is that 2-layer 2x2 test is not as sensitive to downlink power as 4x4 test. Therefore, the power criteria could be mainly applicable for 4x4 model selection. It would be best to have some empirical data to conclude if power is critical. |
| vivo | For Proposal 1, we prefer Option 2.  Besides, generally support P2 to consider the path loss, but this is only one of the aspects related to channel model characteristic. |

**Sub topic 1-3 Power validation procedure**

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| **Company** | **Comments** |
| vivo | Support the proposals in Issue 1-3-1, Issue 1-3-2, Issue 1-3-3 and Issue 1-3-4. |

**Sub topic 1-4 Channel model validation for FR1**

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| --- | --- |
| **Company** | **Comments** |
| OPPO | **Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  We support Option 2.  **Issue 1-4-3: Reference figure for spatial correlation validation**  Both Option 1 and Option 2 are acceptable. Considering the difficulty on presenting the probe optimization algorithm, Option 1 is actually feasible.  **Issue 1-4-4: Reference validation targets for FR1**  Option 3 is preferred. From current contributions (R4-2106902 & R4-2107127), obvious gaps can be found between two CE venders’ proposals. Although offline discussions are ongoing among CE venders, it is encouraged to clarify the process of getting the alignment from CE venders. |
| vivo | **Issue 1-4-2:** suggest to keep the beam specific approach as baseline.  **Issue 1-4-3:** given the simulation curve with BS filtering effect with limited number of probes has been agreed as reference, we would prefer not to revisit this conclusion. But we share similar interests to see an example probe optimization algorithm. |
| CMCC | **Issue 1-4-2: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  CMCC support Option 2 as our comments in RAN4 #98.  **Issue 1-4-3: Reference figure for spatial correlation validation**  It's difficult to get the alignment between CE venders, so we support Option1.  **Issue 1-4-4: Reference validation targets for FR1**  Option 3 is preferred. |

**Sub topic 1-5 Channel model validation for FR2**

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| --- | --- |
| **Company** | **Comments** |
| vivo | Regarding the channel model issue in 1-5-1 and 1-5-2, we would like to see aligned proposals from CE vendors. |
| CMCC | Issue 1-5-2: Reference validation targets for FR2  For PSP validation, the target PAS should be the theorical one which can be calculated as section 2.1.3 in R4-1706668. |

**Sub topic 1-6 FR2 blocking issue**

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| **Company** | **Comments** |
| OPPO | We support Option 1. To my understanding, the question to be answered is whether the Probe 3 will bring more MU, and this needs more analysis or validation. |
| Keysight | Support Option 2. |
| vivo | Option 1. Given the blocking issue has direct impacts on the quality of the implemented channel model within the test zone, but this is not validated/presented by channel model validation process, so we believe the blocking issue should be further studied. |
| CMCC | Support Option 1. |

**Sub topic 1-7 FR2 MIMO OTA RMC**

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| **Company** | **Comments** |
| Keysight | Support Proposal 1 |
| vivo | Consider existing commercial Channel model emulator in each test lab, we suggest to keep 100MHz for FR2 and conclude the discussion of this topic. |
| MediaTek | We are okay to add 200MHz CBW for 28GHz. However, we prefer to finalize 100MHz CBW details as first priority. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2104510  (TP) | Keysight: we prefer alternate language of the beamforming characteristics and will be working with authors offline. Additionally, the X2V concept should be further clarified in this TP. |
| vivo: we are fine to further refine the wording about beamforming characteristic. |
|  |
| R4-2104511  (TP) | 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.*

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

### CRs/TPs

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

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **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)

# Topic #2: Performance requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4- 2105169 | Huawei, HiSilicon | On remaining open issues of testing parameters for performance  **Observation 1:** according to section TS 37.144 [3] section 8.1.1, maximum downlink power PRS-EPRE-MAX is defined as -80 dBm/15 kHz for LTE UE MIMO OTA.  **Observation 2**: according to TS 36.101 and TS 38.101-1, the sensitivity requirements for LTE and NR are similar for same 2 Rx.  **Observation 3**: according to TS 38.101-1, the sensitivity for bands >3GHz is slightly higher than <3GHz due to higher IL (Insertion Loss, 1dB [5]).  **Observation 4**: in addition to rank=2 as LTE, NR MIMO OTA requires the test of Rank=4 MIMO which requires higher SNR.  **Proposal 1**: for bands>3GHz, for both 10MHz and 40MHz bandwidth, Maximum downlink power PRS-EPRE-MAX should be at least -80 dBm/15 kHz (-77dBm/30kHz), i.e. same as <3GHz. The preferred value is -79dBm/15kHz (-76dBm/30kHz), taking into account the higher insertion loss.  **Proposal 2**: For FR1 MIMO OTA performance requirements, adopt 2 of total 12 as additional restriction of Pmode for 10MHz and 40MHz CHBW  For FR2 MIMO OTA performance requirements, keep the agreement of using “the average over top 50%” as FR2 requirement metric. And the number of missing points should not exceed 18. |
| R4-2105041 | Samsung | Discussion on channel model and downlink power configuration  **Observation 2:** standardized maximum downlink power configuration is the precondition for determination of other figure of merits.  **Proposal 2:** specify maximum downlink power configuration firstly and then determine other related figure of merits. It is encouraged to define the maximum downlink power based on practical measurement for FR1, and to further study how to specify maximum downlink power configuration for FR2. |
| R4-2104513 | vivo | Discussion on FR2 FoM  **Observation 1**: For DUT1 with good MIMO OTA performance, the substitution approach does not have much impact (~0.3dB) on the Power at 50% percentile value and final MASC performance (~0.2dB).  **Observation 2**: For “DUT2- Nominal” and “DUT3-Bad”, similar trend with “DUT1-Good” is observed.  **Observation 3**: For DUT4 with large gain drop from peak to 50%-tile value, the MASC difference is about 0.9dB.  **Observation 4**: The device has large gain drop among different directions would be impacted greater by the substitution approach with more missing points (e.g. ~2.2dB for DUT4 with 9 points missing condition).  **Proposal 1**: The CDF curve should adopt substitution approach, the final MASC is the average of the top 18 points.  **Proposal 2**: Similar to FR1 FoM, RAN4 should define an additional criterion of the number of missing points (i.e. directions that can not reach target throughput even at the maximum downlink power supported by the system) for FR2 MIMO OTA. |
| R4-2106272 | CAICT | Views on how to treat the missing points for FR2 FoM  **Observation 1**: In the case that the number of missing points does not exceed 50% of the total number of test points (i.e., up to 18 missing points), the MASC calculation result will not be affected by the missing points.  **Observation 2**: It is possible for the EUT to obtain a good MASC value even when there are many missing test points, but this MASC value does not reflect the FR2 MIMO OTA performance of the EUT accurately under this condition.  **Proposal 1**: There is no need to consider the impact of orientations those cannot reach target outage TP for defining FR2 MASC.  **Proposal 2**: For FR2 MIMO OTA performance requirement, additional criterion on how many missing points is permitted around the sphere should be defined.  **Note**: Proposal 1 and proposal 2 should be considered in package, which means proposal 1 cannot be applied separately without Proposal 2.  **Observation 3**: For FR1 MIMO OTA performance requirement, the EUT must meet 70% TP in 11 of total 12 azimuthal orientations, i.e., 3 missing points are permitted out of a total of 36 test points with outage point of TP@70%.  **Observation 4**: For FR1 MIMO OTA performance requirement, the EUT must meet 90% TP in [TBD] of total 12 azimuthal orientations, i.e., TP@90% is also regarded as an additional FoM and the maximum number of missing points need further studied.  **Proposal 3**: For outage TP@70%, similar principle for additional criterions can be applied to FR2 MIMO OTA, and the restriction on the number of missing points can be relaxed on the basis of FR1 (FR1: 3 of total 36 test points).  **Proposal 4**: TP@90% is also regarded as an additional FoM and the maximum number of missing points is FFS.  **Proposal 5:** Further check the final number of missing points allowed for FR2 MIMO OTA after the testing parameter are fully defined. |
| R4-2106568 | OPPO | FoM for FR2  **Proposal:** The MASC is derived from averaging the top 18 values of total 36 test points. |
| R4-2107116 | Qualcomm | Discussion on FR2 MIMO OTA performance requirements  **Proposal 1**: RAN4 to agree the revision on the definition of MACS from TS 38.151 as [5].  **Observation 1**: It is not clear how to emulate PSP in the simulation since PSP is one of the criteria for channel validation that depends on several factors.  **Observation 2**: In addition to PSP, there are other criterion such as PDP, Doppler, etc. for channel validation that will also have impact on the simulation results.  **Proposal 2:** RAN4 should start the simulation campaign to calibrate the simulation platform with the channel model assumptions specified in TR38.827 as the first step.  **Proposal 3:** Companies should analyse the impact on the channel validation criterion such as PSP, PDP, doppler etc., and performance difference caused by the channel parameters variation such as AoA/ZoA, PAS, power, delay, etc. those explicitly reflect in the channel model parameters.  **Proposal 4**: The input on variation range of channel model parameters such as AoA/ZoA, PAS, power, delay, etc. impacting by 6 probes should be provided by TE/CE vendors.  Proposal 5: we propose to use the following assumptions for simulation campaign, i.e., using the channel parameters specified TR38.827 as the starting point:  • UE antenna array: two panels 2x2 patches (option 1)  • UE antenna parameters and Beam forming: Follow TR 38.803 (option 1)  • Polarization alignment: polarization aligned between UE and TE (option 1) |
| R4-2107294 | Huawei, HiSilicon | Discussion on FR2 MIMO OTA simulation  **Proposal 1:** 40dB threshold does not affect UE throughput performance with CDL-A InO channel model for FR2.  **Observation 1**: The power distribution of clusters in CDL-A InO channel model is too concentrated, causing the three clusters at the same location to have very high power, and other clusters have almost no impact on UE throughput, which makes the CDL-A InO channel model look like the TDL channel model without angular spread.  **Proposal 2**: Further discuss the necessity of CDL-A InO channel model for FR2 MIMO-OTA.  **Proposal 3**: CE vender are welcome to publish their probe weights and align them to reduce MU for FR2 MIMO OTA. |
| R4-2107363 | Qualcomm Incorporated | TP to TS38.151: revision on definition for MASC |
| R4-2107295 | Huawei, HiSilicon | TP to 38.151 on MIMO Average Spherical Coverage |

## Open issues summary

### Sub-topic 2-1 Maximum downlink RS-EPRE

*The agreement of test parameters for FR1 requirements are shown as below:*

*In RAN4#97e:*

* + - For band frequency <3GHz, the maximum downlink RS-ERPE should be -80dBm/15kHz for 10MHz gNB setting
      * Further study the maximum downlink RS-EPRE for frequency band >3GHz
      * Further study the maximum downlink RS-EPRE for 40MHz bandwidth for the above frequency bands

*In RAN4#98e:*

* + **PRS-EPRE-MAX** for band frequency <3GHz, 40MHz bandwidth
    - [-77dBm/30kHz] (starting point)

Note: This value is pending on further verification and confirmation from TE vendors/Test labs for the feasibility. Further discuss and revise the value is not excluded

*Further proposal on this topic is provided in this meeting:*

**Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz**

* Proposals
  + Proposal 1: define PRS-EPRE-MAX based on practical measurement for FR1.
* Recommended WF
  + TBA

**Issue 2-1-2: PRS-EPRE-MAX for FR1 band frequency >3GHz, 10MHz and 40MHz**

* Proposals
  + Option 1: -80dBm/15kHz (or equivalent -77dBm/30kHz)
  + Option 2: -79dBm/15kHz (or equivalent -76dBm/30kHz)
  + Option 3: based on practical measurement for FR1
* Recommended WF
  + TBA

**Issue 2-1-3: PRS-EPRE-MAX for FR2**

* Proposals
  + Proposal 1: further study how to specify PRS-EPRE-MAX for FR2
* Recommended WF
  + TBA

### Sub-topic 2-2 Figure of Merit for FR1

**Issue 2-2: Restriction of Pmode at 90%TP for 10MHz and 40MHz CHBW**

* Proposals
  + Proposal 1: adopt 2 of total 12 as additional restriction of Pmode at 90%TP for 10MHz and 40MHz CHBW.
* Recommended WF
  + TBA

### Sub-topic 2-3 Figure of Merit for FR2

**Issue 2-3-1: revision on the definition of MACS calculation**

*Moderator: 7 contributions are received, including 2 TPs (R4-2107295, R4-2107363) and 5 discussion paper (R4-2107116, R4-2106568, R4-2106272, R4-2105169, R4-2104513). To facilitate the discussion, moderator tries to summarize companies’ views into 3 options.*

* Proposals
  + Option 1: the final MASC is the average of the top 18 points.
    - Opt-1a: the number of missing points should not exceed 18
    - Opt-1b: the allowed number of missing points is FFS, at least should not exceed 18
    - Opt-1c: the allowed number of missing points is FFS
  + Option 2: the final MASC is the average of the best N sensitivity values. N=⌊M%\*36⌋, M is the percentile rank used in the EIS spherical coverage requirement of the DUT and the total number of test points.
    - Opt-2a: the number of missing points should be less than 36-N
    - Opt-2b: the allowed number of missing points is FFS, at least should not exceed 36-N
  + Option 3: the final MASC is the average of the top 50% points. when some points do not reach 70% maximum throughput, these points will not be considered in the CCDF and N is less than 18.
* Recommended WF
  + TBA

**Issue 2-3-2: additional criterion of FR2 FoM**

* Proposals
  + Proposal 1: For TP@70%, the number of missing points should be defined. (see issue 2-3-1 for details)
  + Proposal 2: TP@90% is also regarded as an additional FoM and the allowed number of missing points is FFS.
  + Proposal 3: Further check the final number of missing points allowed for FR2 MIMO OTA after the testing parameter are fully defined.
* Recommended WF
  + TBA

### Sub-topic 2-4 Framework on FR2 performance evaluation

**Issue 2-4-1: how to emulate the gap between simulation assumptions and measurement environment**

* Proposals
  + Proposal 1: RAN4 should start the simulation campaign to calibrate the simulation platform with the channel model assumptions specified in TR38.827 as the first step.
  + Proposal 2: Companies should analyse the impact on the channel validation criterion such as PSP, PDP, doppler etc., and performance difference caused by the channel parameters variation such as AoA/ZoA, PAS, power, delay, etc. those explicitly reflect in the channel model parameters.
  + Proposal 3: The input on variation range of channel model parameters such as AoA/ZoA, PAS, power, delay, etc. impacting by 6 probes should be provided by TE/CE vendors.
* Recommended WF
  + TBA

### Sub-topic 2-5 FR2 simulation assumption

**Issue 2-5-1: simulation assumptions for FR2**

* Proposals
  + Proposal 1: propose to use the following assumptions for simulation campaign, i.e., using the channel parameters specified TR38.827 as the starting point:
    - UE antenna array: two panels 2x2 patches (option 1)
    - UE antenna parameters and Beam forming: Follow TR 38.803 (option 1)
    - Polarization alignment: polarization aligned between UE and TE (option 1)
* Recommended WF
  + TBA

**Issue 2-5-2: 40dB threshold for cluster power**

* Proposals
  + Proposal 1: 40dB threshold does not affect UE throughput performance with CDL-A InO channel model for FR2.
  + Proposal 2: Further discuss the necessity of CDL-A InO channel model for FR2 MIMO-OTA.
  + Proposal 3: CE vender are welcome to publish their probe weights and align them to reduce MU for FR2 MIMO OTA
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

**Sub topic 2-1 Maximum downlink RS-EPRE**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | **Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz**  As previous email discussion, the appropriate maximum downlink RS-EPRE is highly related to the output/input capability of the test equipment and the placement of the test labs. We would like to keep the previous WF that make -80dBm/15kHz as a starting point, then modify the PRS-EPRE-MAX based on the practical experience.  **Issue 2-1-2: PRS-EPRE-MAX for FR1 band frequency >3GHz, 10MHz and 40MHz**  Similar view with Issue 2-1-1. The starting point can be Option 1 or Option 2.  **Issue 2-1-3: PRS-EPRE-MAX for FR2**  Support P1. We believe further study on this topic needed at current stage. |
| vivo | **Issue 2-1-1:** Practical power validation results at typical low/mid/high bands are encouraged to check the feasibility of the agreed -80dBm/15kHz.  **Issue 2-1-1:** no strong view on Option 1 or Option2. Some demonstration results would be desirable to make the decision. |

**Sub topic 2-2 Figure of Merit for FR1**

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| --- | --- |
| **Company** | **Comments** |
| vivo | Support the proposal as tentative agreement with square bracket. Given this is also applied to high band with 40MHz, we would like to conclude the final decision during the performance discussion stage with more measurement results of real UE and clear understanding of Maximum downlink power supported by the system at each band. |

**Sub topic 2-3 Figure of Merit for FR2**

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| --- | --- |
| **Company** | **Comments** |
| OPPO | **Issue 2-3-1: revision on the definition of MACS calculation**  Support Opt 1b. As specified in WID that “Smartphone is the first priority”, which is PC3 UEs for FR2, M=50%, N=18, Option 2 has the same FoM with Option 1 according to PC3 UEs. |
| vivo | **Issue 2-3-1:** given there is additional criterion on the number of missing points, so we think Opt-1a-1c are not necessary. We support to average the top 18 points to keep the averaging process consistency among different UEs, in case the situation appears that UE with more missing points has a better averaged MASC.  Option2: For the averaging process of other power class, we need further discussions on whether the percentile selected for FR2 MIMO OTA needs to align with EIS spherical coverage performance. We are not clear about the direct dependency between EIS and MASC.  **Issue 2-3-2:** support P1 and P3. Regarding setting 90%TP as the FoM for FR2, we think more discussion is needed. |
| MediaTek | **Issue 2-3-1: revision on the definition of MACS calculation**  Echo OPPO’s comment on PC priority, we also prefer to finalize PC3 discussion firstly to avoid possible confusion and to make the discussion easier.  In this cases, these options actually have some common part from PC3 only view, as shared by OPPO. It may be easier to achieve consensus.  One clarification question on opt-1a/b/c about “allowed number of missing point”. Does it mean “the allowed number of missing points among the selected top 18 points of PC3”? For example, if the allowed number of missing points is 3. Does it mean 15 of top 18 of total 36 will be used to calculate MACS in the end?  If our above understanding is correct, the number is not possible to exceed 18, and then, the option-1-a/b/c are actually same.  **Issue 2-3-2: additional criterion of FR2 FoM**  We prefer to focus on TP@70% firstly, as agreed in prior WF R4-2017585, which will be easier to achieve consensus. |

**Sub topic 2-4 Framework on FR2 performance evaluation**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Keysight | Issue 2-4-1: On Proposal 3, once the reference curves have been agreed, this range can be provided |
| MediaTek | **Issue 2-4-1: how to emulate the gap between simulation assumptions and measurement environment**  Generally speaking, we think the intention of proposal 2&3 are fine, it would make the simulation result can be more aligned and accurate. |

**Sub topic 2-5 FR2 simulation assumptions**

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| --- | --- |
| **Company** | **Comments** |
| Keysight | Issue 2-5-2: cannot support Proposal 3 since the exact probe weights are proprietary |
| vivo | **Issue 2-5-2:** FR2 UMi CDL-C has been selected as the single channel model for FR2 MIMO OTA requirements, we suggest to focus on the simulation and test efforts on this channel model. However, if companies would like to provide results with other channel models (e.g. CDL-A InO), we believe this is contribution driven. |
| MediaTek | **Issue 2-5-1: simulation assumptions for FR2**  There is already agreement in the latest WF (R4-2103915) about UE antenna array:  *“All options can be taken for simulation, in which OP1 and OP2 are with high priority*  *Op1: two panels 2x2 patches*  *Op2: two panels 1x4 patches*  *Op3: three panels 2x2 patches*  *Op4: three panels 1x4 patches”*  If company prefer to have only one UE antenna array type, we prefer 1x4 patches.  Polarization alignment  　We also think the study is important. |

### 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** |
| R4-2107363  (TP) | Moderator: R4-2107363 and R4-2107295 are on the same topic. It is recommended to focus on the open issues of FR2 FoM in Sub-topic 2-3 first, before going into TP discussion. |
| Company B |
|  |
| R4-2107295  (TP) | Moderator: R4-2107363 and R4-2107295 are on the same topic. It is recommended to focus on the open issues of FR2 FoM in Sub-topic 2-3 first, before going into TP discussion. |
| 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:* |

### 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)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents