**3GPP TSG-RAN WG4 Meeting # 101-bis-e R4-211XXXX**

**Electronic Meeting, January 17 – 25, 2022**

**Agenda item:** 6.1.1

**Source:** Moderator (CAICT)

**Title:** Email discussion summary for [101-bis-e][324] NR\_MIMO\_OTA

**Document for:** Information

# Introduction

*Contributions submitted to AI 6.1 NR MIMO OTA WI are captured in this email discussion.*

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

* 1st round: discuss open issues of NR MIMO OTA WI.
* 2nd round: agree TPs, make decisions on the open issues.

# Topic #1: General and Testing methodologies

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2200832**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200832.zip) | CMCC, BUPT | FR1 channel model validation results for CMCC & BUPT joint lab  **Proposal 1:** **The reference PDP values considering the effect of VNA bandwidth need to be decided in this meeting firstly, and the pass/fail limits can be discussed based on which.**  **Proposal 2: We suggest different pass/fail limits should be set for different region of spatial correlations. In other words, limits for low spatial correlation can be considered looser than those for high spatial correlation.** |
| [**R4-2200906**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200906.zip) | Apple | FR1 MIMO OTA Lab Alignment, Channel Model Validation  **Observation 1:** 3GPP has not yet agreed on the filtering method. The majority view is to filter the theoretical (compute with no filtering) with using a 200MHz BW.  **Observation 2:** Using the proposed filtering, the delta is around +/- 1.6dB for the amplitude and 5ns in time.  **Observation 3:** With no agreement on Obervation1, it is difficult to judge the PDP measured results. |
| **[R4-2201494](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201494.zip)** | Xiaomi | Validation results and limits for FR1 CDL-C UMa channel model-v1  **Proposal 1: To adopt the option 2 as Pass/Fail limit as: Bands of [±10%] of correlation capped at 100% from the target. Additionally, when the upper bound reaches [30%], the limit stays at [30%] and the lower limit drops to 0%**  **Proposal 2: Pass/Fail limits are formed as bands of [±10%] of correlation capped at 100% for the upper limit for target correlation of 35% and above. For target correlations below 35%, the band is widened to [±20%] capped at 0%. (R4-2119093)**  **Proposal 3: It is proposed that “[±1dB] of the theoretical target” as the Pass/Fail limit for V/H Ratio.** |
| [**R4-2200576**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200576.zip) | MediaTek Beijing Inc. | FR1 MIMO OTA channel validation  ***Proposal1:*** *Adopt PDP pass/fail limits as below table.*   |  |  |  | | --- | --- | --- | |  | **Power Tolerance** | **Delay Tolerance** | | **Paths from 0dB to 10dB** | [±1dB] | [±6ns] | | **Paths from 10dB to 20dB** | [±2.5dB] | [±6ns] | | **Paths from 20dB to 30dB** | [±5dB] | [±6ns] | | **Paths from 30dB to 40dB** | [±10dB] | [±6ns] |   ***Proposal2:*** *Define cross-polarization pass/fail limit as [±1dB].*  ***Observation****: Channel validation result are submitted for all listed items as one of Lab volunteers:*   |  |  | | --- | --- | |  | **Case** | | Channel Model Validation | PDP | | Doppler/Temporal Correlation | | Spatial correlation | | Cross-polarization | | Power validation | |
| **[R4-2201591](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201591.zip)** | CAICT | FR1 MIMO OTA channel model validation results and views on PDP pass/fail limits  **Observation 1: CAICT’s PDP measurement results of FR1 CDL-C UMa channel model match well with the target values.**  **Observation 2: CAICT’s Cross-polarization measurement results of FR1 CDL-C UMa channel model match well with the target values.**  **Observation 3: The PDP measurement result is affected by the CE BW in practice, but the “peak positions” on the measured PDP are almost unaffected.**  **Proposal 1: Adopt the discrete “peak values” on the 200MHz filtered PDP simulation curve as the new PDP reference.**  **Proposal 2: The effect of CE BW on the PDP measurement result should be taken into account when defining PDP pass/fail limits, i.e., the pass/fail limits should be reasonably wide to accommodate PDP measurement results with different CE BWs.**  **Observation 4: The same absolute value of test error will cause a larger deviation value in dB when a cluster is weaker.**  **Proposal 3: Define different power tolerances for clusters with different path loss. The power tolerance for weaker clusters should be larger.**  **Proposal 4: Adopt the PDP pass/fail limits** **proposed in R4-2119093 as below.**   |  |  |  | | --- | --- | --- | |  | **Power Tolerance** | **Delay Tolerance** | | **Paths from 0dB to 10dB** | [±1dB] | [±6ns] | | **Paths from 10dB to 20dB** | [±2.5dB] | [±6ns] | | **Paths from 20dB to 30dB** | [±5dB] | [±6ns] | | **Paths from 30dB to 40dB** | [±10dB] | [±6ns] | |
| **[R4-2201919](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201919.zip)** | Keysight Technologies UK Ltd | Pass/Fail Limits for FR1 Channel Model Validation  **Proposal 1: Adopt the 200 MHz filter with Hanning window for 5 ns quantized reference PDP for generating the filtered reference PDP data as described in this paper.**  **Proposal 2: Adopt the delay and power sample values for UMa and UMi models according to Tables 1 and 2 as reference data for PDP validation measurement.** |
| [**R4-2200731**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200731.zip) | Samsung | Max downlink power verification of MIMO OTA test system  **Observation 1: max downlink power value is still in bracket and is worthwhile further check in practical test**  **Observation 2: accuracy of max downlink power of test system has little impact to final TRMS, but affect much on the additional criterion in terms of exemption point number**  **Proposal 1: verify the feasibility of previously agreed max downlink power parameter and further check if there is more headroom to improve the value in the upcoming lab validation and alignment test.**  **Proposal 2: make sure the systematic offset from power validation result is applicable for max downlink power and is also compensated, for the sake of additional pass/fail criterion in terms of exemption point number.**  **Proposal 3: RAN4 discuss whether to specify detailed PDSCH power offset relative to total RS EPRE.** |
| [**R4-2201920**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201920.zip) | Keysight Technologies UK Ltd | Illustration of Device Orientations for Select Test Points  **Proposal 1: Endorse this TP to include illustrations of device/positioner/probe configurations & orientations based on the sample system for various test points** |
| [**R4-2200967**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200967.zip) | vivo | TP to TS38.151 on FR2 maximum downlink power and test procedure |
| [**R4-2200780**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200780.zip) | Qualcomm Incorporated | TP on TS 38.151 for test parameters of FR2 performance  **Observation 1: The maximum DL power of -79.1dBm/120kHz is in line with the parameters of current FR2 test system.**  **Observation 2: The pass criterion for PC3 UE shall be 18 or more test points meeting or greater than 70% maximum throughput. The criterion for the 90% maximum throughput is FFS.**  **Proposal 1: To approve the below TP on TS 38.151.** |
| **[R4-2200409](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200409.zip)** | Spirent Communications | TP to TS38.151 on FR1 Spatial Channel Model Validation |
| R4-2200573 (reserved) | Huawei, HiSilicon | Further results on FR1 channel model validation |
| R4-2201676 (reserved) | CAICT, CMCC, Keysight Technologies, Spirent Communications | Reference Channel Emulation PDP for Validation Purposes for FR1 CDL-C UMa |
| R4-2200966 (reserved) | vivo | 3GPP TS 38.151 v0.7.0 |

## Open issues summary

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

### Sub-topic 1-1 FR1 channel model validation

**Issue 1-1-1: PDP reference for FR1 CDL-C UMa channel model validation**

*Moderator’s note: In the last RAN4 meeting, this issue has been discussed and the agreements in WF [**R4-2120684] are as below:*

*Agreements:*

*The reference PDP should be filtered to the BW of 200 MHz to compare the measurement results with the reference for FR1channel model validation.*

*The reference PDP filtered to the BW of 200 MHz should be stabilized in Jan. RAN4 meeting. A check point for offline alignment among CE venders before Jan. 2022 is encouraged. It is also encouraged to share the results in the NR MIMO OTA email reflector before Jan. 2022.*

*FFS how to define the pass/fail limits based on 200MHz-filtered reference.*

* Proposals
  + Proposal 1: The reference PDP values considering the effect of VNA bandwidth need to be decided in this meeting firstly, and the pass/fail limits can be discussed based on which. (CMCC, BUPT)
  + Proposal 2: Adopt the discrete “peak values” on the 200MHz filtered PDP simulation curve as the new PDP reference. (CAICT)
  + Proposal 3: Adopt the 200 MHz filter with Hanning window for 5 ns quantized reference PDP for generating the filtered reference PDP data as described in R4-2201919. (Keysight)
  + Proposal 4: Adopt the delay and power sample values for UMa and UMi models according to Tables 1 and 2 in R4-2201919 as reference data for PDP validation measurement. (Keysight)
  + Proposal 5: Others
* Recommended WF
  + TBA

**Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation**

* Proposals
  + Proposal 1: Adopt PDP pass/fail limits proposed in R4-2119093 as below. (MTK, CAICT)

|  |  |  |
| --- | --- | --- |
|  | **Power Tolerance** | **Delay Tolerance** |
| **Paths from 0dB to 10dB** | [±1dB] | [±6ns] |
| **Paths from 10dB to 20dB** | [±2.5dB] | [±6ns] |
| **Paths from 20dB to 30dB** | [±5dB] | [±6ns] |
| **Paths from 30dB to 40dB** | [±10dB] | [±6ns] |

* + Proposal 2: The effect of CE BW on the PDP measurement result should be taken into account when defining PDP pass/fail limits, i.e., the pass/fail limits should be reasonably wide to accommodate PDP measurement results with different CE BWs. (CAICT)
  + Proposal 3: Define different power tolerances for clusters with different path loss. The power tolerance for weaker clusters should be larger. (CAICT)
  + Proposal 4: Others
* Recommended WF
  + TBA

**Issue 1-1-3: Temporal Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**

*Moderator’s note: In the last RAN4 meeting, the following options have been discussed, and the agreements in WF [R4-2120684] are as below:*

* + *Option 1: R4-2118587*

*0.25λ, [+/- 0.05, capped at 1]*

*0.5λ, [ +/- 0.05]*

*1 λ, [ +/- 0.075]*

*1.5λ, [ +/- 0.1]*

*2λ, [ +/- 0.1]*

*2.5λ and greater, [ +/- 0.2]*

* + *Option 2: Pass/Fail limits are formed as bands of [±10%] of correlation capped at 100% from the target. Additionally, when the upper bound reaches [30%], the limit stays at [30%] and the lower limit drops to 0%. (R4-2119093)*

*GTW Agreement: Option 2 as starting point, meanwhile companies are encouraged to continue offline discussion together with other parameters and final conclusion will be made in Jan 2022 RAN4 meeting.*

* Proposals
  + Proposal 1: Adopt the starting point agreed in the last meeting as the pass/fail limits, i.e., Pass/Fail limits are formed as bands of [±10%] of correlation capped at 100% from the target. Additionally, when the upper bound reaches [30%], the limit stays at [30%] and the lower limit drops to 0%. (Xiaomi)
  + Proposal 2: Others
* Recommended WF
  + Adopt the Temporal Correlation pass/fail limits proposed in R4-2119093, i.e., Pass/Fail limits are formed as bands of [±10%] of correlation capped at 100% from the target. Additionally, when the upper bound reaches [30%], the limit stays at [30%] and the lower limit drops to 0%.

**Issue 1-1-4: Spatial Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**

*Moderator’s note: In the last RAN4 meeting, the following options have been discussed, and the agreements in WF [R4-2120684] are as below:*

* + *Option 1: Adopt the Spatial Correlation pass/fail limits presented in R4-2118587.*
  + *Option 2: Pass/Fail limits are formed as bands of [±10%] of correlation capped at 100% for the upper limit for target correlation of 35% and above. For target correlations below 35%, the band is widened to [±20%] capped at 0%. (R4-2119093)*

*GTW Agreement: Option 2 as starting point, meanwhile companies are encouraged to continue offline discussion together with other parameters and final conclusion will be made in Jan 2022 RAN4 meeting.*

* Proposals
  + Proposal 1: Adopt the starting point agreed in the last meeting as the pass/fail limits, Pass/Fail limits are formed as bands of [±10%] of correlation capped at 100% for the upper limit for target correlation of 35% and above. For target correlations below 35%, the band is widened to [±20%] capped at 0%. (Xiaomi)
  + Proposal 2: We suggest different pass/fail limits should be set for different region of spatial correlations. In other words, limits for low spatial correlation can be considered looser than those for high spatial correlation. (CMCC, BUPT)
  + Proposal 3: Others
* Recommended WF
  + Adopt the Spatial Correlation pass/fail limits proposed in R4-2119093, i.e., Pass/Fail limits are formed as bands of [±10%] of correlation capped at 100% for the upper limit for target correlation of 35% and above. For target correlations below 35%, the band is widened to [±20%] capped at 0%.

**Issue 1-1-5:** **V/H ratio pass/fail limits for FR1 CDL-C UMa channel model validation**

* Proposals
  + Proposal 1: Define the V/H ratio pass/fail limit as [±1dB]. (Xiaomi, MTK)
  + Proposal 2: Others
* Recommended WF
  + TBA

### Sub-topic 1-2 Summary of FR1 MIMO OTA channel model validation results

**Issue 1-2: Summary of FR1 MIMO OTA channel model validation results**

*Moderator’s note: In the last meeting, CAICT (R4-2119558) and Huawei (R4-2119541) have shared part of the FR1 channel model validation results. In this meeting, MediaTek (R4-2200576), Apple (R4-2200906), Xiaomi (R4-2201494), CMCC&BUPT (R4-2200832), CAICT (R4-2201591), and Huawei (R4-2200573) submitted all/part of the validation results. Up to now, 6 labs have submitted part/all of the FR1 MIMO OTA channel model validation results.*

* Proposal
  + Comments and further validation results from companies are welcome.
* Recommended WF
  + TBA

### Sub-topic 1-3 Max downlink power verification of MIMO OTA test system

**Issue 1-3-1: The previously agreed max DL power parameter for FR1**

* Proposal (Samsung):
  + Verify the feasibility of previously agreed max downlink power parameter, i.e., [-80dBm/15kHz (or equivalent 77dBm/30kHz)], and further check if there is more headroom to improve the value in the upcoming lab validation and alignment test.
* Recommended WF
  + TBA

**Issue 1-3-2: The systematic offset for max downlink power**

* Proposal (Samsung):
  + Make sure the systematic offset from power validation result is applicable for max downlink power and is also compensated, for the sake of additional pass/fail criterion in terms of exemption point number.
* Recommended WF
  + TBA

**Issue 1-3-3: Whether to specify PDSCH power offset relative to RS EPRE for NR**

* Proposal (Samsung):
  + RAN4 discuss whether to specify detailed PDSCH power offset relative to total RS EPRE.
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

*One of the two formats, i.e. either example 1 or 2 can be used by moderators.*

Sub-topic 1-1 FR1 channel model validation

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | **Issue 1-1-1: PDP reference for FR1 CDL-C UMa channel model validation**  **Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation**  **Issue 1-1-3: Temporal Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**  **Issue 1-1-4: Spatial Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**  **Issue 1-1-5: V/H ratio pass/fail limits for FR1 CDL-C UMa channel model validation** |
| Spirent | **Issue 1-1-1: PDP reference for FR1 CDL-C UMa channel model validation**  **The proposal in R4-2201919 has two fundamental flaws:**  1.- Use of a Hanning window                  a) A Hanning window spans the whole 200MHz and it gradually approaches 0. This is quite different from the sharp roll off imposed by the CE  2.- Ignores the CE BW                  a) This sets the height of the sidelobes in the PDP.  It can be clearly seen in the contributions from companies showing PDP validations that the PDP responses are not as sharp as the filtered PDPs shown in R4-2201919. Take for example the PDP for beam 1 at 2.45GHz. In R4-2201919, the simulation for the strongest cluster (232.4, 235.4 and 239.4 ns) indicates that the CE’s BW has no impact. This is because the sidelobes are non-existing, but in reality, the sidelobes actually reach out to the next cluster (289.6 and 299.6ns) and make it difficult distinguish. A new approach that takes into account the CE frequency response (BW and shape), and uses a rectangular window for the VNA response will produce simulated results that are closer to measurements.  **Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation**  **Support proposal 1.**  **Issue 1-1-3: Temporal Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**  **Support Option 2**  **Issue 1-1-4: Spatial Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**  **Support Option 2**  **Issue 1-1-5: V/H ratio pass/fail limits for FR1 CDL-C UMa channel model validation**  **Support Proposal 1 ( this is also in R4-2119093)** |

Sub-topic 1-2 Summary of FR1 MIMO OTA channel model validation results

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

Sub-topic 1-3 Max downlink power verification of MIMO OTA test system

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | **Issue 1-3-1: The previously agreed max DL power parameter for FR1**  **Issue 1-3-2: The systematic offset for max downlink power**  **Issue 1-3-3: Whether to specify PDSCH power offset relative to RS EPRE for NR** |

### 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** |
| [**R4-2201920**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201920.zip)  (Illustration of Device Orientations for Select Test Points) | Company A |
| Company B |
|  |
| [**R4-2200967**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200967.zip)  (FR2 maximum downlink power and test procedure) | Company A |
| Company B |
|  |
| [**R4-2200780**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200780.zip)  (test parameters of FR2 performance) | Company A |
| Company B |
|  |
| [**R4-2200409**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200409.zip)  (FR1 Spatial Channel Model Validation) | 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:* |

### 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 requirement

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2201602**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201602.zip) | CAICT | Framework for FR1 MIMO OTA lab alignment activity  **Proposal 1: Approve the above Framework for FR1 MIMO OTA lab alignment activity.** |
| [**R4-2200572**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200572.zip) | Huawei, HiSilicon | On framework for PAD alignment of NR UE FR1 MIMO OTA  **Proposal 1: The pass/fail limit for lab PAD alignment is meeting for all three PAD candidates for each tested band.**  **Proposal 2: TMRSreference equal to the average of performance alignment results submitted to RAN4#102-e meeting. Late submission in RAN4#103-e can be considered for lab alignment, but will not change the reference TMRS value.** |
| [**R4-2200968**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200968.zip) | vivo | Proposal for MU budget of FR1 MIMO OTA  **Proposal 1: Approve the Measurement Uncertainty budget in Table 2 for FR1 MPAC system.** |
| [**R4-2200969**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200969.zip) | vivo | Pass/Fail limit for FR1 MIMO OTA lab alignment activity  **Proposal 1: Define the TRMS test tolerance for FR1 MIMO OTA as 0.5\* MU budget.**  **Proposal 2: Based on the analysis in [9], if that MU budget of FR1 MPAC can be agreed, the test tolerance of TRMS should be 1.5dB for bands<3GHz and 1.7dB for bands>3GHz;**  **Proposal 3: Limit the maximum deviation of TRMS between performance alignment lab and averaged value to [1.5dB] for bands<3GHz, and [1.7dB] for bands>3GHz, i.e. the maximum deviation between labs can be 3dB and 3.4dB.** |
| [**R4-2200970**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200970.zip) | vivo | Discussion on framework for FR1 MIMO OTA performance  **Proposal 1: RAN4 should discuss the maximum number of measurement results that each lab can submit.**  **Proposal 2: The selection of commercial devices to define FR1 MIMO OTA requirements should cover various of devices in the market.** |
| [**R4-2201282**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201282.zip) | OPPO | Commercial devices preparation and data handling  **Proposal 1: The measured commercial devices from every aligned lab should cover the low, middle and high price range. The detail price mapping to the range of low, middle and high can be further discussed in RAN4.**  **Proposal 2: Encourage all the aligned test labs to provide as many measurement data of commercial devices as they can.**  **Proposal 3: Regarding the measurement data on the same UE model from several test labs, take the average of the measurement data as one data in the data pool.** |
| **[R4-2200777](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200777.zip)** | Qualcomm Incorporated | Discussion on FR2 MIMO OTA requirements  **Observation 1: The polarization mismatch between TE and UE will not have impact on the 2-layer MIMO performance.**  **Observation 2: The best sensitivity among the 36 test points in the simulation might not be in line with the sensitivity of boresight and the sensitivity drop to 50%-ile might be smaller than 10.9dB due to the spatial under-sampling.**  **Observation 3: Per the formula of MACS defined in TS38.151, the MASC of meeting 70% maximum throughput is calculated as -135.8dBm/Hz.**  **Proposal 1: RAN4 to consider the AoA/ZoA offset, and power and delay offset of clusters in CDL-C for FR2 MIMO OTA simulation.** |
| **[R4-2200779](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200779.zip)** | Qualcomm Incorporated | Discussion on preliminary MU assessment for FR2 MIMO OTA  **Proposal 1: To agree the above MU budget for FR2 MIMO OTA 3D-MPAC.** |
| [**R4-2201441**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201441.zip) | Huawei,HiSilicon | Discussion FR2 MIMO OTA performance requirements  **Proposal 1: If there is not enough input for AoA/ZoA, PAS, power, delay, etc., those impacted by 6 probes, RAN4 to evaluate the offset of equivalent SNR due to non-ideal factors in order to move the simulation forward.**    **Proposal 2: RAN4 to explain how to calculate sensitivity values by obtained SNR from simulation.** |
| [**R4-2200580**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200580.zip) | MediaTek Beijing Inc. | FR2 MIMO OTA Simulation |
| R4-2200778 (reserved) | Qualcomm Incorporated | Summary results for FR2 MIMO OTA simulation |

## Open issues summary

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

### Sub-topic 2-1 MU budget and TRMS test tolerance for FR1 MIMO OTA

**Issue 2-1-1: Measurement uncertainty (MU) budget for FR1 MPAC system**

* Proposal (vivo, R4-2200968):
  + Approve the below Measurement Uncertainty budget for FR1 MPAC system.
* Table 2: Measurement uncertainty budget for FR1 MPAC system

| UID | Description of uncertainty contribution | Example value (410MHz<f≤3GHz) | Example value (3GHz <f≤7.125GHz) | Distribution of the probability | Std Uncertainty (410MHz<f≤3GHz) [dB] | Std Uncertainty (3GHz <f≤7.125GHz) [dB] |
| --- | --- | --- | --- | --- | --- | --- |
| Stage 2: DUT measurement | | | | | |  |
| 1 | Mismatch for measurement process | 0 | 0 | U-Shaped | 0 | 0 |
| 2 | Measure distance uncertainty | 0 | 0 | Normal | 0 | 0 |
| 3 | Quality of quiet zone | 0.6 | 0.6 | Actual | 0.6 | 0.6 |
| 4 | Base Station simulator | 1.5dB | 2dB | Rectangular | 0.87 | 1.15 |
| 5 | Channel Emulator  - absolute output power - output signal stability - output stability with temperature | 1.5dB 0.5dB 0.4dB | 1.5dB 0.5dB 0.4dB | Actual  (normal- power; rect-stability) | 0.84 | 0.84 |
| 6 | Amplifier uncertainties | 0.7dB | 0.7dB | Rectangular | 0.4 | 0.4 |
| 7 | Random uncertainty | 0.2dB | 0.2dB | Normal | 0.12 | 0.12 |
| 8 | Throughput measurement: output level step resolution | 0.25dB | 0.25dB | Rectangular | 0.14 | 0.14 |
| 9 | DUT sensitivity drift | 0.2 | 0.2 | Rectangular | 0.12 | 0.12 |
| 10 | Signal flatness | 0 | 0 | Normal | 0 | 0 |
| Stage 1: Calibration measurement | | | | | |  |
| 11 | Mismatch for calibration process  - loopback cable path  - system input path  - reference antenna | 0.2 | 0.2 | U-Shaped | 0.14 | 0.14 |
| 12 | Reference antenna positioning misalignment | 0 | 0 | Normal | 0 | 0 |
| 13 | Quality of quiet zone | 0.6 | 0.6 | Rectangular | 0.35 | 0.35 |
| 14 | Total uncertainty of the Network Analyzer | 0.5 | 0.5 | Rectangular | 0.29 | 0.29 |
| 15 | Uncertainty of an absolute gain of the calibration antenna | 1 | 1 | Normal | 0.5 | 0.5 |
| 16 | Offset of the Phase Center of the Reference Antenna | 0 | 0 | Normal | 0 | 0 |
| **Total Expanded Uncertainty, U, with 95% Confidence Interval** | | | | | **3.03** | **3.38** |

* Recommended WF
  + TBA

**Issue 2-1-2: TRMS test tolerance for FR1 MIMO OTA**

* Proposals (vivo, R4-2200969):
  + Proposal 1: Define the TRMS test tolerance for FR1 MIMO OTA as 0.5\* MU budget.
  + Proposal 2: Based on the analysis in R4-2200968, if that MU budget of FR1 MPAC can be agreed, the test tolerance of TRMS should be 1.5dB for bands<3GHz and 1.7dB for bands>3GHz
* Recommended WF
  + TBA

### Sub-topic 2-2 Framework for FR1 MIMO OTA lab alignment activity

*Moderator’s note: In the last RAN4 meeting, the following agreements have been captured in the WF [R4-2120684]:*

***Issue 2-3-1: How to process the lab alignment results***

*GTW Agreement:*

* *To guarantee a timely progress of the WI,* *the average of the PAD measurement results submitted on or before April.30 2022 will be treated as the reference value of the PAD based on the condition at least 3 labs’ results collected* 
  + *All labs shall have the opportunity to get PADs for test in time*
* *The framework for PAD alignment and pass/fail criteria need to be decided by Jan 2022 RAN4 meeting.*

***Issue 2-3-2: Which value shall be used for alignment comparison***

*Agreement:*

*TRMS value is used for alignment comparison.*

***Issue 2-3-3: Pass/fail limit for lab alignment***

*Agreement:*

*RAN4 should define the pass/fail limit for lab alignment, based on MU value of MPAC system.*

*Contributions R4-2201602 (CAICT), R4-2200572 (Huawei, HiSilicon), and R4-2200969 (vivo) discussed the framework for PAD alignment and the pass/fail limits.*

**Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**

* Proposals:
  + Proposal 1: The reference value of each PAD should be the average of the PAD measurement results submitted on or before 30 April 2022, based on the condition at least 3 labs’ results collected. (CAICT)
  + Proposal 2: TMRSreference equal to the average of performance alignment results submitted to RAN4#102-e meeting. Late submission in RAN4#103-e can be considered for lab alignment, but will not change the reference TMRS value. (Huawei, HiSilicon)
  + Proposal 3: others
* Recommended WF
  + TBA

**Issue 2-2-2: Pass/fail limit for FR1 MIMO OTA lab alignment**

* Proposals:
  + Proposal 1: Limit the maximum deviation of TRMS between each performance alignment lab and Averaged Value to [1.5dB] for bands<3GHz, and [1.7dB] for bands>3GHz, i.e. the maximum deviation between labs can be 3dB and 3.4dB. (vivo)
  + Proposal 2: The pass/fail limit for lab PAD alignment is meeting for all three PAD candidates for each tested band. (Huawei, HiSilicon)
  + Proposal 3: others
* Recommended WF
  + TBA

**Issue 2-2-3: Framework for FR1 MIMO OTA lab alignment activity**

*Moderator’s note: The framework for FR1 MIMO OTA lab alignment activity provided by R4-2118604 (CAICT) is as below. It is suggested to update R4-2118604 to capture the agreements on Issues 2-2-1 and 2-2-2 after the 1st round, if applicable.*

*For performance alignment measurement,*

1. *Labs/companies volunteer to participate in the performance requirement part shall complete the lab alignment measurements and system validation measurements, results should be submitted to RAN4 for review.*
2. *Using the testing conditions as defined in TS38.151.*
3. *The test bands for lab alignment are n41 and n78. Three performance alignment devices (PADs) for each band should be tested to ensure the alignment of measurement results.*
4. *TRMS value in SA mode will be used for alignment comparison.*
5. *The reference value of each PAD should be the average of the PAD measurement results submitted on or before 30 April 2022, based on the condition at least 3 labs’ results collected.*
6. *The acceptance criteria for declaring alignment should be defined based on MU value of MPAC system. The detailed criteria for accepting the outcome of the lab alignment activity are listed in Table 1.*

***Table 1. Requirements for lab alignment results (FR1 MIMO OTA****)*

|  |  |  |
| --- | --- | --- |
| ***Band*** | ***Case*** | ***Acceptance criteria*** |
| *n41* | *PAD\_1* | *The deviation between the measurement result and the reference value of each PAD shall be less than TBD, i.e.,*  *≦TBD* |
| *PAD\_2* |
| *PAD\_3* |
| *n78* | *PAD\_1* | *The deviation between the measurement result and the reference value of each PAD shall be less than TBD, i.e.,*  *≦TBD* |
| *PAD\_2* |
| *PAD\_3* |

*Note:*

1. *The PAD measurement results shall NOT be shared to anyone before submitting to RAN4 meetings or sharing in the NR MIMO OTA reflector. Comparison and alignment analyses should only be done in RAN4 meetings.*
2. *Three PADs for each band are listed in Table 2. Labs should submit PAD measurements results in an anonymous approach, i.e., the PADs for each band should be marked as PAD\_1, PAD\_2, and PAD\_3, respectively. The mapping between the codename PAD\_n and the actual PAD shall only be known among the labs participated in the alignment activity, and shall NOT be disclosed to any other companies.*

***Table 2. PADs for lab alignment (FR1 MIMO OTA****)*

|  |  |
| --- | --- |
| ***Test band*** | ***PAD*** |
| *n41* | *1. PAD candidate\_SAMSUNG*  *2. PAD candidate\_Xiaomi*  *3. PAD candidate\_OPPO* |
| *n78* | *1. PAD candidate\_SAMSUNG*  *2. PAD candidate\_Xiaomi*  *3. PAD candidate\_vivo* |

* Proposal:
  + Approve the above Framework in R4-2118604 for FR1 MIMO OTA lab alignment activity.
* Recommended WF
  + TBA

### Sub-topic 2-3 FR1 MIMO OTA test campaign

**Issue 2-3-1: How much measurement data of commercial devices should be submitted by labs**

*Moderator’s note: As agreed in the approved Framework on FR1 MIMO OTA requirements development [R4-2108617, 3GPP RAN4#99-e], the minimum number of devices for defining requirements in each band is 15.*

* Proposals
  + Proposal 1: RAN4 should discuss the maximum number of measurement results that each lab can submit. (vivo)
  + Proposal 2: Encourage all the aligned test labs to provide as many measurement data of commercial devices as they can. (OPPO)
  + Proposal 3: others
* Recommended WF
  + TBA

**Issue 2-3-2: How to select commercial devices to define FR1 MIMO OTA requirements**

* Proposals
  + Proposal 1: The selection of commercial devices to define FR1 MIMO OTA requirements should cover various of devices in the market. (vivo)
  + Proposal 2: The measured commercial devices from every aligned lab should cover the low, middle and high price range. The detail price mapping to the range of low, middle and high can be further discussed in RAN4. (OPPO)
  + Proposal 3: others
* Recommended WF
  + TBA

**Issue 2-3-3: How to avoid/address the same UE model measured in several labs**

* Proposals
  + Proposal 1: Regarding the measurement data on the same UE model from several test labs, take the average of the measurement data as one data in the data pool. (OPPO)
  + Proposal 2: others
* Recommended WF
  + TBA

### Sub-topic 2-4 FR2 MIMO OTA performance requirements

**Issue 2-4-1: FR2 MIMO OTA simulation**

* Proposals:
  + Proposal 1: RAN4 to consider the AoA/ZoA offset, and power and delay offset of clusters in CDL-C for FR2 MIMO OTA simulation. (Qualcomm)
  + Proposal 2: If there is not enough input for AoA/ZoA, PAS, power, delay, etc., those impacted by 6 probes, RAN4 to evaluate the offset of equivalent SNR due to non-ideal factors in order to move the simulation forward. (Huawei, HiSilicon)
* Recommended WF
  + TBA

**Issue 2-4-2: How to calculate sensitivity values by SNR values**

* Proposal (Huawei, HiSilicon):
  + RAN4 to explain how to calculate sensitivity values by obtained SNR from simulation.
* Recommended WF
  + TBA

### Sub-topic 2-5 Summary results for alignment of FR2 MIMO OTA

**Issue 2-5: Summary results for alignment of FR2 MIMO OTA**

*Moderator’s note: In the last meeting, Qualcomm and Huawei have shared their simulation results in* *R4-2118143. In this meeting, MediaTek submitted the FR2 MIMO OTA simulation result in R4-2200580.*

* Proposal
  + Comments and simulation inputs from companies are welcome.
* Recommended WF
  + TBA

### Sub-topic 2-6 MU budget for FR2 MIMO OTA

**Issue 2-6: MU budget for FR2 MIMO OTA 3D-MPAC**

* Proposal (Qualcomm):
  + To agree the below MU budget for FR2 MIMO OTA 3D-MPAC.
* Table 1: Measurement uncertainty budget for FR2 3D-MPAC

| UID | Description of uncertainty contribution | Example value (26.5GHz≤f≤29.5GHz) | Example value (37GHz ≤f≤40GHz) | Distribution of the probability | Details in |
| --- | --- | --- | --- | --- | --- |
| Stage 2: DUT measurement | | | | | |
| 1 | Mismatch for measurement process |  | TBD | U-Shaped | B.2.2.1 |
| 2 | Measure distance uncertainty |  | TBD | Normal | B.2.2.2 |
| 3 | Quality of quiet zone | [1.50dB] | TBD | Rectangular | B.2.2.3 |
| 4 | Base Station simulator | [1.67dB] | TBD | Rectangular | B.2.2.4 |
| 5 | Channel Emulator  -absolute value  -stability  -linearity |  | TBD | Normal | B.2.2.5 |
| 6 | Amplifier uncertainties | [1.00dB] | TBD | Rectangular | B.2.2.6 |
| 7 | Random uncertainty | [0.20dB] | TBD | Normal | B.2.2.7 |
| 8 | Throughput measurement: output level step resolution | [0.23dB] | TBD | Rectangular | B.2.2.8 |
| 9 | DUT sensitivity drift |  | TBD | Rectangular | B.2.2.9 |
| 10 | Signal flatness |  | TBD | Normal | B.2.2.10 |
| Stage 1: Calibration measurement | | | | | |
| 11 | Mismatch for calibration process  - loopback cable path  - system input path  - reference antenna |  | TBD | U-Shaped | B.2.2.11 |
| 12 | Reference antenna positioning misalignment | 0 | TBD | Normal | B.2.2.12 |
| 13 | Quality of quiet zone | [1.50] | TBD | Rectangular | B.2.2.3 |
| 14 | Total uncertainty of the Network Analyzer | [0.25] | TBD | Rectangular | B.2.2.13 |
| 15 | Uncertainty of an absolute gain of the calibration antenna | [0.80dB] | TBD | Normal | B.2.2.14 |
| 16 | Offset of the Phase Center of the Reference Antenna | 0 | TBD | Normal | B.2.2.16 |

* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1 MU budget and TRMS test tolerance for FR1 MIMO OTA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | **Issue 2-1-1: Measurement uncertainty (MU) budget for FR1 MPAC system**  **Issue 2-1-2: TRMS test tolerance for FR1 MIMO OTA** |

Sub topic 2-2 Framework for FR1 MIMO OTA lab alignment activity

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**  **Issue 2-2-2: Pass/fail limit for FR1 MIMO OTA lab alignment**  **Issue 2-2-3: Framework for FR1 MIMO OTA lab alignment activity** |

Sub topic 2-3 FR1 MIMO OTA test campaign

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | **Issue 2-3-1: How much measurement data of commercial devices should be submitted by labs**  **Issue 2-3-2: How to select commercial devices to define FR1 MIMO OTA requirements**  **Issue 2-3-3: How to avoid/address the same UE model measured in several labs** |

Sub topic 2-4 FR2 MIMO OTA performance requirements

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | **Issue 2-4-1: FR2 MIMO OTA simulation**  **Issue 2-4-2: How to calculate sensitivity values by SNR values** |

Sub topic 2-5 Summary results for alignment of FR2 MIMO OTA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

Sub topic 2-6 MU budget for FR2 MIMO OTA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

### 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:* |

### 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** |
| R4-211xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-2200409 | TP to TS38.151 on FR1 Spatial Channel Model Validation | Spirent Communications |  | other |
| R4-2200572 | On framework for PAD alignment of NR UE FR1 MIMO OTA | Huawei, HiSilicon |  | discussion |
| R4-2200573 | Further results on FR1 channel model validation | Huawei, HiSilicon |  | discussion |
| R4-2200576 | FR1 MIMO OTA channel validation | MediaTek Beijing Inc. |  | discussion |
| R4-2200580 | FR2 MIMO OTA Simulation | MediaTek Beijing Inc. |  | discussion |
| R4-2200731 | Max downlink power verification of MIMO OTA test system | Samsung |  | discussion |
| R4-2200777 | Discussion on FR2 MIMO OTA requirements | Qualcomm Incorporated |  | discussion |
| R4-2200778 | Summary results for FR2 MIMO OTA simulation | Qualcomm Incorporated |  | discussion |
| R4-2200779 | Discussion on preliminary MU assessment for FR2 MIMO OTA | Qualcomm Incorporated |  | discussion |
| R4-2200780 | TP on TS 38.151 for test parameters of FR2 performance | Qualcomm Incorporated |  | pCR |
| R4-2200832 | FR1 channel model validation results for CMCC & BUPT joint lab | CMCC BUPT |  | discussion |
| R4-2200906 | FR1 MIMO OTA Lab Alignment, Channel Model Validation | Apple |  | discussion |
| R4-2200966 | 3GPP TS 38.151 v0.7.0 | vivo |  | draft TS |
| R4-2200967 | TP to TS38.151 on FR2 maximum downlink power and test procedure | vivo |  | pCR |
| R4-2200968 | Proposal for MU budget of FR1 MIMO OTA | vivo |  | other |
| R4-2200969 | Pass/Fail limit for FR1 MIMO OTA lab alignment activity | vivo |  | other |
| R4-2200970 | Discussion on framework for FR1 MIMO OTA performance | vivo |  | discussion |
| R4-2201282 | Commercial devices preparation and data handling | OPPO |  | discussion |
| R4-2201441 | Discussion FR2 MIMO OTA performance requirements | Huawei,HiSilicon |  | discussion |
| R4-2201494 | Validation results and limits for FR1 CDL-C UMa channel model-v1 | Xiaomi |  | discussion |
| R4-2201591 | FR1 MIMO OTA channel model validation results and views on PDP pass/fail limits | CAICT |  | discussion |
| R4-2201602 | Framework for FR1 MIMO OTA lab alignment activity | CAICT |  | discussion |
| R4-2201676 | Reference Channel Emulation PDP for Validation Purposes for FR1 CDL-C UMa | CAICT, CMCC, Keysight Technologies, Spirent Communications |  | discussion |
| R4-2201919 | Pass/Fail Limits for FR1 Channel Model Validation | Keysight Technologies UK Ltd |  | discussion |
| R4-2201920 | Illustration of Device Orientations for Select Test Points | Keysight Technologies UK Ltd |  | pCR |

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** |
| R4-211xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-211xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-211xxxx | 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

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
|  |  |  |

Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)