**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] |

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| **[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 CE2.- 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)** |
| Huawei, Hisilicon | **Issue 1-1-1: PDP reference for FR1 CDL-C UMa channel model validation**We prefer Proposal 5 others, a modification based on Proposal 1: “*The reference PDP values considering the effect of VNA and CE bandwidth need to be decided in this meeting firstly, and the pass/fail limits can be discussed based on which.*”We agree with Spirent that CE BW need to be considered. “*test bandwidth is no more than 40MHz*” as discussed in our R4-2200573.**Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation**We are fine with all proposals i.e. 1, 2 and 3.**Issue 1-1-3: Temporal Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**Agree with recommended WF.**Issue 1-1-4: Spatial Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**Agree with recommended WF.**Issue 1-1-5: V/H ratio pass/fail limits for FR1 CDL-C UMa channel model validation**Support Proposal 1. |
| CAICT | **Issue 1-1-1: PDP reference for FR1 CDL-C UMa channel model validation**To Keysight: Thank you for providing the simulated 200MHz filtered PDP. We are wondering what’s the technical reason to choose Hanning window in simulation?To Spirent: Thank you for the analysis. We are interested in the new approach that takes into account the CE frequency response (BW and shape), and uses a rectangular window for the VNA response. Could you please provide such simulated PDP curves?Regarding the filtered PDP, there are two key factors in simulation: 1) the bandwidth, 2) the window type. It will be helpful to figure out how the two factors affect the shape of filtered PDP. We measured PDP with 100MHz and 200MHz CE BWs respectively (see the figure below, also in R4-2201591), although the shapes are affected by different CE BWs, the “peak values” are almost unaffected. But it is not sure whether 40MHz CE BW and different window types will affect the “peak values”. We expect CE vendors could provide simulated filtered PDP with different BWs and window types:- If the “peak values” are not affected, we support to adopt the “peak values” in the simulation curves as new PDP reference, and consider the CE BW’s impact when defining pass/fail limits.- If the “peak values” are affected, we suggest to analyse and discuss based on the simulation PDP results. A window type produces simulated results that are closer to measurements should be adopted. **Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation**Support Proposal 1, Proposal 2, and Proposal 3. It can be clearly seen from the PDP measurement results submitted by the labs that the CE bandwidth indeed has an obvious impact on the shape of the measured PDP, especially in Huawei’s contribution. Thus, we believe the CE BW’s impact should be taken into account when determining the PDP pass/fail limits, i.e., the pass/fail limits should be reasonably wide to accommodate PDP measurement results with different CE BWs (40MHz, 100MHz, …)Besides, we support to define different power tolerances for clusters with different path loss. The relative path loss of the clusters has a large dynamic range of 40dB. It is challenging to accurately measure the weaker clusters. The same absolute value of test error will cause a larger deviation value in dB when a cluster is weaker. E.g., the absolute deviation between 0dB and -10dB is 0.9, but the absolute deviation between -30dB and -40dB is 0.0009. Thus, it is reasonable to define a larger power tolerance for weaker clusters.Based on the above observations, we support to define the PDP pass/fail limits as Proposal 1.**Issue 1-1-3: Temporal Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**Support the recommended WF (Option 2)**Issue 1-1-4: Spatial Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**Support the recommended WF (Option 2)**Issue 1-1-5: V/H ratio pass/fail limits for FR1 CDL-C UMa channel model validation**Support Proposal 1 ([±1dB]).  |
| OPPO | **Issue 1-1-1: PDP reference for FR1 CDL-C UMa channel model validation**We support Proposal 1 and Huawei’s comment. The reference PDP should be considered combined with VNA bandwidth and CE bandwidth. It seems that 200MHz of VNA bandwidth is agreeable around interesting companies. However, as CAICT commented, the main divergence is the bandwidth of CE and shape of filter window. It is recommended to update the reference PDP with the group agreed CE bandwidth and filter window, otherwise the impact should be considered in pass/fail limits.We also support Proposal 2. The group should target to get consensus on the discrete peak values for the new PDP reference in this meeting.Regarding Proposal 3, the reason of using Hanning window need to be further illustrated.**Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation**We support Proposal 1, 2, 3. From current submitted validation results, the most controversial point is the curve around 300ns delay in UMa CDL-C Beam 1 at frequency of 2.45GHz. The clusters around 300ns is submerged in the envelope of the strong cluster at 230ns, which is probably affected by different settings of CE bandwidth and filter shape. This should be considered when making decision on PDP pass/fail limits.**Issue 1-1-3: Temporal Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**We support Proposal 1.**Issue 1-1-4: Spatial Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**We support Proposal 1 and 2.**Issue 1-1-5: V/H ratio pass/fail limits for FR1 CDL-C UMa channel model validation**We support Proposal 1. |
| Keysight | **Issue 1-1-1: PDP reference for FR1 CDL-C UMa channel model validation**Support P1, P3, P4. *Response to Huawei:*We agree that if 40 MHz CE BW must be supported, that needs to be considered for discrete tap delay samples since all taps are not resolvable at 40 MHz.*Response to CAICT/Spirent:*The Hanning window was chosen to provide good representation of theoretical 200 MHz filtered PDP reference. This is also shown to match well with measurement result in R4-2200906. The purpose was not to simulate the CE impact and the PDP shape outside the peaks. Instead, the purpose was to provide a realistic reference for the measured PDP peak powers considering that some of the taps are not resolvable by 200 MHz BW measurement and thus multiple taps contribute into same peak for some of the delays. We don’t see how CE response shape impact could be included into reference since that is assumed to be vendor specific.Below are some examples with different windows and BWs. We don’t consider CE impact here since we assume it to be vendor specific. The Hanning window provides best match with the theoretical reference and the peak powers are well aligned with our observations from measurements. If 40 MHz CE BW needs to be supported, the measurement BW also needs to be changed to 40 MHz and BW specific PDP reference needs to be defined. Here is an example of 40 MHz CE with 200 MHz measurement bandwidth. Obviously, the result is far from the reference and not acceptable.  The measurement result matches well with the reference if 40 MHz BW is used also in VNA measurement as shown below. **Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation**On P1&P2: the pass/fail limits proposed in R4-2119093 are too loose; stricter limits would be preferred. PDP reference data with BW filtering needs to be agreed before agreeing pass/fail limits.On P3: Agree, but we believe the measurement accuracy for weak clusters is reasonably good**Issue 1-1-3: Temporal Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**The Doppler spectrum measurement based method introduces uncertainty in the measurement results due to very long convergence time of the channel model. Time domain IQ-data measurement based method should be added into TS.38.151. We can consider the temporal correlation pass/fail limits after clarifying the validation method. Based on the interlab alignment contributions, it seems that some labs have adopted the Doppler spectrum measurement method and some labs have adopted the time domain IQ-measurement based method. Keysight considers proposing tighter limits after including the time domain method. **Issue 1-1-4: Spatial Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**We support defining different tolerances for different regions of the spatial correlation function, but instead of defining the regions based on correlation level, we propose to define the regions based on distance from reference point. The reason for this is that the 16 probe implementation of spatial correlation function does not follow the theoretical model far beyond one lambda distance from reference point and therefore accurate model implementation further from reference point is not feasible. Our proposal is to allow larger tolerances for the sample points further than 1.1 lambda from the reference. Based on the measurement results contributed as part of the interlab alignment, we also consider that the tolerances could be slightly tighter than previously proposed. Our proposal for the spatial correlation pass/fail limits is: * Adopt the pass/fail limit [+/- 0.075] for SCF up to 1.1 lambda distance from the reference point (270°).
* Adopt the pass/fail limit [+/- 0.15] for SCF beyond 1.1 lambda distance from the reference point (270°).

**Issue 1-1-5: V/H ratio pass/fail limits for FR1 CDL-C UMa channel model validation**Support Proposal 1 |
| MediaTek | **Issue 1-1-2:** Proposal1**Issue 1-1-3:** Proposal1**Issue 1-1-4:** Proposal1**Issue 1-1-5:** Proposal1 |
| Apple | **Issue 1-1-1:** Support Proposal 1. Following CAICT comments, the Proposal 2 can’t be agreed at this point and requires further understanding to be considered **Issue 1-1-2**: Support Proposal 2**Issue 1-1-3**: Support Proposal 1**Issue 1-1-4**: Support Proposal 1. Additionally, the Draft version of R4-2200906 CM validation v1 was uploaded on the Round 1 folder with the addition of Spatial Correlation data at 2450MHz which was missing from the original contribution. **Issue 1-1-5:** Support Proposal 1 |
| CMCC | **Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation**Regarding the PDP pass/fail limits issue, we have several considerations:1. Based on offline discussions among CE vendors and measurement results CAICT has proposed in [R4-2201591](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201591.zip), we believe PDP measurement results are strongly related with the adopted windows shape and CE bandwidth, and we did some simulations using different windows, the simulation approach is same with KS proposed in [R4-2201919](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201919.zip). Simulation results are as follows and it is can be observed that different windows shape would result in different PDP measurement shapes even the peak value. Simulations with other windows shape are also welcome to discuss. Hanning Window, Hamming Window and Kaiser Window are included,

Hanning Window: Hamming Window: Kaiser Window: 1. We support Spirent’s proposal that the strongest cluster of Beam1(2.45GHz & 3.6GHz) will affect the next cluster (289.6 and 299.6ns) due to the sidelobes effect and make it difficult to distinguish, PDP measurement results from labs which have provided channel validation data in this meeting can also prove this point. Hence, we propose the pass/fail limits of the specific cluster can be looser than others.

Considering above two points, our proposal is that the window effect of CE should not be included in the target, for example, except for KS and Spirent, some other CE vendors may adopt different filter windows. To solve the time resolution issue and make the measurement results can be compared with the reference value conveniently, we propose to adopt the summing cluster values in [R4-2118587](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-e/Docs/R4-2118587.zip) as target values avoiding the effect of CE windows. The specific target value and limits are as follows, **Clusters except Beam1 295ns #cluster**:

|  |  |  |
| --- | --- | --- |
|  | **Power Tolerance** | **Delay Tolerance** |
| **Paths from 0dB to 10dB** | [±0.85dB] | [±11ns] |
| **Paths from 10dB to 20dB** | [±1.5dB] | [±11ns] |
| **Paths from 20dB to 40dB** | [±2.5dB] | [±11ns] |

**#cluster Beam1 295ns：** **Power tolerance: [±5dB]** **Delay tolerance: [±11ns]**It also can be observed more clearly in following tables,2.45GHz Beam1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cluster# | Time(ns) | Reference（dB） | Power limits | Delay limits |
| 1 | 0.0 | -34.3 | [±2.5dB] | [±11ns] |
| 2 | 80 | -19.5 | [±1.5dB] | [±11ns] |
| 3 | 230 | 0 | [±0.85dB] | [±11ns] |
| 4 | 295 | -33.6 | **[±5dB]** | [±11ns] |
| 5 | 450 | -35.8 | [±2.5dB] | [±11ns] |
| 6 | 480 | -34.0 | [±2.5dB] | [±11ns] |

2.45GHz Beam2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cluster# | Time(ns) | Reference（dB） | Power limits | Delay limits |
| 1 | 0.0 | -27.9 | [±2.5dB] | [±11ns] |
| 2 | 75 | 0 | [±0.85dB] | [±11ns] |
| 3 | 235 | -18.4 | [±1.5dB] | [±11ns] |
| 4 | 290 | -28.1 | [±2.5dB] | [±11ns] |
| 5 | 450 | -27.9 | [±2.5dB] | [±11ns] |
| 6 | 480 | -27.9 | [±2.5dB] | [±11ns] |

3.6GHz Beam1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cluster# | Time(ns) | Reference（dB） | Power limits | Delay limits |
| 1 | 0.0 | -34.3 | [±2.5dB] | [±11ns] |
| 2 | 80 | -19.3 | [±1.5dB] | [±11ns] |
| 3 | 230 | 0 | [±0.85dB] | [±11ns] |
| 4 | 295 | -34.7 | **[±5dB]** | [±11ns] |
| 5 | 450 | -35.9 | [±2.5dB] | [±11ns] |
| 6 | 480 | -34.8 | [±2.5dB] | [±11ns] |

3.6GHz Beam2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cluster# | Time(ns) | Reference（dB） | Power limits | Delay limits |
| 1 | 0.0 | -27.8 | [±2.5dB] | [±11ns] |
| 2 | 75 | 0 | [±0.85dB] | [±11ns] |
| 3 | 235 | -18.3 | [±1.5dB] | [±11ns] |
| 4 | 290 | -29.1 | [±2.5dB] | [±11ns] |
| 5 | 450 | -28.1 | [±2.5dB] | [±11ns] |
| 6 | 480 | -28.8 | [±2.5dB] | [±11ns] |

**Issue 1-1-3: Temporal Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**We support Proposal 1.**Issue 1-1-4: Spatial Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**We support Proposal 1.**Issue 1-1-5: V/H ratio pass/fail limits for FR1 CDL-C UMa channel model validation**We support Proposal 1. |
| vivo | **Issue 1-1-1: PDP reference for FR1 CDL-C UMa channel model validation**Similar to the logic of MU assessment with worst case, in contrast, the reference curve definition should be best case with large CE bandwidth. However, as many companies commented, considering the CE implementation impacts, the suggestion is that group defines a Relaxed pass/fail limit with the consideration of several CE bandwidth ≥40MHz and different filtering window. **Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation**In general Proposal 1 is OK. But given the discussion in Issue 1-1-1 in unclear, the tolerance for paths from 30dB to 40dB should be further relaxed, based on results from several companies.**Issue 1-1-3: Temporal Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**Recommended WF is OK, sufficient flexibility is ensured.**Issue 1-1-4: Spatial Correlation pass/fail limits for FR1 CDL-C UMa channel model validation**Recommended WF is OK, sufficient flexibility is ensured.**Issue 1-1-5: V/H ratio pass/fail limits for FR1 CDL-C UMa channel model validation**[±1dB] is reasonable. |
| Xiaomi | **Issue 1-1-1:**Agree with CAICT and CMCC that the CE BW should be considered.Issue 1-1-2:For the pass/fail limit, it seems that we need to wait for the reference to be finished first.Furthermore, we propose to consider the MU in the pass/fail limit which is similar to TRMS pass/fail limit frame work.Issue 1-1-3:Support proposal 1.Issue 1-1-4:Support proposal 1.Issue 1-1-5:Support proposal 1. |
| Huawei, Hisilicon | **Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation**In addition to pass/fail limit, for the reference PDP value, in R4-2200573 we propose similar approach as CMCC’s comment above, i.e. combine the close cluster which are not resolvable due to limited hardware bandwidth e.g. VNA, CE etcDetailed dB values are slightly different from above CMCC’s, so I embed the calculation excel below for convenience.  |
| CAICT | **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**Considering the limited R17 timeline, and most labs have completed the measurement for FR1 channel model validation, it is an urgent need to conclude the PDP reference and pass/fail limits in this meeting. So we encourage to discuss PDP reference and pass/fail limits as a package. Thanks for Keysight’s and CMCC’s simulation inputs. Now it is clear that different CE/VNA BWs and window shapes will produce different PDP shapes in reality. For PDP reference, we think the approach proposed by CMCC and Huawei is a good choice to preclude the CE impact. Thank Huawei for sharing the calculation table. For PDP pass/fail limits, we echo vivo’s comments and believe the impacts of different CE BWs and window shapes should be taken into account, i.e., the pass/fail limits should be reasonably wide to accommodate these impacts.  |

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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| MediaTek | Thanks for moderator’s clear summary. |

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 FR1Issue 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** |
| Huawei, Hisilicon | **Issue 1-3-1: The previously agreed max DL power parameter for FR1**Support the proposal**Issue 1-3-2: The systematic offset for max downlink power**Support the proposal**Issue 1-3-3: Whether to specify PDSCH power offset relative to RS EPRE for NR**Support the proposal |
| Samsung | **Issue 1-3-1: The previously agreed max DL power parameter for FR1**Support the proposal as proponent**Issue 1-3-2: The systematic offset for max downlink power**Support the proposal as proponent. The point is to make sure the offset value accurately apply to all downlink power levels.**Issue 1-3-3: Whether to specify PDSCH power offset relative to RS EPRE for NR**Support the proposal as proponent. If consensus is achieved, TP can be provided to next meeting by interested companies. |
| CAICT | **Issue 1-3-1: The previously agreed max DL power parameter for FR1**Support to verify the feasibility of previously agreed max downlink power parameter. If it is feasible, we prefer to keep it as -80dBm/15kHz (or equivalent -77dBm/30kHz), rather than change it. **Issue 1-3-2: The systematic offset for max downlink power**Support the proposal**Issue 1-3-3: Whether to specify PDSCH power offset relative to RS EPRE for NR**Support the proposal |
| OPPO | **Issue 1-3-1: The previously agreed max DL power parameter for FR1**Support the proposal**Issue 1-3-2: The systematic offset for max downlink power**Support the proposal**Issue 1-3-3: Whether to specify PDSCH power offset relative to RS EPRE for NR**Support the proposal |
| vivo | Support all the proposals in Sub-topic 1-3 One clarification question, regarding the power validation applicable for max downlink power, is the intention to set the power validation fixed at Max Downlink Power condition for lab alignment activity? Otherwise, how to ensure this proposal. |
| CAICT | **Issue 1-3-1: The previously agreed max DL power parameter for FR1**Considering the max downlink power parameter [-80dBm/15kHz (or equivalent -77dBm/30kHz)] is a well-discussed consensus, and some labs have equipped their systems according to this target value (e.g., have purchased and assembled suitable power amplifiers), it is better to keep it unchanged. We support to modify the proposal as “Verify the feasibility of previously agreed max downlink power parameter [-80dBm/15kHz (or equivalent -77dBm/30kHz)]. If feasible, remove the square brackets.” |

### 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) | vivo: thanks to Keysight for providing the additional illustrations to make the spec easier to read.  |
| 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) | Samsung: in last meeting [-79.1dBm/120kHz] is agreed as starting point. If this tentative data is to be captured into TS, we’d better to leave an agreement in WF that this value is allowed to be revisited after practical test. |
| vivo: the suggestion from Samsung is reasonable. |
|  |
| [**R4-2200780**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200780.zip)(test parameters of FR2 performance) |  Samsung: in last meeting [-79.1dBm/120kHz] is agreed as starting point. If this tentative data is to be captured into TS, we’d better to leave an agreement in WF that this value is allowed to be revisited after practical test. Moreover, with -79.1dBm/120kHz max downlink power, it is not guaranteed that all 18 points could fulfil the performance metric. |
| Qualcomm: we are OK to capture in the WF this value is allowed to be revisited. Note that in the current TP, the -79.1dBm/120kHz is with []. |
|  |
| [**R4-2200409**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200409.zip)(FR1 Spatial Channel Model Validation) | vivo: many thanks to CE vendors and system providers for contributing the targets of channel model validation. For PDP part, may need update based on sub-topic 1-1 discussion outcome.  |
| 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 1-1 FR1 channel model validation** | **Issue 1-1-1: PDP reference for FR1 CDL-C UMa channel model validation***10 companies commented this issue. Thank all the discussions and simulation inputs. The obvious observations and majority views are as follows:*1. *CE BW and filter window shape will definitely affect the PDP shape.*
2. *No agreement achieved on which window should be used in the simulation (Hanning window or others).*
3. *CE impact is assumed to be vendor specific, and it should not be considered in the PDP reference.*
4. *To preclude the CE impact, the approach in R4-2118587 suggested by CMCC and Huawei is feasible.*

*Considering it was agreed to conclude this issue in this meeting, the following tentative agreement is recommended to move forward.* *Tentative agreements:** + Adopt the approach in R4-2118587 to generate the PDP reference values.

*Recommendations for 2nd round:*Companies are invited to share their views on the tentative agreement. Further check and finalize the PDP reference values in the 2nd round. Agreements should be captured in the WF. The target is to conclude the PDP reference and pass/fail limits as a package in this meeting. **Issue 1-1-2: PDP pass/fail limits for FR1 CDL-C UMa channel model validation***10 companies commented this issue. 7 companies supported to adopt Proposal 1 as the pass/fail limits. Another majority view is to consider the impact of the CE BW, window type, and measurement uncertainty when defining the pass/fail limits. Few companies suggested to determine Issue 1-1-1 first, but the moderator recommends to discuss and conclude Issues 1-1-1 and 1-1-2 as a package to guarantee the progress of the WI. To move forward, the tentative agreement is recommended as below.* *Tentative agreements:** + Adopt 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] |

*Recommendations for 2nd round:*Companies are invited to share their views on the tentative agreement. Agreements should be captured in the WF. The target is to conclude the PDP reference and pass/fail limits as a package in this meeting. **Issue 1-1-3: Temporal Correlation pass/fail limits for FR1 CDL-C UMa channel model validation***10 companies shared their views on this issue, 9 companies supported the recommend WF. Keysight considers proposing tighter limits after including the time domain IQ-data measurement based method.* *Considering it was agreed to conclude this issue in this meeting, the following tentative agreement is recommended:** + 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%.

*Recommendations for 2nd round:*Further check if the tentative agreement is agreeable.**Issue 1-1-4: Spatial Correlation pass/fail limits for FR1 CDL-C UMa channel model validation***10 companies shared their views on this issue, 9 companies supported the recommend WF. Keysight proposed new spatial correlation pass/fail limits:* * *Adopt the pass/fail limit [+/- 0.075] for SCF up to 1.1 lambda distance from the reference point (270°).*
* *Adopt the pass/fail limit [+/- 0.15] for SCF beyond 1.1 lambda distance from the reference point (270°).*

*Considering it was agreed to conclude this issue in this meeting, the following tentative agreement is recommended:** + 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%.

*Recommendations for 2nd round:*Further check if the tentative agreement is agreeable.**Issue 1-1-5: V/H ratio pass/fail limits for FR1 CDL-C UMa channel model validation***10 companies shared their views on this issue and all of them support Proposal 1.* *Agreement:** + Define the V/H ratio pass/fail limit as [±1dB].

*Recommendations for 2nd round:*None.  |
| **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***Recommendations for 2nd round:**Further measurement results and comments are welcome.*  |
| **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***5 companies shared their views on this issue. 4 companies supported the proposal, but CAICT insisted not to change the value [-80dBm/15kHz (or equivalent -77dBm/30kHz)] if it is verified to be feasible, considering it was a prior consensus.**Tentative agreement:** + Verify the feasibility of previously agreed max downlink power parameter [-80dBm/15kHz (or equivalent -77dBm/30kHz)]. If feasible, remove the square brackets.

*Recommendations for 2nd round:*Further if the tentative agreement is agreeable. Agreements should be captured in the WF. **Issue 1-3-2: The systematic offset for max downlink power***5 companies shared their views on this issue and all of them supported the proposal.* *A remaining clarification question raised by vivo: Regarding the power validation applicable for max downlink power, is the intention to set the power validation fixed at Max Downlink Power condition for lab alignment activity? Otherwise, how to ensure this proposal.**Tentative agreement:** + 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.

*Recommendations for 2nd round:*Further clarify and check the tentative agreement. Agreements should be captured in the WF.**Issue 1-3-3: Whether to specify PDSCH power offset relative to RS EPRE for NR***5 companies shared their views on this issue and all of them supported the proposal.* *Agreement:** + RAN4 discuss whether to specify detailed PDSCH power offset relative to total RS EPRE.
 |

### 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** $\left|TRMS\_{measured}-TRMS\_{reference}\right|\leq NR expanded MU$ **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 | 1.5dB0.5dB0.4dB | 1.5dB0.5dB0.4dB | 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 $\left|TRMS\_{measured}-TRMS\_{reference}\right|\leq NR expanded MU$ 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.,*$\left|TRMS\_{average,70}\\_mea-TRMS\_{average,70}\\_ref\right|$*≦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.,*$\left|TRMS\_{average,70}\\_mea-TRMS\_{average,70}\\_ref\right|$*≦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** |
| Samsung | **Issue 2-1-1: Measurement uncertainty (MU) budget for FR1 MPAC system**Support the proposal**Issue 2-1-2: TRMS test tolerance for FR1 MIMO OTA**Support the proposal |
| Keysight | **Issue 2-1-1: Measurement uncertainty (MU) budget for FR1 MPAC system**Fader related parameters, i.e., item 5 in the table is ok for Keysight.**Issue 2-1-2: TRMS test tolerance for FR1 MIMO OTA**Test tolerances for conformance testing are defined in RAN5. Instead of referring to test tolerances, the contribution should specify in P1 that for the pass/fail determination of labs participating in the lab alignment activities, the maximum deviation between the TRMS measured in the respective labs and the reference (average), shall be 0.5\*preliminary assessed MU. We agree with the approach in principle but without defining a test tolerance as it can be confused with the test tolerance defined in RAN5.  |
| vivo | **Issue 2-1-1: Measurement uncertainty (MU) budget for FR1 MPAC system**Support the proposal as proponent.**Issue 2-1-2: TRMS test tolerance for FR1 MIMO OTA**Support the proposals. Feedback to Keysight, indeed, the final TT for test requirement will be defined in RAN5 test spec. This test tolerance is something initially for providing guidance for lab alignment and performance test activity discussions in RAN4.  |

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** |
| Huawei, Hisilicon | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**Propose a mix of 1&2 for consideration: “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. Late submission in RAN4#103-e can be considered for lab alignment, but will not change the reference TMRS value.”**Issue 2-2-2: Pass/fail limit for FR1 MIMO OTA lab alignment**Support proposal 2.The pass/fail limit for lab PAD alignment is a different concept compared with TRMS test tolerance.* “The pass/fail limit for lab PAD alignment”: the difference of measurement results from different labs on one reference PAD, this is exactly same as the meaning of MU (Measurement uncertainty)
* “TRMS test tolerance”: the tolerance to relax device requirements because of MU of test equipment. Based on the principle “sharing risk”, usually TT < MU

**Issue 2-2-3: Framework for FR1 MIMO OTA lab alignment activity**The proposal can be revised based on the discussion of Issue 2-2-1 |
| Huawei, Hisilicon | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**Huawei proposed mixed proposal above is reasonable.**Issue 2-2-2: Pass/fail limit for FR1 MIMO OTA lab alignment**On one hand we understand that usually TT<MU, on the other hand if MU is directly used as lab alignment pass/fail limit, then the maximum deviation among labs would be up to 6~6.8dB. It seems the purpose of lab alignment is not so meaningful with such huge difference among labs.**Issue 2-2-3: Framework for FR1 MIMO OTA lab alignment activity**The proposal is generally agreeable, further refinement is expected based on some related open issue discussion. |
| CAICT | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**Support Huawei’s mixed proposal: “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. Late submission in RAN4#103-e can be considered for lab alignment, but will not change the reference TMRS value.” |
| OPPO | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**Huawei’s mixed version seems better and agreeable. We believe it’s too rush to finish the PAD measurement for most of the volunteer labs before RAN4 #102-e taking PAD roaming into account.**Issue 2-2-2: Pass/fail limit for FR1 MIMO OTA lab alignment**We have similar concern with Samsung that 6-6.8dB is too big difference among labs, and it will leave the trouble to performance requirement definition stage.Another issue should be concluded that how many PADs (3 PADs for each band) passed the limit can be considered as the lab is aligned? All of PADs or some of PADs?**Issue 2-2-3: Framework for FR1 MIMO OTA lab alignment activity**Generally agree with the proposal. |
| Keysight | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**Should the deadline of 30 April (~a week before the submission deadline for RAN4#103-e) be relaxed a bit to coincide with the submission deadline of RAN4#103-e, i.e., 6 May? That way, on-time contributions with PAD measurement data for RAN4#103-e (submitted after 30 April) can be considered for the reference value and are not considered late. The mixed proposal should be clarified as on-time contributions submitted after 30 April (previously agreed deadline for PAD results) and by 6 May (on time submission deadline) currently fall in between the two deadlines in the mixed proposal: (April 30) and “late submission in RAN4#103-e” (≥May 7)**Issue 2-2-2: Pass/fail limit for FR1 MIMO OTA lab alignment**Support Proposal 1; setting the maximum deviation to 1.0 \* preliminary MU seems excessive |
| MediaTek | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**We are generally okay for Huawei’s mixed proposal concept, and further align RAN4#103 tdoc submission deadline as Keysight’s comment is made sense, to have a solid/clear deadline by system.**Issue 2-2-2: Pass/fail limit for FR1 MIMO OTA lab alignment**It’s better that we further discuss it after having exact PAD test results.**Issue 2-2-3: Framework for FR1 MIMO OTA lab alignment activity**Thanks for the draft. We echo moderator’s note “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.” |
| vivo | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**The mixed proposal is reasonable.**Issue 2-2-2: Pass/fail limit for FR1 MIMO OTA lab alignment**Support proposal 1.**Issue 2-2-3: Framework for FR1 MIMO OTA lab alignment activity**Generally OK, update is needed based on discussions from other issues. |
| Xiaomi | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**We are OK with Huawei’s mixed proposal.**Issue 2-2-2: Pass/fail limit for FR1 MIMO OTA lab alignment**We agree with MTK that we can wait a little bit for the TRMS results of PADs come out to decide the final pass/fail limit. |
| CAICT | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment**Response to Keysight: In the last RAN4 meeting, the initial deadline for PAD measurement results submission was the Feb. RAN4 meeting for completing the WI within the limited R17 timeline. After the struggling GTW discussion, companies finally reached the agreement on the deadline 30 April. The PAD measurement results can be either submitted to Feb. RAN4 meeting or shared in the email reflector. It is better to respect the prior agreement. According to the approved time plan, measurement data of commercial devices for developing requirements should be submitted to the May RAN4 meeting. The purpose to set a deadline before the May RAN4 meeting is to reserve some time for offline discussing the lab alignment results, then companies can concentrate more on developing the performance requirements in the May RAN4 meeting. Thanks for pointing out the ambiguity, the mixed proposal can be revised as: “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. Late submission after 30 April 2022 can be considered for lab alignment, but will not change the reference TMRS value.” |

Sub topic 2-3 FR1 MIMO OTA test campaign

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| --- | --- |
| **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** |
| Samsung | **Issue 2-3-1: How much measurement data of commercial devices should be submitted by labs**Given the pass/fail limit in **Issue 2-2-2 is** large, proposal 1 seems necessary so as to decrease the uncertainty due to lab deviation as much as possible. On the other hand, proposal 2 is also needed to encourage each lab struggling to test as many UE as the maximum number.**Issue 2-3-2: How to select commercial devices to define FR1 MIMO OTA requirements**Support proposal 1 and 2.**Issue 2-3-3: How to avoid/address the same UE model measured in several labs**As an autonomous approach, a question is how we know the same UE model is used in different lab. If it could be known, why don’t we avoid this issue before testing?  |
| CAICT | **Issue 2-3-1: How much measurement data of commercial devices should be submitted by labs**Support Proposal 1. To obtain unbiased CDF curve, it should be avoided that few labs dominate the data pool. Considering the minimum number of devices for defining requirements in each band is 15, and 6 labs have submitted channel model validation results, the maximum number of measurement data for each band that each lab can submit can be [8].**Issue 2-3-2: How to select commercial devices to define FR1 MIMO OTA requirements**Support Proposals 1&2. **Issue 2-3-3: How to avoid/address the same UE model measured in several labs**The supported bands information of each UE should be shared, which can help to avoid/judge the same UE model to some extent.  |
| OPPO | **Issue 2-3-1: How much measurement data of commercial devices should be submitted by labs**As proponent of Proposal 2, the intension is to encourage the aligned labs to contribute to the commercial device data pool within the limited time window. Only limiting the maximum number of test data for each lab can not fundamentally solve the problem of dominating the data pool. A range of the number of test data for each band that each lab can submit can be [3-8].**Issue 2-3-2: How to select commercial devices to define FR1 MIMO OTA requirements**Support Proposal 1 and 2.**Issue 2-3-3: How to avoid/address the same UE model measured in several labs**As proponent, response to Samsung’s question: considering all the aligned labs perform commercial device measurement individually in parallel, it is difficult to judge, if two labs plan to test the same UE model, which lab can continue and which one have to quit. Unless, every lab shares their plan of measurement UE list before starting the test, and removes the repeated model in advance to avoid the same model be tested. In this situation, the way of sharing and maintaining the planed measurement UE list should be further discussed. |
| MediaTek | **Issue 2-3-2: How to select commercial devices to define FR1 MIMO OTA requirements**Both proposals are made sense for us.**Issue 2-3-3: How to avoid/address the same UE model measured in several labs**We are fine for the concept. Of course, try to avoid the situation in advanced as possible is good. |
| vivo | **Issue 2-3-1: How much measurement data of commercial devices should be submitted by labs**Support proposal 1. We are also supportive for the suggested value [8] from moderator.**Issue 2-3-2: How to select commercial devices to define FR1 MIMO OTA requirements**Support proposal 1 and 2. But we are wondering whether 3GPP is a good place to decide and provide the clear price line for low/mid/high end smartphone. Some wrong guidance/impression would be provided for the industry. **Issue 2-3-3: How to avoid/address the same UE model measured in several labs**Given the agreed anonymous approach, proposal 1 is ideally OK, but can not be carried out. |
| Xiaomi | **Issue 2-3-1: How much measurement data of commercial devices should be submitted by labs**Support proposal 1. We are also ok with the suggested value as 8.**Issue 2-3-2: How to select commercial devices to define FR1 MIMO OTA requirements**Support proposal 1.  |

Sub topic 2-4 FR2 MIMO OTA performance requirements

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | **Issue 2-4-1: FR2 MIMO OTA simulation****The two proposals are not contradictory. With considering the offset of channel model parameters, finally, we will get the equivalent SNR offset. Maybe we can merge the two proposals:****RAN4 to evaluate the offset of equivalent SNR due to the non-ideal factors including AoA/ZoA, power and delay offset of clusters.****Issue 2-4-2: How to calculate sensitivity values by SNR values**First of all, we can have get the MIMO sensitivity at the beam peak direction with below equation.MIMO sensitivity at beam peak direction= REFSENS + required SNR at baseband -(-1) (reference SNR for REFSENS) + 3dB (diversity gain)Then with the required SNR for 36 test directions, we can get the MIMO sensitivity by considering the required SNR gap, for example:MIMO sensitivity at test direction X = MIMO sensitivity at beam peak direction + (required SNR at test direction X - required SNR at peak direction)One question on Huawei, in last meeting, per the submitted simulation from Huawei, it seems the required SNR for peak direction is 13.7dB and 17.0dB for 70% and 90% T-put, respectively. In paper R4-2201441, the best SNR among 36 test direction is even better than that for beam peak direction (i.e., 10.5dB and 15dB). Is there any changes on the simulation assumptions?  |
| MediaTek | **Issue 2-4-1: FR2 MIMO OTA simulation**We think first priority is **proposal 1**, we can further study how these offsets impact on FR2 MIMO OTA performance assuming that more detail description on the offsets, and how much the variance is when the probes considered are provided.**Proposal 2** could be a backup, and we can further discuss how to offset/transfer the SNR result..**Issue 2-4-2: How to calculate sensitivity values by SNR values**Maybe we can align the SNR is calculated at the point between modem and RF chain. In this case, the relationship would be” SNR = SENS + Gain\_ANT + Gain\_BF – Noc” |

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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Samsung | **Issue 2-5: Summary results for alignment of FR2 MIMO OTA**Just would like to clarify that the ongoing simulation is for simulator alignment purpose only, not for performance simulation, and some simulation assumptions were also agreed for alignment purpose only. Is the understanding right? If so, the simulation results could not be used for performance metric decision on the remaining TBD item. |
| MediaTek | **Issue 2-5: Summary results for alignment of FR2 MIMO OTA****To Samsung:** these data is for simulator alignment only based on fundamental assumption.  |
| Qualcomm | **Issue 2-5: Summary results for alignment of FR2 MIMO OTA****To Samsung, the simulator alignment is based on the results for peak direction. By now, three companies provided the results and they are quite aligned.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Description** | QC | HW | MTK | STD | SPAN | AVE |
| Case 1 | 11.7 | 13.7 | 11.3 | 1.3 | 2.4 | 12.2 |
| Case 2 | 16.45 | 17.0 | 14.2 | 1.5 | 2.8 | 15.9 |

**For the results with 36 test directions, it can be the basis for requirements development with further consider on issue 2-4-1.****I copied the simulation assumptions for requirements development. Companies can make the comments.**

|  |
| --- |
| * UE antenna array: two panels 1x4 patches
 |
| * UE antenna parameters and Beam forming: Follow TR 38.803
 |
| * Channel model parameters: CDL-C Umi defined in TR38.827. The offset of channel model parameters due to the non-ideal factors are FFS.
* Test directions: 36 test directions specified in TR 38.827
 |

 |

Sub topic 2-6 MU budget for FR2 MIMO OTA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Keysight | The MU values in 38.810 are outdated; instead, the TR 38.903 from UE RF and RRM test cases should be consulted for more up-to-date MU values.  |
| Vivo | The MU value for FR2 should be further discussed.  |
| Qualcomm | Thanks for the comments. We will update the MU per TR38.903. |

### 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 2-1 MU budget and TRMS test tolerance for FR1 MIMO OTA** | **Issue 2-1-1: Measurement uncertainty (MU) budget for FR1 MPAC system***There’s no objection from companies to the proposal.* *Agreements:*o Approve the Measurement Uncertainty budget in R4-2200968 for FR1 MPAC system.*Recommendations for 2nd round:*None. **Issue 2-1-2: TRMS test tolerance for FR1 MIMO OTA***3 companies commented this issue. Samsung and vivo supported the proposals. Keysight agrees with the approach in principle but without defining a test tolerance here as it can be confused with the test tolerance defined in RAN5. Vivo made some clarifications on the meaning and purpose of the test tolerance here.* *Tentative agreement:*o Define the TRMS test tolerance for FR1 MIMO OTA as 0.5\* MU budget.o Based on the analysis in R4-2200968, the test tolerance of TRMS should be 1.5dB for bands<3GHz and 1.7dB for bands>3GHz.*Recommendations for 2nd round:*Further check if more clarifications are needed or if the wording should be revised. Agreements should be captured in the WF on NR MIMO OTA. |
| **Sub-topic 2-2 Framework for FR1 MIMO OTA lab alignment activity** | **Issue 2-2-1: Reference value for FR1 MIMO OTA lab alignment***8 companies commented this issue and all of them agreed with the following tentative agreement, except the deadline 30 April. 2 companies (Keysight and MTK) prefer to postpone the deadline to 6 May, but the moderator strongly recommends to be aligned with the prior agreement and keep it as 30 April.* *Tentative agreement:*o 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. Late submission after 30 April 2022 can be considered for lab alignment, but will not change the reference TMRS value.*Recommendations for 2nd round:*Further check if the above tentative agreement is agreeable.**Issue 2-2-2: Pass/fail limit for FR1 MIMO OTA lab alignment***7 companies shared their views on this issue. 4 companies (vivo, Keysight, Samsung, OPPO) prefer P1, 2 companies (MTK, Xiaomi) suggest to further discuss it after having PAD test results, 1 company (Huawei) supports P2.* *Besides, OPPO pointed out that another issue should be concluded is how many PADs passed the limit can be considered as the lab is aligned?* *All of PADs or some of PADs?**Candidate options:** + Option 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)
	+ Option 2: The pass/fail limit for lab PAD alignment is meeting $\left|TRMS\_{measured}-TRMS\_{reference}\right|\leq NR expanded MU$ for all three PAD candidates for each tested band. (Huawei, HiSilicon)
	+ Option 3: FFS after having some PAD test results

*The other issue: How many PADs should be passed? All of PADs or some of PADs?**Recommendations for 2nd round:*Further discuss the pass/fail limit for FR1 MIMO OTA lab alignment and the other issue.**Issue 2-2-3: Framework for FR1 MIMO OTA lab alignment activity***Recommendations for 2nd round:*Revise the framework in R4-2118604 based on discussion outcomes from Issues 2-2-1 and 2-2-2. The target is to approve the revised framework.  |
| **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***6 companies shared their views on this issue and all of them supported Proposal 1 and 3 companies also supported Proposal 2. Based on the discussion, the following tentative agreement is recommended:** + The maximum number of measurement results for each band that each lab can submit is [8]. The aligned labs are encouraged to submit as much data as possible.

*Recommendations for 2nd round:*Further check if the tentative agreement is agreeable. Agreements should be captured in the WF.**Issue 2-3-2: How to select commercial devices to define FR1 MIMO OTA requirements***6 companies shared their views on this issue and all of them supported Proposal 1. Companies are also basically supportive to Proposal 2, but vivo suggested not to decide the clear price line.* *Tentative agreement:** + The selection of commercial devices to define FR1 MIMO OTA requirements should cover various of devices in the market. The measured commercial devices from every aligned lab should cover the low, middle and high price range.

*Recommendations for 2nd round:*Further check if the tentative agreement is agreeable or if the wording should be revised. Agreements should be captured in the WF.**Issue 2-3-3: How to** **avoid/address the same UE model measured in several labs***5 companies shared their views on this issue. Companies are basically fine with the concept of the proposal, but questioned how to carried out considering the* *anonymous approach.*  *Recommendations for 2nd round:*Further discuss this issue. Proposals for avoiding the same UE model measured in several labs are welcome. Agreements should be captured in WF. |
| **Sub-topic 2-4 FR2 MIMO OTA performance requirements** | **Issue 2-4-1: FR2 MIMO OTA simulation***2 companies (Qualcomm and MTK) shared their views on this issue. No obvious agreement achieved in the 1st round.* *Recommendations for 2nd round:*Further discuss this issue. Agreements should be captured in the WF. **Issue 2-4-2: How to calculate sensitivity values by SNR values***2 companies (Qualcomm and MTK) shared their views on this issue. No obvious agreement achieved in the 1st round.* *Recommendations for 2nd round:*Further discuss this issue. Agreements should be captured in the WF.  |
| **Sub-topic 2-5 Summary results for alignment of FR2 MIMO OTA** | **Issue 2-5: Summary results for alignment of FR2 MIMO OTA***Recommendations for 2nd round:*Qualcomm copied the simulation assumptions for requirements development as below. Companies can make comments. * UE antenna array: two panels 1x4 patches
* UE antenna parameters and Beam forming: Follow TR 38.803
* Channel model parameters: CDL-C Umi defined in TR38.827. The offset of channel model parameters due to the non-ideal factors are FFS.
* Test directions: 36 test directions specified in TR 38.827
 |
| **Sub-topic 2-6 MU budget for FR2 MIMO OTA** | **Issue 2-6: MU budget for FR2 MIMO OTA 3D-MPAC***Qualcomm indicated they will* *update the MU per TR38.903. Vivo supports to further discuss the MU value for FR2.* *Recommendations for 2nd round:*Update the MU per TR38.903, and further check if it should be further discussed.  |
| **Sub-topic 2-7 FR2 maximum downlink power** | **Issue 2-7: TP to TS38.151 on FR2 maximum downlink power***Tentative agreement:** + The tentative data [-79.1dBm/120kHz] is allowed to be revisited after practical test.

*Recommendations for 2nd round:*Further check if the tentative agreement is agreeable. Agreements should be captured in the WF.  |

### 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 NR MIMO OTA | vivo, CAICT |  |
|  |  |  |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-2200409 | TP to TS38.151 on FR1 Spatial Channel Model Validation  | Spirent Communications | Revised | other |
| R4-2200572 | On framework for PAD alignment of NR UE FR1 MIMO OTA | Huawei, HiSilicon | Noted | discussion |
| R4-2200573 | Further results on FR1 channel model validation | Huawei, HiSilicon | Noted | discussion |
| R4-2200576 | FR1 MIMO OTA channel validation | MediaTek Beijing Inc. | Noted | discussion |
| R4-2200580 | FR2 MIMO OTA Simulation | MediaTek Beijing Inc. | Noted | discussion |
| R4-2200731 | Max downlink power verification of MIMO OTA test system | Samsung | Noted | discussion |
| R4-2200777 | Discussion on FR2 MIMO OTA requirements | Qualcomm Incorporated | Noted  | discussion |
| R4-2200778 | Summary results for FR2 MIMO OTA simulation | Qualcomm Incorporated | Noted | discussion |
| R4-2200779 | Discussion on preliminary MU assessment for FR2 MIMO OTA | Qualcomm Incorporated | Revised  | discussion |
| R4-2200780 | TP on TS 38.151 for test parameters of FR2 performance | Qualcomm Incorporated | Agreeable | pCR |
| R4-2200832 | FR1 channel model validation results for CMCC & BUPT joint lab | CMCC BUPT | Noted | discussion |
| R4-2200906 | FR1 MIMO OTA Lab Alignment, Channel Model Validation | Apple | Revised | discussion |
| R4-2200966 | 3GPP TS 38.151 v0.7.0 | vivo | Return to  | draft TS |
| R4-2200967 | TP to TS38.151 on FR2 maximum downlink power and test procedure | vivo | Agreeable | pCR |
| R4-2200968 | Proposal for MU budget of FR1 MIMO OTA | vivo | Agreeable | other |
| R4-2200969 | Pass/Fail limit for FR1 MIMO OTA lab alignment activity | vivo | Noted | other |
| R4-2200970 | Discussion on framework for FR1 MIMO OTA performance | vivo | Noted | discussion |
| R4-2201282 | Commercial devices preparation and data handling | OPPO | Noted  | discussion |
| R4-2201441 | Discussion FR2 MIMO OTA performance requirements | Huawei,HiSilicon | Noted | discussion |
| R4-2201494 | Validation results and limits for FR1 CDL-C UMa channel model-v1 | Xiaomi | Noted | discussion |
| R4-2201591 | FR1 MIMO OTA channel model validation results and views on PDP pass/fail limits | CAICT | Noted | discussion |
| R4-2201602 | Framework for FR1 MIMO OTA lab alignment activity | CAICT | Revised  | discussion |
| R4-2201676 | Reference Channel Emulation PDP for Validation Purposes for FR1 CDL-C UMa | CAICT, CMCC, Keysight Technologies, Spirent Communications | Return to  | discussion |
| R4-2201919 | Pass/Fail Limits for FR1 Channel Model Validation | Keysight Technologies UK Ltd | Revised  | discussion |
| R4-2201920 | Illustration of Device Orientations for Select Test Points | Keysight Technologies UK Ltd | Agreeable | 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)