**3GPP TSG-RAN WG4 Meeting # 98-e R4-2XXXXXX**

**Electronic Meeting, Jan. 25-Feb. 5, 2021**

**Agenda item:** 11.1.1

**Source:** Moderator (CAICT)

**Title:** Email discussion summary for [98e][329] NR\_MIMO\_OTA

**Document for:** Information

# Introduction

AI 11.1 NR MIMO OTA WI and AI 7.19.7 TR38.827 maintenance are included in this email discussion. (note: R4-2102018 moved to AI11.11.1)

In the RAN4#97e meeting, next steps of NR MIMO OTA WI were captured in the WF [1]:

Next steps:

* + FR2 simulation results of UE performance are encouraged
  + Confirm the Channel models mapping for NR MIMO OTA requirements
  + Discuss the pass/fail limit and reference figure of channel model validation
  + Further confirm detailed testing parameters for requirements (e.g. Maximum downlink power)
  + Further discuss the Figure of Merit for FR1 and FR2
  + Measurement results of FR1 or FR2 UEs are encouraged for disc ussion
  + Analysis on number of test points vs uncertainty of FR2 MIMO OTA requirements

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

• 1st round: agree TPs and CRs, discuss channel model topics, test parameters, FoM, simulation assumptions and other open issues for NR MIMO OTA.

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

# Topic #1: General and Testing methodologies

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2101941 | CAICT, Keysight, ETS-Lindgren | FR1 MIMO OTA measurement results and channel model mapping  **Observation 1:** The agreed channel model mapping baseline is suitable for FR1 MIMO OTA testing.  **Proposal 1: Adopt CDL-C UMa model for 4x4 testing and CDL-A UMi model for 2x2 testing.** |
| R4-2101827 | vivo | Discussion on Channel models mapping for FR1 MIMO OTA requirement  **Observation 1**: Decision on Mapping FR1 UMa and UMi scenarios to 2x2 and 4x4 MIMO OTA test cases, respectively, was not made by technical evaluation of the suitability of the MIMO layer *vs* given scenario.  **Observation 2**: Among the new channel models, CDL-A and CDL-C were initially selected for simulation to define FR1 system layout, due to the consideration of simulation workload.  **Observation 3**: During LTE MIMO OTA performance activity, large number of measurements with real commercial UEs had been done before making the final decision of channel model for requirements.  **Observation 4**: After BS pattern filtering effect, the CDL-C channel model with large angular separation is more suitable for FR1 MIMO OTA requirement.  **Observation 5**: After BS pattern filtering effect, the CDL-A channel model is directional with very limited angular separation, which is not suitable for FR1 MIMO OTA requirement.  **Observation 6**: The weighted RMC spatial correlation error of UMi CDL-A channel model is very large.  **Observation 7**: For FR1 MPAC system with 16 uniformly-spaced probes, new channel model with wide angular spread (e.g. CDL-C UMi) can be well supported easily.  **Proposal 1: RAN4 should do more simulation analysis and some confirmatory measurements to select the final channel model for FR1 MIMO OTA requirement.**  Proposal 2: It is proposed to select CDL-C UMi with 4x4 and CDL-C UMa with 2x2 for FR1 MIMO OTA requirement.  Proposal 3: In case RAN4 agrees that just a single channel model is required for FR1 MIMO OTA requirement, select the CDL-C UMi channel model for both 2x2 and 4x4. |
| R4-2102613 | Keysight Technologies, China Mobile | gNB Beams Usage Criteria for NR FR1 MIMO OTA Channel Model Validation  **Observation 1:** Spatial correlation curves for the same beam and orthogonal polarizations are same.  **Observation 2:** For CDL-A UMi model, the difference in spatial correlation between the two strongest beams result is insignificant  **Observation 3:** For CDL-C UMa model, the combined beam spatial correlation profiles are different from the beam specific profiles.  **Observation 4:** For a CDL-C UMa model, the beam specific spatial correlation profile cannot be determined from the combined beam profile.  **Proposal: Choose Option 2 for FR1 MIMO OTA channel model validation.** |
| R4-2100845 | Spirent Communications | Channel Model Validation Bounds  **Proposal 1:** FR1PDP Power = [±0.8 dB]. PDP excess delay = [±11ns].  **Proposal 2 and 4:** Bounds for FR1 and FR2 Autocorrelation  0.5λ, [NonPolarized value +/- 0.1 capped at 1] 1 λ, [NonPolarized value +/- 0.2] 1.5λ, [NonPolarized value +/- 0.25] 2λ, [NonPolarized value +/- 0.2] 2.5λ and greater, [Below 0.35]  **Proposal 3 and 5:** FR1andFR2Bounds for V/H = [±0.9 dB]. |
| R4-2101757 | OPPO | Consideration on 3D-MPAC probe locations configuration for FR2 MIMO OTA  **Observation 1**: blocking issue would exists in current implementation, and the size and material of the positioner may affect the level of uncertainty.  **Proposal 1: uncertainty evaluation of the blocking issue should consider the size and material of the positioner.**  **Observation 2**: traditional OTA chamber is unavailable for current implementation of measurement probes and positioner.  **Observation 3**: the implementation has limitation on extending the dynamic OTA testing in future.  **Proposal 2: enhanced implementation or solution which could address these issues can be considered by RAN4 in future.** |
| R4-2102400 | Huawei, HiSilicon | Analysis on number of test points vs uncertainty of FR2 MIMO OTA requirements  **Observation1**: In single probe case, the 50%CDF values converge significantly with lager grid points, i.e. STD decreases along with 36, 72, 144 or 288 grid points. The results are similar with EIS spherical coverage analysis in TR 38.810 Table G.3.3.2.1-2.  **Observation2:** In MIMO case, the 50%CDF values do not converge significantly with lager grid points.  **Observation3:** In MIMO case, the two metrics (“50%CDF” or “average over top 50%”) are similar in terms of STD i.e. measurement uncertainty.  **Observation4:** MIMO OTA Specification TR38.827 has defined fixed channel model position relative to the test system, and UE test positions are also well specified. These conditions will make sure that all UE are verified in similar environment even they are tested in different labs.  **Proposal 1: Keep current agreement that “36 evenly spaced test points with a constant density” are used for FR2 UE MIMO OTA test.**  **Proposal 2: Keep current agreement that “Select averaging all the values better than [50%] percentile of CCDF as the Figure of Merit for FR2 MIMO OTA requirement”, and “not to introduce “[50%] percentile of the CCDF curve” as another FoM”.**  **Proposal 3: Conclude the open issue about “Further analysis on number of test points vs uncertainty of FR2 MIMO OTA requirements”** |
| R4-2102729 | Huawei, HiSilicon | Consideration on FR2 MIMO OTA UE requirement  **Proposal 1: 40dB is an appropriate threshold, which does not affect the theoretical PAS.**  **Proposal 2: We adopt 200MHz channel bandwidth for NR FR2 MIMO OTA at Band n257/n258/n261.** |
| R4-2101823 | vivo, CAICT | TP to TS38.151 v0.1.0 on FR2 Channel model and RMC |
| R4-2101824 | vivo, CAICT | TP to TS 38.151 v0.1.0 on FR2 test system for requirements |
| R4-2101822  (reserved) | vivo | New version TS |

## Open issues summary

### Sub-topic 1-1 channel model mapping

*Moderator notes:* *The selection of channel model may have an impact on channel model validation limits, test parameters, lab alignment and other open issues. It will be helpful to make conclusion on this topic at early time, especially for 4x4 testing.*

**Issue 1-1: which option is preferred?**

*Based on the WF of RAN4#97e, the agreement is listed as below:*

* CDL-A UMi model is not suitable for 4x4 4-layer performance testing. Channel models mapping for NR MIMO OTA test need to be reconsidered. The group will confirm the conclusion in RAN4#98e based on below options:
* Option1: CDL-C UMa for 4x4 and CDL-A UMi for 2x2 (is agreed baseline)
* Option2: CDL-C UMi for 4x4 and CDL-C UMa for 2x2
* Option3: CDL-C UMi for 4x4 and CDL-A UMa for 2x2

*In RAN4#98e, more analyses are shared in [R4-2101941] and [R4-2101827], proposals are provided as below:*

* Proposals
  + Option 1: CDL-C UMa for 4x4 testing and CDL-A UMi for 2x2 testing (baseline)
  + Option 2: CDL-C UMi for 4x4 testing and CDL-C UMa for 2x2 testing
  + Option 3: CDL-C UMi channel model for both 2x2 and 4x4 testing
  + Option 4: RAN4 should do more simulation analysis and some confirmatory measurements to select the final channel model for FR1 MIMO OTA requirement.
* Recommended WF
  + TBA

### Sub-topic 1-2 Channel model validation

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

*Three possible options for gNB beam usage criteria are listed in [R4-2102613]:*

* Option 1: Beam specific: The two strongest beams are measured separately.
* Option 2: Combined beams: The two strongest beams are combined at the input of the channel emulator for validation of spatial correlation. The PDP validation is done separately for each beam in this case.
* Option 3: Beam specific + Combined beams: The validation based on both option1 and option2.
* Proposals
  + Proposal 1: Choose Option 2 for FR1 MIMO OTA channel model validation.
* Recommended WF
  + TBA

**Issue 1-2-2: Spatial correlation validation**

* Proposals
  + Observation 1 (from R4-2102613): Spatial correlation curves for the same beam and orthogonal polarizations are same.
  + Proposal from moderator: For spatial correlation validation, only Vertical validation is required. (A further demonstration of this proposal is needed, if option2 is agreed in Issue 1-2-1)
* Recommended WF
  + TBA

**Issue 1-2-3: Channel model validation bounds**

* Proposals
  + Proposal 1: FR1 PDP Power = [±0.8 dB]. PDP excess delay = [±11ns].
  + Proposal 2 and 4: Bounds for FR1 and FR2 Autocorrelation

0.5λ, [NonPolarized value +/- 0.1 capped at 1]

1 λ, [NonPolarized value +/- 0.2]

1.5λ, [NonPolarized value +/- 0.25]

2λ, [NonPolarized value +/- 0.2]

2.5λ and greater, [Below 0.35]

* + Proposal 3 and 5: FR1 and FR2 Bounds for V/H = [±0.9 dB].
* Recommended WF
  + TBA

**Issue 1-2-4: threshold of cluster power**

*In RAN4#97e, 40dB threshold is considered as a starting point and the group agreed to further discuss the final threshold.*

* Proposals
  + Proposal 1: 40dB is an appropriate threshold, which does not affect the theoretical PAS.
* Recommended WF
  + TBA

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

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

* Proposals
  + Proposal 1: uncertainty evaluation of the blocking issue should consider the size and material of the positioner.
  + Proposal 2: enhanced implementation or solution which could address these issues can be considered by RAN4 in future.
* Recommended WF
  + TBA

**Issue 1-3-2: number of test point vs uncertainty of FR2 MIMO OTA requirements**

* Proposals
  + Proposal 1: Keep current agreement that “36 evenly spaced test points with a constant density” are used for FR2 UE MIMO OTA test.
  + Proposal 2: Conclude the open issue about “Further analysis on number of test points vs uncertainty of FR2 MIMO OTA requirements”.
* Recommended WF
  + TBA

### Sub-topic 1-4 FR2 MIMO OTA RMC

**Issue 1-4: System implementation of 3D-MPAC**

*16QAM RMC with 100MHz bandwidth (TR38.827 table 8.2-7) is adopted as the only RMC for FR2 MIMO OTA in RAN4#97e. In this meeting, Additional bandwidth of FR2 MIMO OTA RMC is proposed in [R4-2102729]:*

* Proposals
  + Proposal 1: adopt 200MHz channel bandwidth for NR FR2 MIMO OTA at Band n257/n258/n261.
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | **Issue 1-1: which option is preferred?**  We would like to thank the companies who have brought more analyses in this meeting, after carefully studied these new results, we think it is an important topic which deserve more consideration. Therefore we prefer option 4 i.e. need more study.  **Issue 1-3-2: number of test point vs uncertainty of FR2 MIMO OTA requirements**  Thank KS for the questions. The ideal PAS of UMi CDL-C was used in the simulation of R4-2102400. And as proposed in QC’s contribution [R4-2102497](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2102497.zip), I think it will be good if someone can provide “*the parameters of channel model after BS filtering under 6 probes layout*”  Regarding “*the mean error instead of the span*”, as discussed in R4-2102400, we found in MIMO case (with PAS), even with very large number of grids, the results of different UE positions do not converge to a single line as spherical coverage test (below left figure). Therefore we are not able to calculate the mean error which needs a reference line as the basis. I think the theory behind this phenomenon is MIMO case have different characteristic from spherical coverage test. The latter one is the integration over the sphere of antenna radiation pattern. With increase grid number the spherical coverage results will converge to single value regardless of the UE’s relative positions to the coordinate system.    Single probe w/o PAS MIMO UMi CDL-C with PAS  **Issue 1-2-3: Channel model validation bounds**  Some values of validation parameters are proposed, but target PSP related to the probe weight is missed. We are confused about the impact of a target PSP of 80%, 90%, or other values on measurement results. More analysis and discussion are welcome.  C:\Users\k00590301\AppData\Roaming\eSpace_Desktop\UserData\k00590301\imagefiles\39629253-67CF-47AD-BCFB-7D57B98F33D0.png  **Issue 1-2-4: threshold of cluster power**  From the perspective of PSP, 40 dB is an appropriate threshold. However, for FR2 CDL-A, whether the reserved three clusters affect the UE throughput needs to be further discussed.  To KS: An ideal PAS was used.  To Spirent: It is not sure whether the 0.15% error at 30dB will affect the measurement results, so we conservatively recommend 40dB.  **Issue 1-4: System implementation of 3D-MPAC**  From TS 38.331, Channel bandwidth 200MHz is the one shall be set to 1 in UE capability, it can be seen as below. It means UE is mandatory to support 200MHz CBW for FR2. Considering the feasible SNR range and the mandatory CBW, we propose to at least use 200MHz CBW for 28GHz Bands. As far as we know, the channel simulator supports 200 MHz bandwidth. |
| Keysight | **Issue 1-1: which option is preferred?**  Our preference is to stick with the previously agreed baseline and combinations (CDL-C UMa and CDL-A UMi agreed in the SI phase) since it will involve updating channel model and validation data reference curves. From a practical view, there might not be a significant difference between the models  •The angle spreads of UMi ASD ~24 deg, ASA ~57 deg (TR 38.827 Table 7.2-4)  •The angle spreads of UMa ASD ~26 deg, ASA ~74 deg (TR 38.827 Table 7.2-4)  After gNB filtering, it is expected that the difference is very small as the departure side is almost same.  **Issue 1-2-2: Spatial correlation validation**  Support proposal from moderator  **Issue 1-2-3: Channel model validation bounds**  P1, P3, P5: KS supports  P2, P4: we believe the limits should be tightened more and we suggest the following instead  0.25λ, [NonPolarized value +/- 0.05]  0.5λ, [NonPolarized value +/- 0.05] 1 λ, [NonPolarized value +/- 0.075] 1.5λ, [NonPolarized value +/- 0.1] 2λ, [NonPolarized value +/- 0.1] 2.5λ and greater, [NonPolarized value +/- 0.2]  This would result in bounds such as these    Once the RMS correlation error approach and the reference curves are agreed, similar bounds need to be agreed.  **Issue 1-2-4: threshold of cluster power**  Support 40dB threshold  **Issue 1-3-1: System implementation of 3D-MPAC**  On P1: the QoQZ evaluation (without re-positioning approach) already takes size and materials of the positioner into account  On P2: at this point, our preference is to keep the probe locations the same among all system implementations. Once more experience has been gathered, this topic could get revisited.  **Issue 1-3-2: number of test point vs uncertainty of FR2 MIMO OTA requirements**  KS appreciates the detailed MU analysis in R4-2102400. It would be helpful if we could see the mean error instead of the span. Also, could Huawei clarify that that 6 probes were used to implement the PAS or was an ideal PAS used? |
| Spirent | **Question for KS/ETS/CAICT on R4-2101941**  Question 1: were the 2 strongest beams used for the 4x4 case with CDL-C?  Question 2: is CDL-A measured with only the strongest beam?  **Questions for KS/CM on R4-2102613**  Question1:  What is meant by combined beams at the input to the channel emulator?  Are these beams weighted according the beam steering directions?  Are these two beams measured utilizing a sinusoid at the carrier frequency, or measured as a wide-band uncorrelated signal representing different information content?  Question2: Were the two clusters with repeated angles split into mid-paths as in 38.901? If not, there is an ambiguity in how the rays are combined. (due to coherent addition at an unspecified phase producing a power change)  **Issue 1-2-3**  The proposal has the bounds in square brackets so they can be changed as measured data comes from several labs, and the MU budget is better defined. We prefer to leave the bounds as proposed. Also, it would be better to define all the target curves and values before settling in the bounds.  **Issue 1-2-4**  Our simulations indicate that a threshold of 30dB is almost as good as 40dB. Please see below:  PSP\_CDL-A-InO =   99.9366   99.9923   99.9995   99.9995   99.9996   99.9999  TH               =      -10            -20             -30          -40             -50            -60      TH               =       -10            -20           -30             -40           -50            -60  PSP\_CDLC\_UMi =   98.4686   99.5438   99.8443   99.9682   99.9989   99.9999  The best case mean PSP is ~ 90 and the center of the test volume is ~ 96 for this model, so the 0.15% error at -30dB seems reasonable. |
| vivo | **Issue 1-1 channel model mapping:**  **We support to consider option 2,3,4. Given the group has done much work on CDL-C UMa, alternative option to select CDL-C UMa for both 2x2 and 4x4 is also acceptable for us. From our view, the key is that CDL-A channel model is not suitable to define FR1 MIMO OTA requirements. The reason is summarized:**  **1, Two strongest beams for CDL-A implementation toward the same cluster. [R4-2100845]**   * **Two strongest beams assumed in current CDL-A UMi model illuminate the same cluster, correlation between the two beams becomes very high!** * **CDL-C UMa model has multiple strong spatial clusters, and the two strongest BS beams are pointed towards different strong clusters with sufficient angular separation, TX-antenna correlation is low.**     **2, The CDL-A channel model has very high spatial correlation. [R4-2102613]**   * **UE would need very high DL power and low correlation MIMO antenna,**     **3, Spatial characteristic of SCME UMi for 3GPP LTE MIMO OTA requirement [TR37.977]**   * **Although the validation approach for LTE and FR1 on spatial correlation is different, we can also conclude that LTE MIMO OTA adopted low correlation channel model**     **4, Real 5G UE performance [R4-2101941]**   * **2 of 3 UEs fail the criterion in azimuthal orientations (1 of 12 azimuthal orientations at 70%TP)** * **For the high correlated CDL-A, the risk of UE failing criterion in azimuthal orientations could be much higher!** * **Very high DL power should be supported by the test system from test labs**     **5, Using CDL-A UMi, there will be large spatial correlation RMS error (>0.3) during channel model implementation, from [R4-1909728]**   * **large Spatial correlation error means the real characteristic from the channel model table is not well implemented.**     **In summary, from the above information, we believe CDL-A channel model is not suitable to define FR1 MIMO OTA requirements. Option 2: CDL-C UMi for 4x4 testing and CDL-C UMa for 2x2 testing is our preference.**  **However, given 4x4 requirement for band >2.6GHz are the 1st priority in the WID and group has done much work on CDL-C UMa, we are also OK to keep CDL-C UMa for 4x4, from not delay the progress perspective.**  **For 2x2, we do not support CDL-A channel model. Whether reusing CDL-C UMa for 2x2 or considering a new one, is FFS. More measurements of FR1 2x2 MIMO OTA with commercial 5G UEs are required.**  **Issue 1-2-1: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  We believe the methodology on how to implement the BS beam filtering to channel models should be the same for channel model validation and MIMO OTA testing. So, one clarification question to CE vendors is that how does the gNB beams being implemented during the MIMO OTA testing, for example for 4x4 case of each input port of CE, are the same combine beam for each port? Or separated as Beam1\_V, Beam2\_V, Beam1\_H, Beam2\_H?  **Issue 1-2-2: Spatial correlation validation**  Support the proposal from Moderator, vertical validation is sufficient for spatial correlation to reduce the test time significantly.  **Issue 1-2-3: Channel model validation bounds**  Generally, we are supportive of the values in the proposal.  However, for PDP, given NR MIMO OTA has much larger dynamic range (agreed as 40dB as starting point) compared with LTE SCME UMi (only 12.4dB), we are a bit worried about the validation accuracy of low power clusters.  As shown in R4-2016561, even for FR1 channel model validation, the clusters lower than -20dB have large power offset. For FR2, given the limited dynamic range of the test system, we think the situation might be worse.  Therefore, we would encourage companies to consider a relaxed limit for low power clusters (e.g. under 30dB).    **Issue 1-2-4: threshold of cluster power**  For FR1 we support the 40dB threshold.  For FR2, if the group can confirm that 30dB is sufficient, we prefer to adopt 30dB for FR2 channel model validation  **Issue 1-3-1: System implementation of 3D-MPAC**  We support to study a new MU element to address the FR2 blocking issue.  **Issue 1-3-2: number of test point vs uncertainty of FR2 MIMO OTA requirements**  Conclude the FR2 test points and move forward to the FoMs and performance discussion.  **Issue 1-4: System implementation of 3D-MPAC**  Given the high downlink power of FR2 3D-MPAC system is required, RAN4 should be careful to define a wider bandwidth for FR2 MIMO OTA requirement. Most importantly, the physical bandwidth limitation of Channel Emulator should also be considered. Therefore, the agreed 100MHz bandwidth for FR2 MIMO OTA requirement should not be changed. |
| Samsung | **Issue 1-1: which option is preferred?**  We echo vivo’s analysis on the high spatial correlation of CDL-A Umi channel model. High spatial correlation leads to high DL power which is still open issue for maximum downlink RS-ERPE configuration. Moreover, practical test result shown in Fig.3 of R4-2101941 indicates that throughput of 2x2 CDL-A Umi gradually drops from 100%TP once DL power is decreasing from normalized 0dB  So it seems premature to agree CDL-A Umi for 2x2.  **Issue 1-3-1: System implementation of 3D-MPAC**  It is supported that the FR2 blocking issue is addressed by MU. The blocking issue for the test points outside of top 50% performance test points can be ignored.  **Issue 1-3-2: number of test point vs uncertainty of FR2 MIMO OTA requirements**  Thanks Huawei for the MU analysis on 36 test points. We support the two proposals and FR2 test points can be concluded.  **Issue 1-4: System implementation of 3D-MPAC(FR2 MIMO OTA RMC)**  When defining FR2 RMC in TR38.827, SNR range is considered so that compromise has to be made on modulation, bandwidth etc. in Rel-17 WI phase, we further concluded that 64QAM is not feasible due to SNR range issue. Due to limited upper bound of SNR range, it is quite challenging to change the previously agreed 100MHz BW to 200MHz BW. Before SNR of DL signal is guaranteed for higher BW for all FR2 bands, 100MHz is better to be kept. |
| Qualcomm | **Issue 1-1: which option is preferred?**  Based on the analysis from companies, it can be seen that CDL-C is more suitable than CDL-A for MIMO OTA testing.  We’re open to further discuss the channel model mapping considering PAS in channel model, test coverage and network deployment input from operators in next meeting.  If the group is to agree one of options to move forward, we are OK with option 1 and option 2. Option 3, i.e., using the same channel model for 2\*2 and 4\*4 is not preferred.  **Issue 1-3-1: System implementation of 3D-MPAC**  We support P2. The forward compatibility to support more realistic testing case, e.g., dynamic testing should be considered. It can help to save FR2 testing cost.  **Issue 1-3-2: number of test point vs uncertainty of FR2 MIMO OTA requirements**  R4-2102400 provided a good analysis on the number of test points vs MU. From the simulation results, it seems the reason that why STD is almost the same for different test point number is due to PAS. If RAN4 concludes increasing number of test point would not improve MU for FR2 MIMO OTA requirements, the current agreement of 36 test points shall be kept.  **Issue 1-4: System implementation of 3D-MPAC**  From the achievable SNR analysis, there is a risk to adopt wider channel, i.e., 200MHz for FR2 MIMO OTA since the gap between achievable SNR and required SNR is marginal for 70% TP. If the target of 95% TP is further considered, the feasible SNR would be limited. Furthermore, RAN5 is discussing the fading crest factor for FR2 Demod testing which will have impact on the achievable SNR when fading channel is considered. Therefore, for FR2 MIMO OTA testing, the achievable SNR would be further reduced by fading crest factor. With that, we suggest to keeping the conclusion of 100MHz channel BW for FR2 MIMO OTA. |
| MediaTek | **Issue 1-3-2: number of test point vs uncertainty of FR2 MIMO OTA requirements** General speaking, we prefer “*Proposal 1: Keep current agreement that “36 evenly spaced test points with a constant density” are used for FR2 UE MIMO OTA test.*”, however, more data for clarification raised by Keysight would be helpful.  **Issue 1-4: System implementation of 3D-MPAC**  We’d like to clarify is there extra benefit to adopt one more bandwidth (200 MHz) for NR FR2 MIMO OTA at Band n257/n258/n261. |
| OPPO | **Issue 1-1: which option is preferred?**  From contributions, we agree that CDL-A is not a suitable channel model for FR1 MIMO OTA because of lack of spatial distinguishable clusters.  Considering there is no significant difference between UMi and UMa, we can accept both CDL-C UMi and CDL-C UMa for 4x4 testing. And for 2x2 testing, whether using the same channel model with 4x4 or different with 4x4 need more study and measurement data.  **Issue 1-2-1: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  The channel model under validation should reflect the condition that DUT experienced. Obviously, DUT received both beams simultaneously during MIMO OTA test. So, generally speaking, we support Option 2, that the spatial correlation should be done with the two strongest beams combined.  Here is **a question for KS & CMCC on R4-2102613.** Regarding Observation 4: For a CDL-C UMa model, the beam specific spatial correlation profile cannot be determined from the combined beam profile, which means there is no clear relationship (i.e. linear addition) between combined beams and two separate beams on the result of spatial correlation, the question is how to determine the combined beams validation can ensure enough consistent performance between different implementations or labs?  **Issue 1-2-2: Spatial correlation validation**  Support the proposal from moderator.  **Issue 1-3-1: System implementation of 3D-MPAC**  We support Proposal 1.  And response to KS: QoQZ is evaluated under the condition with single measurement probe. We believe that the situation changed when the implementation of 6-probe constellation introduced. Whether MU affected need further study.  Support Proposal 2. The purpose of the proposal is not to introduce “unstable factors”, but to leave possibility of other implementation to the industry. Of course the base line of the implementation is the proposal in R4-2016210 from KS.  **Issue 1-3-2: number of test point vs uncertainty of FR2 MIMO OTA requirements**  Support both of P1 and P2. |
| CAICT | **Issue 1-1: which option is preferred?**  This is an important topic, which will have a series of impacts on channel model validation limits, reference curves, PRS-EPRE-MAX and Restriction of Pmode. Companies has done much work on the agreed channel model baseline, changing combination of the channel models, or keeping this problem to be determined at this stage will affect the progress of the project. Therefore, we prefer to keep the agreed baseline as much as possible.  However, considering that companies have concerns about CDL-A model for 2x2 testing, and 4x4 requirement for band >2.6GHz are the 1st priority in the WID, we are ok to further check whether CDL-A is suitable if CDL-C Uma for 4x4 can be agreed.  **Response to Spirent**: For Question 1, yes. The 2 strongest beams are used for the 4x4 testing, as defined in TR38.827. For Question 2, according to my understanding, yes.  **Issue 1-2-2 spatial correlation validation**  We support that vertical validation is sufficient for spatial correlation validation.  **Issue 1-2-3 Channel model validation bounds**  It would be helpful to define the target values before we make final decision on the bounds.  For SCME Umi model in LTE MIMO OTA, the limits for PDP are defined as the maximum power deviation of each of the 6 cluster, and maximum delay deviation per cluster. However, for FR1 MIMO OTA, the bandwidth limited measurement system is not able to differentiate between all taps and therefore multiple taps are summed up in some of the peaks of the measured impulse response.  Therefore, the target values for PDP validation need to be specified.    We would like to accept the proposed bounds as starting point and further verify if they are appropriate.  **Issue 1-2-4 threshold of cluster power**  We support the proposal of 40dB threshold. 30dB for FR2 is also acceptable for us if companies can reach an agreement.  **Issue 1-3-2 Number of test point vs uncertainty of FR2 MIMO OTA requirements**  We support to keep the 36 test points and conclude this open issue.  **Issue 1-4 FR2 MIMO OTA RMC**  We echo vivo, Samsung and QC’s comments and suggest keeping the 100MHz channel BW for FR2 MIMO OTA. |
| Keysight | **Response to Spirent regarding “Questions for KS/CM on R4-2102613”; should address vivo’s question as well**  Question 1 Response: Combined beams means summing of inputs of 4-port channel model, i.e., the 2 dual-polarized BS beams that are embedded in the channel model are summed. The weighting of these 4 ports don’t have to be defined as the beams and polarizations in CDL-C model have low correlation. The 4 beams that are embedded in the channel model, are composed using the antenna array and weighting definitions in 38.827.  Question 2 Response: The channel models are generated according to TR 38.827. The mid-paths were included accordingly  **Response to vivo regarding Issue 1-1 channel model mapping:**  Regarding comment #1: the two beams illuminate the same cluster, but with the different polarization. This model is suitable to test whether the DUT’s antenna is designed with polarization diversity. If the DUT’s antenna is designed to receive signal from both polarization V and H, it will not have problem with 2x2 test. Only one beam direction is used for 2x2 test, i.e. 2 polarizations of same beam direction. Those two beams have low correlation. CDL-A model has low Tx-correlation in 2x2 test.  Regarding comment #2: We agree that UMi CDL-A is not suitable to test 4x4. But the channel coefficients for two different polarizations are almost independent. As the figures from R4-2016209 indicate,      Ant1 and Ant2 use different polarizations, the correlation is only 0.123. Ant1 and Ant3 use the same polarization the correlation is 0.999, that’s why it is not suitable for 4x4. This shows that since two eigenvalue numbers are within a reasonable range, the 2x2 test should not have problem.  Regarding comment #3: see response above  Regarding comment #4: we have not seen this issue when testing UMi CDL-A on 5G UEs  Regarding comment #5: KS pointed out the large spatial correlation errors for the considered channel models with the 16 uniform probe configuration but at that time, this issue was of much less concern than being able to leverage existing systems and progressing with the test plan. It is interesting that this is now re-surfacing as concern  **Issue 1-2-4: threshold of cluster power**  Our preference is to keep the 40dB threshold for FR1 and FR2 given there are no testability concerns with this threshold.  **Issue 1-3-1: System implementation of 3D-MPAC**  It is not clear how a blocking MU element would be evaluated. When the re-positioning approach is applied to the test cases (baseline for MU/MTSU purposes in RAN5 for UE RF test cases), no blocking would be experienced. If the re-positioning concept is not applied, the blocking of Probe 1 (along z) seems to be very similar to blocking of Probe 3 if not worse (since Probe 3 is shifted further away from the zy axis and therefore away from the positioner; see illustration below). Since the maximum theta of the 36th test point is ~162deg, the blocking should small. As such, the blocking effects should be captured appropriately with Probe 1 and the current QoQZ validation approach.  We therefore currently do not support P1 and P2. |
| CMCC | **Issue 1-2-1:The response to the Questions of OPPO for KS/CM on R4-2102613**  The spatial correlation is determined by power and phase. The power has been already validated using PDP seperately. And if phase of any beam is wrong, the combined spatial correlation can not be validated.  **Issue 1-2-3: Channel model validation bounds**  From China Mobile's point of view, we suggest that the Channel model validation bounds should be a little broader. Consider the differences in algorithms and implementations between companies, We recommend that some room be kept in order to benefit the development of MIMO OTA.  **Issue 1-3-1: System implementation of 3D-MPAC**  Support Proposal 2: Enhanced implementation or solution which could address these issues can be considered by RAN4 in future.  For Proposal 1,it is not clear whether blocking issue is covered by MU properly and adequately. |
| R&S | **Issue 1-3-1: System implementation of 3D-MPAC**  Regarding Proposal 1, we have expressed several times that the “re-positioning approach” is the best option to minimize this kind of blocking issues. In case the “re-positioning approach” is not used in a system, it is true the blocking issue raised in R4-2101757 might not be fully captured by current QoQZ definition to a single probe, and thus further evaluation is required.  We support Proposal 2. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2101823  (TP) | Company A |
| Company B |
|  |
| R4-2101824  (TP) | Keysight: Changes proposed in R4-2102615 should be incorporated in this CR |
| 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 channel model mapping** | **Issue 1-1: which option is preferred?**  *7 companies shared views on this issue, there is no rejection to using CDL-C for 4x4 testing. However, companies still have concerns about using CDL-A model for 2x2 testing.*  *Tentative agreements:*   * Stick with the previously agreed baseline for 4x4 testing: CDL-C UMa for 4x4   *Candidate options for 2x2 testing:*   * *Option 1: CDL-A UMi (agreed baseline in RAN4#97e for further checking)* * *Option 2: CDL-C UMa* * *Option 3: CDL-C Umi* * *Option 4: further study is needed*   *Recommendations for 2nd round:*  Further discuss the suitable channel model for 2x2 testing. |
| **Sub-topic 1-2 Channel model validation** | **Issue 1-2-1: gNB Beams Usage Criteria for FR1 MIMO OTA Channel Model Validation**  *Although there is no clear objection to option2, several questions on paper have been raised, agreeable of option2 need to be confirmed during 2nd round*  *Recommendations for 2nd round:*  Confirm Option 2 is agreeable for FR1 MIMO OTA channel model validation. Further discuss whether the “The two strongest beams are combined at the input of the channel emulator” is only for validation or also for MIMO OTA testing.  **Issue 1-2-2: Spatial correlation validation**  *Agreements:*   * For spatial correlation validation, only Vertical validation is required.   *Recommendations for 2nd round:*  Further clarify whether this agreement can apply to combined beam in issue 1-2-1.  **Issue 1-2-3: Channel model validation bounds**  *6 Companies have shared comments on this topic, but it seems no clear consensus have been reached.*  *Recommendations for 2nd round:*  More analysis and discussion on this topic are encouraged. Can we keep the bounds as proposed with square brackets? The value can be revisited in the future as measured data comes from several labs, and the target values and MU budget are better defined.  **Issue 1-2-4: threshold of cluster power**  *Tentative agreements:*   * For FR1, adopt 40dB threshold for cluster power.   *Candidate options for FR2:*   * Option 1: 40dB threshold (starting point) * Option 2: 30dB threshold   *Recommendations for 2nd round:*  Further discuss the threshold of cluster power for FR2. |
| **Sub-topic 1-3 Optimization of test methodologies** | **Issue 1-3-1: System implementation of 3D-MPAC**  *For proposal 1, no clear consensus has been reached.*  *For proposal 2, 4 companies support this proposal. 1 company prefer to keep the probe locations the same among all system implementations at this time, but once more experience has been gathered, this topic could get revisited.*  *Tentative agreements:*   * Keep the probe locations the same among system implementations at this time, but enhanced implementation or solution can be considered by RAN4 in future.   *Candidate options for Proposal 1:*   * Option 1: study MU evaluation to address the blocking issue * Option 2: no additional evaluation is required * Option 3: other solutions   *Recommendations for 2nd round:*  Further discuss on this topic.  **Issue 1-3-2: number of test point vs uncertainty of FR2 MIMO OTA requirements**  *Majority views support both proposal 1 and proposal 2.*  *Agreements:*   * Conclude this topic with previous agreed FR2 test points.   *Recommendations for 2nd round:*  None. |
| **Sub-topic 1-4 FR2 MIMO OTA RMC** | **Issue 1-4: FR2 MIMO OTA RMC**  *6 companies shared views on this topic, 4 company support keeping the previously agreed 100MHz BW, 1 company support adopting 200MHz BW for Bands n257/n258/n261(at least for 28GHz Band).*  *Agreements:*   * Keep the previously agreed 100MHz BW for FR2 MIMO OTA RMC.   *Recommendations for 2nd round:*  None. |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on NR MIMO OTA | vivo, CAICT |

### CRs/TPs

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

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
| R4-2101823  (TP) | *No comments received. However, suggest to revise this TP to capture the agreement in Issue 3-3.*  *“To be revised”*  *Capture final agreements* |
| R4-2101824  (TP) | *Suggest to revise this TP to capture the changes proposed in R4-2102615.*  *“To be revised”*  *Capture final agreements* |
| R4-2101822  (new version TS) | *Return to* |

## Discussion on 2nd round

### Sub-topic 1-1 channel model mapping

**Issue 1-1: which option is preferred?**

*Candidate options for 2x2 testing:*

* Option 1: CDL-A UMi (agreed baseline in RAN4#97e for further checking)
* Option 2: CDL-C Uma
* Option 3: CDL-C Umi
* Option 4: further study is needed

*Recommendations for 2nd round:*

Further discuss the suitable channel model for 2x2 testing.

### Sub-topic 1-2 Channel model validation

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

*Recommendations for 2nd round:*

Confirm Option 2 is agreeable for FR1 MIMO OTA channel model validation. Further discuss whether the “The two strongest beams are combined at the input of the channel emulator” is only for validation or also for MIMO OTA testing.

**Issue 1-2-2: Spatial correlation validation**

*Agreements:*

* For spatial correlation validation, only Vertical validation is required.

*Recommendations for 2nd round:*

Further clarify whether this agreement can apply to combined beam in issue 1-2-1.

**Issue 1-2-3: Channel model validation bounds**

*Recommendations for 2nd round:*

More analysis and discussion on this topic are encouraged. Can we keep the bounds as proposed with square brackets? The value can be revisited in the future as measured data comes from several labs and the target values and MU budget are better defined.

**Issue 1-2-4: threshold of cluster power**

*Candidate options for FR2:*

* Option 1: 40dB threshold
* Option 2: 30dB threshold

*Recommendations for 2nd round:*

Further discuss the threshold of cluster power for FR2.

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

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

*Candidate options for Proposal 1:*

* Option 1: study MU evaluation to address the blocking issue
* Option 2: no additional evaluation is required
* Option 3: other solutions

*Recommendations for 2nd round:*

Further discuss on this topic.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |

## Summary on 2nd round (if applicable)

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

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

# Topic #2: Performance requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2101826 | vivo | Discussion on testing parameters for NR MIMO OTA requirement  **Observation 1**: For band frequency >3GHz, the required higher DL power of 4x4 and achievable lower power is a big contradictory issue.  **Observation 2**: if *PRS-EPRE-MAX* is not defined properly, then there would be a risk that the UE will not be able to reach high throughput level (i.e. need high DL power), which would result in bad TRMS performance or failing the criterion in azimuthal orientations.  **Observation 3**: The started DL power is always set as a proper value lower than *PRS-EPRE-MAX* for each test, as long as the throughput curve can cover the range from [95% or 90%] TP to 70%TP.  **Proposal 1: For band frequency <3GHz, the maximum downlink RS-ERPE in the centre of the test zone should be -83 dBm/30kHz for 40MHz.**  **Proposal 2: RAN4 should carefully define the maximum downlink RS-ERPE for bands above 3GHz, more analysis and measurement results would be helpful.**  **Proposal 3: Adopt the same requirement on restriction of PMODE for 10MHz and 40MHz, i.e. for 40MHz CHBW, the 11 of total 12 PMODE should reach 70%TP.**  **Proposal 4: Adopting the restriction of PMODE for 10MHz and 40MHz that the 10 of total 12 PMODE should reach 90%TP.**  **Proposal 5: RAN4 should further study the rationality of restriction of PMODE at 90%TP based on real measurement results.** |
| R4-2100892 | Samsung | Discussion on FR1 test parameters and Figure of Merit  **Observation 1:** gNB is supposed to output 13.5dB more downlink power to achieve -80dBm/15kHz (-77dBm/30kHz) RS-ERPE at test centre for TDD bands higher than 3GHz with 40MHZ CHBW compared with FDD bands with 10MHz CHBW.  **Observation 2:** to achieve -80dBm/15kHz (-77dBm/30kHz) RS-ERPE at test centre for TDD bands higher than 3GHz with 40MHZ CHBW, the required output power from test equipment is nearly reaching its maximum output power capability.  **Observation 3:** the limited gap between PRS-EPRE-MAX and TRMS requirement allows no room to further reduce the maximum downlink RS-ERPE parameter from 80dBm/15kHz (-77dBm/30kHz)  **Proposal 1: As a starting point, PRS-EPRE-MAX (maximum downlink RS-ERPE) parameter shall be at least maintained as -80dBm/15kHz or equivalent (-77dBm/30kHz) for frequency band >3GHz and for 40MHz bandwidth. Test equipment vendors are encouraged to further check if RS-ERPE larger than -80dBm/15kHz (-77dBm/30kHz) is feasible or not.**  **Observation 4:** exception points rule depends on the maximum downlink RS-ERPE parameter value.  **Observation 5:** even if the maximum downlink RS-ERPE parameter is determined as 80dBm/15kHz (-77dBm/30kHz) for frequency band >3GHz and for 40MHz bandwidth, the exception point rule needs further study or depending on practical test.  **Proposal 2: 90%TP rather than 95%TP is preferred as the additional test metric.** |
| R4-2101758 | OPPO | Consideration on how to treat the missing orientations for FR2.  **Observation 1:** the maximum number of exception points for FR1 10MHz CHBW testing is 3 with 36 test points in total.  **Observation 2:** better TRMSaverage performance has more performance shrinking when replacing missing points with the maximum downlink RS-EPRE, which means the traditional substitution approach weakens the performance distinguishing ability.  **Proposal 1: keep the FR2 permitted exception points aligned with FR1.**  **Proposal 2: new substitution approach for the missing points should be considered with respect to the performance distinguishing ability.** |
| R4-2102497 | Qualcomm Incorporated | Discussion on FR2 MIMO OTA performance requirements  **Proposal 2: No need to consider the impact of orientations those cannot reach target outage throughput on FR2 MIMO OTA requirements.**  **Proposal 3: RAN4 shall provide the paraments of channel model after BS filtering under 6 probes layout as the reference and companies can use the reference parameters to calibration platform and provide simulation results.**  **Proposal 4: RAN4 to agree simulation assumptions listed in section 2.2.2.** |
| R4-2102719 | Huawei, HiSilicon | Simulation assumption summary for NR FR2 MIMO OTA  **Proposal 1:** The direction of the BS strongest beams in CDL-A InO and CDL-C UMi models are (-4.0°, 93.6°) and (12.0°,100.7°), respectively.  **Proposal 2:** when the 40dB threshold is adopted, the number of clusters in CDL-A InO and CDL-C UMi models can be reduced to 3 and 14, respectively.  **Proposal 3:** Target PSP for simulation should be slightly higher than the measurement requirements and more analysis is encouraged.  **Proposal 4:** Companies select different antenna types from Table 2 to provide simulation results in the future.  **Proposal 5:** It is proposed to adopt the two ideal cases for simulating the polarization alignment between the probe and the UE. |
| R4-2101825 | vivo, CAICT | TP to TS38.151 v0.1.0 on Performance metrics for NR MIMO OTA requirements |

## Open issues summary

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

**Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz, 40MHz bandwidth**

* Proposals
  + Option 1: PRS-EPRE-MAX in the centre of the test zone should be -83 dBm/30kHz.
  + Option 2: As a starting point, PRS-EPRE-MAX shall be at least maintained as -80dBm/15kHz or equivalent (-77dBm/30kHz).
* Recommended WF
  + TBA

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

* Proposals
  + Option 1: Accept -80dBm/15kHz or equivalent (-77dBm/30kHz) as a starting point.
  + Option 2: More analysis is needed.
* Recommended WF
  + TBA

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

**Issue 2-2-1: Restriction of Pmode at 70%TP for 40MHz CHBW**

* Proposals
  + Proposal 1: Adopt the same requirement on restriction of PMODE for 10MHz and 40MHz, i.e. for 40MHz CHBW, the 11 of total 12 PMODE should reach 70%TP.
* Recommended WF
  + TBA

**Issue 2-2-2: Additional restriction of Pmode for 10MHz and 40MHz CHBW**

* Proposals
  + Proposal 1: Adopting the restriction of PMODE for 10MHz and 40MHz that the 10 of total 12 PMODE should reach 90%TP.
  + Proposal 2: RAN4 should further study the rationality of restriction of PMODE at 90%TP based on real measurement results
  + Proposal 3: 90%TP rather than 95%TP is preferred as the additional test metric
* Recommended WF
  + TBA

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

**Issue 2-3: how to treat the orientations that cannot reach target outage TP?**

* Proposals
  + Option 1: Keep the FR2 permitted exception points aligned with FR1, i.e., 3 with 36 test points in total. New substitution approach for the missing points should be considered.
  + Option 2: No need to consider the impact of orientations those cannot reach target outage throughput on FR2 MIMO OTA requirements.
* Recommended WF
  + TBA

### Sub-topic 2-4 Simulation assumptions for FR2

*Views on simulation assumptions for FR2 MIMO OTA are shared in [R4-2102497] and [R4-2102719]*

**Issue 2-4-1: simulation assumption of PSP**

* Proposals
  + Option1: Target PSP for simulation should be slightly higher than the measurement requirements and more analysis is encouraged. *R4-2102719*
  + Option2: RAN4 shall provide the paraments of channel model after BS filtering under 6 probes layout as the reference and companies can use the reference parameters to calibration platform and provide simulation results. *R4-2102497*
* Recommended WF
  + TBA

**Issue 2-4-2: The direction of BS strongest beam**

* Proposals
  + The direction of the BS strongest beams in CDL-A InO and CDL-C UMi models are (-4.0°, 93.6°) and (-12.0°,100.7°), respectively. *R4-2102719*
* Recommended WF
  + TBA

**Issue 2-4-3: Number of clusters**

* Proposals
  + When the 40dB threshold is adopted, the number of clusters in CDL-A InO and CDL-C UMi models can be reduced to 3 and 14, respectively. *R4-2102719*
* Recommended WF
  + TBA

**Issue 2-4-4: UE antenna types**

* Proposals
  + Option 1: Companies select different antenna types to provide simulation results in the future. *R4-2102719*
  + Option 2: antenna type assumption in *R4-2102497*
* Recommended WF
  + TBA

**Issue 2-4-5: Polarization alignment**

* Proposals
  + It is proposed to adopt the two ideal cases for simulating the polarization alignment between the probe and the UE. *R4-2102719*
* Recommended WF
  + TBA

**Issue 2-4-6: BS/UE antenna parameters and Beam forming**

* Proposals
  + BS and UE antenna parameters in R4-2102497
* Recommended WF
  + TBA

**Issue 2-4-7: RMC parameters**

* Proposals
  + RMC parameters in R4-2102719
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei | **Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz, 40MHz bandwidth**  Regarding option1, besides the consideration of “Maximum output power of BS emulator”, we think the ability of UE to meet certain criteria at this power should also be considered, for example “10 of total 12 PMODE should reach 90%TP” as in issue 2-2-2. Therefore we think more study is needed.  **Issue 2-3: how to treat the orientations that cannot reach target outage TP?**  We think Ootion2 makes more sense, because we already agreed to use “the average over top 50%” as FR2 requirement metric. Those missing points are automatically precluded.  **Issue 2-4-2: The direction of BS strongest beam**  We hope that the direction of the BS strongest beams can be changed to CR to TR 38.827. could moderator allocate a CR T-doc number for TR 38.827? Thank you.  **Issue 2-4-3: Number of clusters**  40 dB is an appropriate threshold. However, for FR2 CDL-A, whether the reserved three clusters affect the UE throughput needs to be further discussed.  **Issue 2-4-4: UE antenna types**  The UE antenna types listed in option 2 already include option 1, where two panels are prioritized.  **Issue 2-4-6:** **BS/****UE antenna parameters and Beam forming**  BS antenna parameters have been defined in TR 38.827, and the beam forming can be found in TR 38.803. for UE, antenna parameters in TR 38.803 could be an option for simulation, we would like to see if there is more options.  **Issue 2-4-7: RMC parameters**  We provide a preliminary summary of the simulation assumptions aligned with the measurement parameters in TR 38.827 as much as possible in R4-2102719. Companies are encouraged to continue to supplement and comment on this summary. |
| Keysight | **Issue 2-4-2: The direction of BS strongest beam**  We can support Proposal 1.  **Issue 2-4-3: Number of clusters**  We need a couple more days to confirm the number of clusters with 40dB threshold. |
| vivo | **Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz, 40MHz bandwidth**  The commercial BS emulator outputs Fixed Cell power for different bandwidth (e.g. -2dBm for LTE 5/10/20 MHz), but not the fixed PSD. Therefore, the reached maximum EPRE for 40MHz should be 6dB lower (if same SCS), so option 1 is the reasonable value.  **Issue 2-1-2: PRS-EPRE-MAX for band frequency >3GHz**  We support option 2, the maximum downlink power for frequency bands >3GHz needs more study. System calibration and power validation results from companies are encouraged.  This value is also related to the channel model characteristic, so decision on Issue 1-1 also impacts.  **Issue 2-2-1: Restriction of Pmode at 70%TP for 40MHz CHBW**  Support proposal 1.  **Issue 2-2-2: Additional restriction of Pmode for 10MHz and 40MHz CHBW**  Support all the proposals.  **Issue 2-3: how to treat the orientations that cannot reach target outage TP?**  Support option 2.  **2.2.4 Sub-topic 2-4 Simulation assumptions for FR2**  General view on simulation assumptions for FR2 in Issue 2-4-1 to 2-4-7, the simulation assumption should be aligned with the measurement parameters in TR 38.827 as much as possible. |
| Samsung | **Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz, 40MHz bandwidth**  Maximum output power capability of test equipment side is almost the same for different bandwidth without considering MPR, but we don’t think -80dBm/15kHz for 10MHz is the maximum cell power limit. Take LTE as example, *PRS-EPRE-MAX* is configured as -80dBm/15kHz for 10MHz BW FDD, but for 20MHz BW TDD, *PRS-EPRE-MAX* is not scaled remains the same as -80dBm/15kHz.  To maintain throughput performance, the same PSD of downlink signal should be guaranteed, so -77dBm/30kHz is equivalent with -80dBm/15kHz in terms of PSD regardless of bandwidth.  So option 2 (at least -77dBm/30kHz) is reasonable.  **Issue 2-1-2: PRS-EPRE-MAX for band frequency >3GHz**  We support option 1 but also fine with option 2 for further study.  **Issue 2-2-1: Restriction of Pmode at 70%TP for 40MHz CHBW**  This issue has strong relationship with Issue 2-1-1 and Issue 2-1-2. Before *PRS-EPRE-MAX* is concluded, it is too early to agree the proposal.  **Issue 2-2-2: Additional restriction of Pmode for 10MHz and 40MHz CHBW**  Support proposal 2 and 3. About proposal 1, it is similar as Issue 2-2-1, before *PRS-EPRE-MAX* is concluded, it is too early to agree the proposal.  **Issue 2-3: how to treat the orientations that cannot reach target outage TP?**  In principle option 2 is reasonable since only 18 of 36 points accounted. However, there is a precondition that the SNR range should be guaranteed for the top 18 test points. Before the maximum downlink signal power configuration is standardized and SNR has been guaranteed especially for FR2 high bands, it is premature to agree option 2.  **Issue 2-4-4: UE antenna types**  In last meeting it is agreed that two panels assumption is prioritized than three panel assumption. We are fine to run simulation with both two panels and three panels, but the minimum requirement derivation should not be equally based on two or three panels, but two panels should be prioritized.  **Issue 2-4-5: Polarization alignment**  Is proposed two cases standing for best case and worst case?  **Issue 2-4-7: RMC parameters**  We echo with vivo that simulation assumption should be aligned with TR38.827 as much as possible. |
| Qualcomm | **Issue 2-2-2: Additional restriction of Pmode for 10MHz and 40MHz CHBW**  For 70% TP, as RAN4 agreed, 11 of 12 test points shall reach the target T-put which reuse performance requirements of LTE MIMO OTA. If 90% TP is agreed as the additional performance metric, the problem is how to define the number of missing points? If 10 of 12 test point passing the requirements are selected as the metric, it will lead to misalignment between LTE and NR MIMO OTA requirements. Then 3GPP might have different FoM from other standard organizations such as CCSA and CTIA. We suggest to packing target TP percentage and number of outage test point when discussing the performance requirements for FR1 MIMO OTA, that can help to harmonize the performance metric among the standard organizations, the metric should be selected from:   * Option 1: 70% TP: 11 of 12; 95% TP: 10 of 12; * Option 2: 70% TP: all 12; 90% TP: 11 of 12;   **Issue 2-3: how to treat the orientations that cannot reach target outage TP?**  We support option 2.  **Issue 2-4-1: simulation assumption of PSP**  We prefer option 2.  For option 1, it is not clear how to add PSP difference in the simulation. RAN4 should agree the simulation procedure first and then to decide PSP limit in the simulation.  For option 2, the reference channel parameters with 6 probes are needed. The parameters are related with power weight for the probes. Need feedback/information from CE/TE vendors.  **Issue 2-4-4: UE antenna types**  Option 1 and option 2 are coupling. Option 1 lists the possible UE panel number and option 2 lists the antenna parameters. We could merge option 1 and option 2 as the antenna parameters. Companies can select the antenna types and assumptions based on option 1 and option 2 for simulation.  **Issue 2-4-7: RMC parameters**  Clarification questions to Huawei: RMC and other parameters listed in R4-2102719 are in line with parameters defined in TR38.827? We should make sure all the simulation parameters are from test parameters defined in TR38.827. |
| MediaTek | **Issue 2-4-1: simulation assumption of PSP**  We support Option2“RAN4 shall provide the paraments of channel model after BS filtering under 6 probes layout as the reference and companies can use the reference parameters to calibration platform and provide simulation results. *R4-2102497”*  **Issue 2-3: how to treat the orientations that cannot reach target outage TP?**  We echo Samsung’s comment “In principle option 2 is reasonable since only 18 of 36 points accounted. However, there is a precondition that the SNR range should be guaranteed for the top 18 test points. Before the maximum downlink signal power configuration is standardized and SNR has been guaranteed especially for FR2 high bands, it is premature to agree option 2.” |
| OPPO | **Issue 2-2-1: Restriction of Pmode at 70%TP for 40MHz CHBW**  Support Proposal 1.  **Issue 2-2-2: Additional restriction of Pmode for 10MHz and 40MHz CHBW**  Support proposal 2. The gain from additional restriction should be investigated.  **Issue 2-3: how to treat the orientations that cannot reach target outage TP?**  When calculating FR2 requirement metric with the average of top 50% test points, it is right that the missing points are precluded under the condition of at least 18 of 36 test points reach the target outage throughput. Moreover, we should consider how many missing points permitted around the sphere, just like the restriction of FR1 that how many points out of 12 Pmode should reach 90% throughput, which determine the MIMO performance in real network for FR2 PC3 devices. |
| CAICT | **Issue 2-1-1 PRS-EPRE-MAX for band frequency <3GHz, 40MHz bandwidth**  Prefer option 1.  **Issue 2-2-1: Restriction of Pmode at 70%TP for 40MHz CHBW**  We support proposal 1.  **Issue 2-2-2: Additional restriction of Pmode for 10MHz and 40MHz CHBW**  We support the proposals. Prefer 90%TP as the additional test metric.  **Issue 2-3: how to treat the orientations that cannot reach target outage TP**  Regarding the FoM of FR2 MIMO OTA, an average approach within the “MIMO OTA Spherical Coverage” is adopted. To average all the values better than [50%] percentile of CCDF, the formula should be:    Based on the above formular, it is not necessary to consider the 3 missing points because they are not taken into consideration when deriving the FR2 MIMO OTA requirement. The problem is how to judge the UE performance if too many test points failed to reach the target TP in extreme cases. For example:   * More than half of the total 36 test points failed to reach 70%TP * Does this mean that as long as the top 50% results is good enough, it is acceptable even if the last 50% results can not reach the target TP?   **Sub-topic 2-4 Simulation assumptions for FR2**  We share similar views with vivo that the simulation assumption should be aligned with the measurement parameters in TR 38.827 as much as possible.   * + - 1. **Issue 2-4-2 The direction of BS strongest beam**   Moderator’s response to HW: I will request a CR number for TR 38.827 in the 1st round summary if necessary. Hope this is ok for you.  **Issue 2-4-3 Number of clusters**  We appreciate the detailed analysis. According to R4-2102719 and R4-2102729, CDL-C UMi clusters within a threshold of 40dB after BS filtering should be #1, #2, #3, #4, #5, #6, #7, #8, #10, #11, #13, #14, #15, #16, the number of clusters can be reduced to 14. However, if we look at another contribution R4-2100845, it seems that cluster #9 is also in the dynamic range of 40dB, and the total number of clusters should be 15.  It would be helpful to align the simulation results before we confirm the clusters. |
| Keysight | **Issue 2-4-3: Number of clusters**  We can confirm that we obtain the same clusters as shown in Table 1 of R4-2102719 with 40dB threshold |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2101825  (TP) | 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 Maximum downlink RS-EPRE** | **Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz, 40MHz bandwidth**  *This topic remains controversial, more discussion is needed.*  *Candidate options:*   * Option 1: -83dBm/30kHz, based on current physical output characteristic of commercial BS emulators (fixed output power of “-80dBm/15kHz \* 10MHz” at 40MHz) * Option 2: -80dBm/15kHz or equivalent (-77dBm/30kHz), Based on the two assumptions: TE outputs constant DL PSD (fixed PSD of -80dBm/15kHz at 40MHz) and agreed -80dBm/15kHz at 10MHz is not the real Maximum output power of the TE * Option 3: more study is needed   *Recommendations for 2nd round:*  Further discuss on this topic.  **Issue 2-1-2: PRS-EPRE-MAX for band frequency >3GHz**  *Agreements:*   * The maximum downlink power for frequency bands >3GHz needs more study.   *Recommendations for 2nd round:*  None. |
| **Sub-topic 2-2 Figure of Merit for FR1** | **Issue 2-2-1: Restriction of Pmode at 70%TP for 40MHz CHBW**  *3 companies support proposal 1, 1 company pointed out it is too early to agree the proposal before PRS-EPRE-MAX is concluded.*  *Recommendations for 2nd round:*  Further discuss on this topic. Agreement can be captured in the WF on NR MIMO OTA.  **Issue 2-2-2: Additional restriction of Pmode for 10MHz and 40MHz CHBW**  *3 companies support adopting 90%TP as the additional test metric. 1 company support defining the target TP percentage and number of outage test points in package. 1 company pointed out that the gain from additional restriction should be investigated.*  *Recommendations for 2nd round:*  Further discuss on this topic. Agreement can be captured in the WF on NR MIMO OTA. |
| **Sub-topic 2-3 Figure of Merit for FR2** | **Issue 2-3: how to treat the orientations that cannot reach target outage TP?**  *The main comments from companies are summarized:*   * P1: No need to consider the impact of orientations those cannot reach target outage throughput on FR2 MIMO OTA requirements. * P2: we should consider how many missing points are permitted around the sphere * P3: the SNR range should be guaranteed for the top 18 test points. It is premature to agree P1 before PRS-EPRE-MAX is standardized and SNR has been guaranteed especially for FR2 high bands.   *Recommendations for 2nd round:*  Further discuss on this topic. Agreement can be captured in the WF on NR MIMO OTA. |
| **Sub-topic 2-4 Simulation assumptions for FR2** | *For sub-topic 2-4, several companies highlight that* ***the simulation assumptions should be aligned with TR38.827 as much as possible****.*  **Issue 2-4-1: simulation assumption of PSP**  *Tentative agreements:*   * RAN4 shall provide the paraments of channel model after BS filtering under 6 probes layout as the reference and companies can use the reference parameters to calibration platform and provide simulation results. *R4-2102497*   *Recommendations for 2nd round:*  Further discuss the target PSP for simulation. Agreement can be captured in the WF on FR2 MIMO OTA simulation assumptions.  **Issue 2-4-2: The direction of BS strongest beam**  *Agreements:*   * The direction of the BS strongest beams in CDL-A InO and CDL-C UMi models are (-4.0°, 93.6°) and (-12.0°,100.7°), respectively. *R4-2102719*   *Recommendations for 2nd round:*  Request a CR and modify the corresponding content in TR38.827 according to the agreements.  **Issue 2-4-3: Number of clusters**  *Tentative agreement:*   * Proposal 1: When the 40dB threshold is adopted, the number of clusters in CDL-A InO and CDL-C UMi models can be reduced to 3 and 14, respectively. *R4-2102719*   Table 1 Clusters for the two Channel Models   |  |  | | --- | --- | | Channel models | Cluster | | CDL-A InO | #2, #3, #4 | | CDL-C UMi | #1, #2, #3, #4, #5, #6, #7, #8, #10, #11, #13, #14, #15, #16 |   *Recommendations for 2nd round:*  Confirm proposal 1 is agreeable.  **Issue 2-4-4: UE antenna types**  *Recommendations for 2nd round:*  Option 1 and option 2 can be merged as UE antenna parameters. Further discussion on this topic is needed. Agreement can be captured in the WF on FR2 MIMO OTA simulation assumptions.  **Issue 2-4-5: Polarization alignment**  *No support or opposition was received, only 1 company raised a clarification question.*  *Recommendations for 2nd round:*  More discussion is needed before reaching a conclusion. Companies are encouraged to express support or opposition. Agreement can be captured in the WF on FR2 MIMO OTA simulation assumptions.  **Issue 2-4-6: BS/UE antenna parameters and Beam forming**  *No support or opposition was received*  *Recommendations for 2nd round:*  Confirm if the proposal can be agreed. Companies are encouraged to express support or opposition. Agreement can be captured in the WF on FR2 MIMO OTA simulation assumptions.  **Issue 2-4-7: RMC parameters**  *Recommendations for 2nd round:*  Confirm if the RMC parameters can be agreed. Further clarify if the RMC and other parameters listed in R4-2102719 are in line with parameters defined in TR38.827 |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on TP work split and Work Plan | vivo, CAICT, OPPO |
| 2 | WF on FR2 MIMO OTA simulation assumptions  (cover Sub-topic 2-4) | Huawei, HiSilicon |

### 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”* |
| R4-2101825  (TP) | *No comments received, however, additional criterion in azimuthal orientations is under discussion. Suggest to revise this TP to capture the final agreement.*  *“to be revised”*  *Capture final agreements.* |

## Discussion on 2nd round

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

**Issue 2-1-1: PRS-EPRE-MAX for band frequency <3GHz, 40MHz bandwidth**

*Candidate options:*

* Option 1: -83dBm/30kHz, based on current physical output characteristic of commercial BS emulators (fixed output power of “-80dBm/15kHz \* 10MHz” at 40MHz)
* Option 2: -80dBm/15kHz or equivalent (-77dBm/30kHz), Based on the two assumptions: TE outputs constant DL PSD (fixed PSD of -80dBm/15kHz at 40MHz) and agreed -80dBm/15kHz at 10MHz is not the real Maximum output power of the TE
* Option 3: more study is needed

*Recommendations for 2nd round:*

Further discuss on this topic.

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

**Issue 2-2-1: Restriction of Pmode at 70%TP for 40MHz CHBW**

*3 companies support proposal 1, 1 company pointed out it is too early to agree the proposal before PRS-EPRE-MAX is concluded.*

*Recommendations for 2nd round:*

Further discuss on this topic. Agreement can be captured in the WF on NR MIMO OTA.

**Issue 2-2-2: Additional restriction of Pmode for 10MHz and 40MHz CHBW**

*3 companies support adopting 90%TP as the additional test metric. 1 company support defining the target TP percentage and number of outage test points in package. 1 company pointed out that the gain from additional restriction should be investigated.*

*Recommendations for 2nd round:*

Further discuss on this topic. Agreement can be captured in the WF on NR MIMO OTA.

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

**Issue 2-3: how to treat the orientations that cannot reach target outage TP?**

*The main comments from companies are summarized:*

* P1: No need to consider the impact of orientations those cannot reach target outage throughput on FR2 MIMO OTA requirements.
* P2: we should consider how many missing points are permitted around the sphere
* P3: the SNR range should be guaranteed for the top 18 test points. It is premature to agree P1 before PRS-EPRE-MAX is standardized and SNR has been guaranteed especially for FR2 high bands.

*Recommendations for 2nd round:*

Further discuss on this topic. Agreement can be captured in the WF on NR MIMO OTA.

### Sub-topic 2-4 Simulation assumptions for FR2

*For sub-topic 2-4, several companies highlight that* ***the simulation assumptions should be aligned with TR38.827 as much as possible****.*

**Issue 2-4-1: simulation assumption of PSP**

*Tentative agreements:*

* RAN4 shall provide the paraments of channel model after BS filtering under 6 probes layout as the reference and companies can use the reference parameters to calibration platform and provide simulation results. *R4-2102497*

*Recommendations for 2nd round:*

Further discuss the target PSP for simulation. Agreement can be captured in the WF on FR2 MIMO OTA simulation assumptions.

**Issue 2-4-3: Number of clusters**

*Tentative agreement:*

* Proposal 1: When the 40dB threshold is adopted, the number of clusters in CDL-A InO and CDL-C UMi models can be reduced to 3 and 14, respectively. *R4-2102719*

Table 1 Clusters for the two Channel Models

|  |  |
| --- | --- |
| Channel models | Cluster |
| CDL-A InO | #2, #3, #4 |
| CDL-C UMi | #1, #2, #3, #4, #5, #6, #7, #8, #10, #11, #13, #14, #15, #16 |

*Recommendations for 2nd round:*

Confirm proposal 1 is agreeable.

**Issue 2-4-4: UE antenna types**

* Proposals
  + Option 1: Companies select different antenna types to provide simulation results in the future. *R4-2102719*
  + Option 2: antenna type assumption in *R4-2102497*

*Recommendations for 2nd round:*

Option 1 and option 2 can be merged as UE antenna parameters. Further discussion on this topic is needed. Agreement can be captured in the WF on FR2 MIMO OTA simulation assumptions.

**Issue 2-4-5: Polarization alignment**

*No support or opposition was received, only 1 company raised a clarification question.*

* Proposals
  + It is proposed to adopt the two ideal cases for simulating the polarization alignment between the probe and the UE. *R4-2102719*

*Recommendations for 2nd round:*

More discussion is needed before reaching a conclusion. Companies are encouraged to express support or opposition. Agreement can be captured in the WF on FR2 MIMO OTA simulation assumptions.

**Issue 2-4-6: BS/UE antenna parameters and Beam forming**

*No support or opposition was received*

* Proposals
  + BS and UE antenna parameters in R4-2102497

*Recommendations for 2nd round:*

Confirm if the proposal can be agreed. Companies are encouraged to express support or opposition. Agreement can be captured in the WF on FR2 MIMO OTA simulation assumptions.

**Issue 2-4-7: RMC parameters**

* Proposals
  + RMC parameters in R4-2102719

*Recommendations for 2nd round:*

Confirm if the RMC parameters can be agreed. Further clarify if the RMC and other parameters listed in R4-2102719 are in line with parameters defined in TR38.827

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |

## Summary on 2nd round (if applicable)

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

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

# Topic #3: TR38.827 maintance

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2101821 | vivo | CR on Uplink Power Control for NR MIMO OTA test  **Reason for change:** The Uplink Power has not been defined for NR MIMO OTA test method.  **Summary of change**: Proper uplink power setting is important to measure accurate MIMO OTA performance, which has impacts on MIMO OTA performance presented in [R4-1704080]. For LTE MIMO OTA testing, +13 dBm was agreed as the uplink power in TR37.977 Annex A.2.  For NR, it is reasonable to reuse this value to ensure error-free operation on the uplink. |
| R4-2102817 | Huawei, HiSilicon | CR to TR 38.827 on channel model rotations  **Reason for change:** The probe layout is not aligned with the clusters in channel model.  **Summary of change:** The goal of channel model rotation is to conveniently find the best feasible probe locations that can efficiently emulate the behaviour of InO CDL-A and UMi CDL-C models inside the chamber. Nevertheless, the difference between the six probes and the channel model after rotation is 180 degrees according to Table 6.2.3-2 of TR38.827. The following figures show the orientations of the rays of the 2 strongest clusters before and after the channel model rotations to fit the probe layout: |
| R4-2102615 | Keysight Technologies UK Ltd | CR on Channel Model Topics  **Reason for change:** Channel model rotations, especially relative orientations between UE and BS and effect on DUT orientations, have not been clarified  **Summary of change**: Clarifications on the channel model rotations are provided |
| R4-2102614 | Keysight Technologies | On Remaining Channel Model Topics  **Observation 1:** Cluster AoAs are centred around 0° with DUT antenna orientation 180° in azimuth.  **Proposal 1: Keep the existing channel model rotations defined in TR38.827.**  **Proposal 2: Keep the existing DUT rotations without adjusting them by the channel model rotations.**  **Observation 2:** The PSP validation is used for sampling the PAS of the channel model at the centre of the test zone regardless of 5cm or 10cm radius.  **Proposal 3: Keep the existing PSP validation procedure with 5cm radius as baseline.**  **Proposal 4: Update the reference spatial correlation curves in TR38.827 based on the selected Option in [8]** |
| R4-2101993 | CAICT, vivo, OPPO, Huawei, HiSilicon, xiaomi, Samsung | Minimum number of slots for FR1 MIMO OTA testing  **Observation 1:** Test results with 10k and 20k subframes are almost the same. A minimum of 10k subframes is sufficient for FR1 MIMO OTA testing.  **Observation 2:** A minimum of 10k subframes can reduce nearly half of the testing time compared to the defined 20k slots for 15kHz SCS and 40k slots for 30kHz SCS**.**  **Proposal 1: Adopt 10k as the minimum number of subframes to perform FR1 MIMO OTA measurement.** |
| R4-2102819 | Huawei, HiSilicon | CR to TR 38.827 on base station beamforming configuration  **Reason for change:** BS beamfirming configuration is slightly adjusted to match for the real implementation.  **Summary of change:** The 128 fixed beams are displayed in Figure 1(a), where the circle size indicates the gain of the beam. As can be seen, the four beams in the red box have the maximum gain. In the actual antenna array design, when the phase shifters behind all antenna elements are set to 0°, one beam with the maximum gain should be in the normal direction of the antenna array. In order to simulate a real codebook, the step is slightly adjusted and the same scan angle range is maintained, as shown in Figure 1(b). |
| R4-2102497 | Qualcomm Incorporated | Discussion on FR2 MIMO OTA performance requirements  **Observation 1**: The agreed minimum number of slots agreed in RAN4 are not aligned with min testing time defined in TS 38.521-4 in some FR1 and FR2 frequencies. The lack of testing time will introduce additional uncertainty in SNR.  **Proposal 1: To avoid additional uncertainty in SNR, the minimum number of slots agreed in RAN4 for MIMO OTA testing is allowed to be revisited in RAN5.** |
| R4-2102081  (reserved) | CAICT, vivo, OPPO, Huawei, HiSilicon, xiaomi, Samsung | CR to TR38.827 Number of Slots for FR1 MIMO OTA test |

## Open issues summary

### Sub-topic 3-1 Channel model topics

**Issue 3-1-1: FR2 Channel Model Rotations**

* Proposals
  + Proposal 1:
    - Option 1: Keep the existing channel model rotations defined in TR38.827.
    - Option 2: Accept the channel model rotations as below:

Table 6.2.3-2. Channel Model Rotations

|  |  |  |  |
| --- | --- | --- | --- |
| InO CDL-A | | UMi CDL-C | |
| Phi [deg] | Theta [deg] | Phi [deg] | Theta [deg] |
| 250.0 | -2.0 | -73.0 | 15.0 |

* + Proposal 2: Keep the existing DUT rotations without adjusting them by the channel model rotations.
* Recommended WF
  + TBA

**Issue 3-1-2: PSP Validation**

* Proposals
  + Proposal 1: Keep the existing PSP validation procedure with 5cm radius as baseline.
* Recommended WF
  + TBA

**Issue 3-1-3: Spatial correlation curves**

*Moderator: This topic depends on the conclusion of issue 1-1 and issue 1-2-1*

* Proposals
  + Proposal 1: Update the reference spatial correlation curves in TR38.827 based on the selected Option in Issue 1-2-1
* Recommended WF
  + TBA

**Issue 3-1-4: BS beamforming configuration**

* Proposals
  + Proposal 1: Update BS beamfirming configuration which makes the strongest beam with phase shifter all set to 0o. details in R4-2102819.
* Recommended WF
  + TBA

### Sub-topic 3-2 Number of slots for FR1 MIMO OTA testing

**Issue 3-2: Minimum number of slots for FR1 MIMO OTA testing**

* Proposals
  + Proposal 1: Adopt 10k as the minimum number of subframes to perform FR1 MIMO OTA measurement.
  + Proposal 2: The minimum number of slots agreed in RAN4 for MIMO OTA testing is allowed to be revisited in RAN5.
* Recommended WF
  + TBA

### Sub-topic 3-3 Uplink Power Control for NR MIMO OTA test

**Issue 3-3: Uplink Power Control**

* Proposals
  + Reuse +13dBm to ensure error-free operation on the uplink.
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Keysight | **Issue 3-1-1: FR2 Channel Model Rotations**  Option 2 is based on an older probe configuration (TR38.827 V16.0.0) and not on the latest configuration agreed in R4-2016211 (not implemented correctly in TR38.827 V16.0.0). We support Option 1 per KS contribution R4-2102614 with the additional clarifications  **Issue 3-1-4: BS beamforming configuration**  We prefer not to make these changes at this point as they affect many existing channel models and validation data reference curves.  **Issue 3-2: Minimum number of slots for FR1 MIMO OTA testing**  Based on the analyses provided in the last meeting, we feel 10k subframes is not enough. More measurements especially on different bands (including low bands) and more devices would be needed to justify such short measurement period. The required time is frequency dependent which was not considered by this single n41 band measurement. |
| vivo | **Issue 3-1-3: Spatial correlation curves**  Depends on decisions on issue 1-1 and issue 1-2-1  **Issue 3-2: Minimum number of slots for FR1 MIMO OTA testing**  We support proposal 1 from the contribution with many co-signers, this is aligned with the CCSA test parameter for LTE MIMO OTA agreed several years ago, which has been demonstrated by many measurement results with large amount of UEs under different bands.  **Issue 3-3: Uplink Power Control**  Agree the proposal, this is an important parameter for MIMO OTA testing, we need to fill in this gap ASAP. |
| Samsung | **Issue 3-2: Minimum number of slots for FR1 MIMO OTA testing**  Based on test results covering many bands, we support proposal 1.  **Issue 3-3: Uplink Power Control**  We support this proposal which is aligned with LTE but still missing in NR. |
| Qualcomm | **Issue 3-2: Minimum number of slots for FR1 MIMO OTA testing**  For P1, is the proposal of 10K slots number applied for all the frequency ranges in FR1? If yes, for lower frequency ranges, it might be insufficient with the rule of 1000λ emulation length (see below table). Clarifications on applicability of 10k slots number are needed.   |  |  |  |  | | --- | --- | --- | --- | | Frequency (GHz) | Speed (km/h) | Doppler (Hz) | min. test time (s) | | 0.6 | 30 | 16.66666667 | 60 | | 2.1 | 30 | 58.33333333 | 17.14285714 | | 3.5 | 30 | 97.22222222 | 10.28571429 | | 6.5 | 30 | 180.5555556 | 5.538461538 | | 26 | 3 | 72.22222222 | 13.84615385 | | 41 | 3 | 113.8888889 | 8.780487805 | | 26 | 12 | 288.8888889 | 3.461538462 | | 41 | 12 | 455.5555556 | 2.195121951 |   Additionally, per procedure of defining the min. number of slots in RAN5, min. number of slots will have impact on the SNR uncertainty. From paper of R4-2102497, we can see for some test cases, the agreements on min number of slots in RAN4 is not in line with RAN5 speciation for Demod testing. We suggest RAN4 to agree that the minimum number of slots for MIMO OTA testing is allowed to be revisited in RAN5. |
| Huawei | **Issue 3-1-1: FR2 Channel Model Rotations**  Thanks Keysight for providing clarifications on the channel model rotations. |
| OPPO | **Issue 3-2: Minimum number of slots for FR1 MIMO OTA testing**  Support Proposal 1. From the contribution of R4-2101993, we see the curves of 10k slots and 20k slots coincide well on both averaged results and separate rotations. |
| CAICT | **Issue 3-1-3 spatial correlation curves**  Thanks to Keysight for providing detailed simulation results. Seems that this topic depends on the conclusions of sub-topic 1-1 and 1-2.  One clarification question:  The reference spatial correlation curves for channel models in R4-2002156 were evaluated using only the first strongest vertically polarized beam. In R4-2102613 and R4-2102614, is beam1 the first strongest beam? If yes, does this mean the correlation curves of beam1 in 2613/2614 should be the same as that in 2156?  **Issue 3-1-4 BS beamforming configuration**  We share similar views with Keysight.  **Issue 3-2 minimum number of slots for FR1 MIMO OTA testing**  We support proposal 1. The minimum of 10k subframes is used by CCSA in LTE MIMO OTA test for different LTE bands. For FR1 MIMO OTA, a comparison test with different number of subframes is performed to further verify the feasibility of 10k subframes. The result shows that the measured performance of FR1 MIMO OTA with 10k and 20k subframes are almost the same, while the test time can be reduced by about half with 10k subframes.  **Issue 3-3: uplink power control**  We support the proposal. |
| Keysight | **Issue 3-1-3 spatial correlation curves**  Response to CAICT: the curves presented in R4-2002156 needed to be updated based on some updated/optimized analyses.  **Issue 3-2: Minimum number of slots for FR1 MIMO OTA testing**  We do not believe that historic LTE data (with 15kHz SCS) can be leveraged to argue the number of slots for NR FR1 (with 30kHz SCS). It is therefore very surprising to see arguments made (without additional FR1 measurements which were suggested last meeting) to set the number of slots to 10k, the same as the number of subframes used in CCSA (while 3GPP and CTIA use 20k subframes). In the last meeting, we had companies admit that the 30kHz SCS will have an effect on number of slots (“Indeed, the emulation time period for 30kHz SCS becomes smaller” and “30kHz SCS for FR1 may have an impact on this conclusion”). Given the absence of NR FR1 measurement data (other than 1 device), especially for low bands, we cannot agree to the proposal to set the number of slots to 10k for all FR1 bands. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2101821 | Company A |
| Company B |
|  |
| R4-2102817 | Moderator: “Postponed”  In the CR coversheet, “CR cover page version”, “spec number” and “other specs affected” are not correct. Need to come back next meeting based on RAN4 Chair’s guidance:  “All CRs, for both open or closed WIs, will be automatically postponed to the next meeting if there are two or more errors on the CR coversheet”  Views on the content can be discussed. Proposal in this CR is also included in Issue 3-1-1. |
| Company B |
|  |
| R4-2102615 | Company A |
| Company B |
|  |
| R4-2102819 | Moderator: “Postponed”  In the CR coversheet, “CR cover page version”, “spec number” and “other specs affected” are not correct. Need to come back next meeting based on RAN4 Chair’s guidance:  “All CRs, for both open or closed WIs, will be automatically postponed to the next meeting if there are two or more errors on the CR coversheet”  Views on the content can be discussed. |
| Company 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 3-1 Channel model topics** | **Issue 3-1-1: FR2 Channel Model Rotations**  *Agreement:*   * Keep the existing channel model rotations defined in TR38.827.   **Issue 3-1-2: PSP validation**  *Agreement:*   * Keep the existing PSP validation procedure with 5cm radius as baseline.   **Issue 3-1-3: Spatial correlation curves**  *Tentative agreements:*   * The spatial correlation curves should be updated to capture the agreement of Issue 1-1 and Issue 1-2-1.   **Issue 3-1-4: BS beamforming configuration**  *Some companies pointed out that changing the BS beamforming configuration at this point will affect many existing channel models and validation data reference curves. Except for 1 company, there is no strong demand for modifying this configuration.*  *Tentative agreements:*   * Do not change BS beamforming configuration at this stage. |
| **Sub-topic 3-2 Number of slots for FR1 MIMO OTA testing** | **Issue 3-2: Minimum number of slots for FR1 MIMO OTA testing**  *6 companies co-signed the paper to support a minimum of 10k subframes , 2 companies pointed out that 10k subframes are not sufficient for all FR1 bands.*  *Recommendations for 2nd round:*  Make decision on the minimum number of subframes for FR1 MIMO OTA. Agreements should be captured in the R4-2102081. |
| **Sub-topic 3-3 Uplink Power Control for NR MIMO OTA test** | **Issue 3-3: Uplink Power Control**  *Agreement:*   * Reuse +13dBm to ensure error-free operation on the uplink.   The Agreement should also be captured in R4-2101823. |

*Suggestion on WF/LS assignment*

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

### CRs/TPs

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

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |
| R4-2101821 | *Agreeable* |
| R4-2102615 | *Agreeable* |
| R4-2102817 | *not agreeable*  *This topic is concluded in Issue 3-1-1* |
| R4-2102819 | *Postponed*  *In the CR coversheet, “CR cover page version”, “spec number” and “other specs affected” are not correct. Need to come back next meeting based on RAN4 Chair’s guidance* |
| R4-2102081 | Return to |
| New CR request | *CR to TR38.827 on the direction of the BS strongest beams*  *Source: Huawei, Hisilicon*  *Request a new CR number for TR38.827 to clarify the direction of BS beams.* |

## Discussion on 2nd round

### Sub-topic 3-1 Channel model topics

**Issue 3-1-3: Spatial correlation curves**

*Tentative agreements:*

* + The spatial correlation curves should be updated to capture the agreement of Issue 1-1 and Issue 1-2-1.

### Sub-topic 3-2 Number of slots for FR1 MIMO OTA testing

**Issue 3-2: Minimum number of slots for FR1 MIMO OTA testing**

*Recommendations for 2nd round:*

Make decision on the minimum number of subframes for FR1 MIMO OTA. Agreements should be captured in the R4-2102081.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |

## Summary on 2nd round (if applicable)

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

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