**3GPP TSG-RAN WG4 Meeting #94-e R4-20xxxxx**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 10.2.1

**Source:** CAICT

**Title:** Email discussion summary for RAN4#94e\_#97\_FS\_NR\_MIMO\_OTA\_test

**Document for:** Information

# Introduction

In the last RAN4 meeting, the actions for finalizing FR2 MIMO OTA were agreed in the WF [1]:

*Actions for finalizing FR2 MIMO OTA：*

* + *Channel model and Quality of Quiet Zone validation procedures:*
    - *TPs to finalize FR2 channel model validation procedure and quiet zone validation procedure*
  + *3D MPAC calibration and test procedures:*
    - *TPs to finalize calibration and test procedures*
  + *MU assessment*
    - *Define key elements and descriptions*
  + *Study feasible SNR ranges for 3D MPAC*
    - *Provide FR2 SNR analysis based on whole 3D-MPAC system*
  + *UE Direction of Travel for FR2 channel models*
    - *Make decision on DoT for FR2, based on the same approach for FR1 in [R4-1915060]*
  + *CE vendors align on channel model tap resolution*
    - *Initial phase definition of channel model shall be studied*

In the RAN plenary meeting, the NR MIMO OTA SI was approved to extend to March 2020 [2]. This is the last RAN4 meeting to finalize all the FR2 MIMO OTA open issues.

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

* 1st round: make decision on the open issues for FR2 NR MIMO OTA, update the TPs based on the comments.
* 2nd round: finalize the content of TPs for each open issue of FR2 MIMO OTA.

# Topic #1: FR2 test methods

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000505 | Qualcomm Incorporated | Proposal: Capture SNR upper bound values in Table 2 and attached calculator in TR38.827.  **Table 1: SNR upper bound value for MIMO OTA with measurement distance of 0.75m**   |  |  |  |  | | --- | --- | --- | --- | |  | **Channel Bandwidth** | **Maximum SNR with 1 probe** | **Maximum SNR with 8 probe3** | | Multi-band UE (Note) | 100 MHz | [24.4dB] | [33.4dB] | | Note 1: For ∑MBp from TS 38.101-2 Table 6.2.1.3-4 allow up to 2 dB.  Note 2: The SNR is calculated based on the UE noise floor derived by REFSENS.  Note 3: Compared with 1 probe, 8 probes can reach up to 9dB gain. | | | |   Observation 1: The SNR upper bound for MIMO OTA with 8 probes is 33.4dB for 100MHz channel bandwidth. |
| R4-2000894 | CAICT | TR38.827 v1.1.0 NR MIMO OTA |
| R4-2000896 | CAICT | TP to TR 38.827 v1.1.0 on FR2 preliminary MU assessment |
| R4-2000897 | CAICT | TP to TR 38.827 v1.1.0 on general part |
| R4-2002073 | Spirent Communications | Proposal 1: Agree on 6 probes, 3 per scaled channel model, in FR2 MPAC MIMO OTA to be minimum number of probes.  Proposal 2: Use table 1 to place probe 1 in chamber for each channel model. Adjacent probes will be placed by optimizing the locations and weights.  Proposal 3: Adopt the table 2 probe locations with target PSP values.  Observation 1: CDL-A InO is single cluster model, while CDL-C UMi has two significant clusters. |
| R4-2002074 | Spirent Communications | TP for System Design and Probe layout for FR2 MPAC MIMO OTA |
| R4-2002100 | Spirent Communications | Proposal 1: Adopt the simplified two step validation technique to FR2 channel model validation. |
| R4-2002102 | Spirent Communications | TP for Verification of FR2 channel models in MPAC system |
| R4-2002117 | ROHDE & SCHWARZ | Proposal 1: Whether to utilize a DFF or IFF system is left up to the system implementation. Only the figure of merit and measurement uncertainty are defined.  Proposal 2: Specific system implementation details like the antenna position and number of antennas are defined separately for each system type (DFF/IFF).  Observation 1: IFF are preferred over DFF systems for RF/RRM/Demod testing.  Observation 2: For RF testing IFF systems provide smaller uncertainties than DFF systems and a higher SNR range.  Observation 3: It is only important for a test system to meet the specified figure of merit. |
| R4-2002151 | Keysight Technologies UK Ltd | TP to TR38.827: FR2 MIMO OTA Calibration and Test Procedures |
| R4-2002152 | Keysight Technologies UK Ltd | TP to 38.827 to introduce EUT orientations for FR2 |
| R4-2002153 | Keysight Technologies UK Ltd | Sample SNR ranges in FR2 OTA setup (late contribution) |
| R4-2002154 | Keysight Technologies UK Ltd, Spirent Communications | Observation 1: The PSP simulations between the two CE vendors that have provided PSP simulations in the past are aligned, with some additional comparisons in progress  Observation 2: Beamforming assumptions are aligned between the two CE vendors that have provided PSP simulations in the past |
| R4-2002155 | Keysight Technologies UK Ltd | Pending proposals |
| R4-2002157 | Keysight Technologies | Observation 1: For the reasonable measurement parameters required for the estimation, the corresponding measurement times could be large. Therefore, it is crucial to define suitable measurement parameters that are efficient in terms of time and the estimation accuracy is not compromised.  Proposal 1: Further investigation is required for defining suitable measurement parameters. Feedback and proposals are welcomed. |

## Open issues summary

### Sub-topic 1-1 FR2 probes layout

**Issue 1-1-1: FR2 probes layout for 3D-MPAC**

* Proposals
  + Option 1: 6 probes approach:
    - Proposal 1: Agree on 6 probes, 3 per scaled channel model, in FR2 MPAC MIMO OTA to be minimum number of probes.
    - Proposal 2: Use table 1 to place probe 1 in chamber for each channel model. Adjacent probes will be placed by optimizing the locations and weights.
    - Proposal 3: Adopt the table 2 probe locations with target PSP values.
  + Option 2: updated proposals in R4-2002155
* Recommended WF
  + TBA

**Issue 1-1-2: feasible SNR ranges for 3D MPAC**

* Proposals
  + Option 1: The SNR upper bound for MIMO OTA with 8 probes is 33.4dB for 100MHz channel bandwidth.
  + Option 2: update proposal based on the late contribution in R4-2002153
* Recommended WF
  + TBA

**Issue 1-1-3: New proposed system for FR2 MIMO OTA**

* Proposals
  + Proposal 1: Whether to utilize a DFF or IFF system is left up to the system implementation. Only the figure of merit and measurement uncertainty are defined.
  + Proposal 2: Specific system implementation details like the antenna position and number of antennas are defined separately for each system type (DFF/IFF).
* Recommended WF
  + New system without clear studied channel model generation, validation and test procedure, is not recommended at this stage

### Sub-topic 1-2 Calibration and validation

**Issue 1-2-1: calibration and test procedures**

* Proposals
  + Check and refine text proposals in R4-2002151
* Recommended WF
  + Update and finalize the calibration and test procedure based on the initial proposals in R4-2002151

**Issue 1-2-2: Channel model and Quality of Quiet Zone validation procedures**

* Proposals
  + Option 1: Adopt the simplified two step validation technique to FR2 channel model validation. In R4-2002102
  + Option 2: Joint Power-Angle-Delay validation approach for FR2. In R4-2002157
* Recommended WF
  + Make decision on how to validate the channel models, and finalize the test proposals in the 2nd round.

**Issue 1-2-3: MU assessment**

* Proposals
  + FR2 preliminary MU assessment in TP R4-2000896
* Recommended WF
  + Update the MU assessment elements based on the Test Proposals in R4-2000896. Finalize the text proposals in the 2nd round.

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| Samsung | Sub topic 1-1:   * Issue 1-1-1:   + Since 3D scan is adopted in FR2 MIMO OTA, so the absolute placement of probe 1 is not so important but what more important is the relative position of other probes compared with probe 1. For proposal 3 of option 1, the distance between probe 1 and probe 2 for CDL-C Umi is so close about 4cm (considering 0.75m range length), I am not sure if 4cm distance is beyond the size of probe. Anyway, when optimizing probe locations, a minimum granularity in distance between probes shall be considered so that it shall not be closer than practical probe size.   + As agreed in R4-1904160, UE Antenna Pattern for channel model generation is isotropic, but not sure whether the figure of merit for PSP is based on isotropic UE antenna pattern or directional UE antenna pattern, could it be clarified? If PSP is based on directional UE antenna pattern, further study of UE antenna array assumption is necessary. * Issue 1-1-2:   + It is good idea to capture SNR range calculation in TR. However, we observed that SNR range calculation is not applicable before performance metric is determined. Both option 1 and option 2, only beam peak direction is considered, it is not aligned with the MIMO OTA test scenario which is involved with non-peak direction test. The SNR range calculation at beam peak direction only works for beam peak direction test; for a 3D test, the SNR range calculation shall consider the worst case among all the test points except the exception points because the exception points will not be taken into account in performance metrics. Thus, SNR range calculation is applicable only after performance metric has been defined.   + Agree with QC that Noc shall not be considered when calculating SNR range since FR2 MIMO OTA is agreed to be noise-limited condition   + The multi-probe gain shall be calculated based on the final determined probe locations and weights rather than 10\*log10(N) etc. Except probe 1, the contribution of other probes is so small that it may be even ignored. * Issue 1-1-3:   Sub topic 1-2:   * Issue 1-2-1: * Issue 1-2-2: * Issue 1-2-3:   Others: |
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### CRs/TPs comments collection

*NR MIMO OTA is a close-to-finalize SI, suggest to focus on finalizing the text proposals for TR.*

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2000894 | Company A |
| Company B |
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| R4-2000896 | Company A |
| Company B |
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| R4-2000897 | Samsung  Agree with Keysight that 20cm test zone size is applicable for PC3 for FR2. But for FR1, power class does not indicate UE type. Maybe just reword to "The test zone size is 20cm for both FR1 and FR2 MIMO OTA testing, larger test zone size is not precluded for further study"? |
| Company B |
|  |
| R4-2002074 | Samsung:   * + For proposal 3, the distance between probe 1 and probe 2 for CDL-C Umi is so close about 4cm (considering 0.75m range length), I am not sure if 4cm distance is beyond the size of probe. Anyway, when optimizing probe locations, a minimum granularity in distance between probes shall be considered so that it shall not be closer than practical probe size.   + Similar concern as Qualcomm. As agreed in R4-1904160, UE Antenna Pattern for channel model generation is isotropic, but not sure whether the figure of merit for PSP is based on isotropic UE antenna pattern or directional UE antenna pattern, could it be clarified? If PSP is based on directional UE antenna pattern, further study of UE antenna array assumption seems necessary. |
| Company B |
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| R4-2002102 (make comments based on the latest version with marks in NR MIMO OTA reflector) | Company A |
| Company B |
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| R4-2002151 | Company A |
| Company B |
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| R4-2002152 | Company A |
| Company B |
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## Summary for 1st round

### Open issues

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

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

*Recommendations on WF/LS assignment*

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

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

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

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| **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: FR2 performance metrics and channel model

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000080 | Qualcomm Incorporated | Observation 1: The current static test mechanism cannot properly filter out UEs that do not proactively readjust their beams with a small delay.  Proposal 1: A scenario where at least UE orientation is rotating over time during a test iteration should be considered for dynamic geometry-based MIMO OTA Testing. Other scenarios are FFS.  Proposal 2: For UE orientation rotation-based tests, the following aspects will be discussed.   * A common framework for RRM/RLM and/or Demod tests * How to implement UE orientation rotation in 3D MPAC system * How to define performance requirements * Whether and how to cope with many different UE implementations especially in terms of beam pattern |
| R4-2000272 | Samsung | Observation 1: different spherical coverage percentile of different power classes, different UE form factors, and limitation of testability SNR range will lead to varying exception points quantity.  Observation 2: exception points issue can be avoided by specifying the test points for TRMS calculation in a unified manner for all power classes.  Proposal 1: define FR2 MIMO OTA performance metric as the averaging of the measured sensitivity at the test points within “MIMO OTA spherical coverage”, where the “MIMO OTA spherical coverage” means the spherical coverage in terms of MIMO OTA sensitivity rather than EIS. |
| R4-2000798 | MediaTek Beijing Inc. | Proposal1: Define fixed initial phase pattern(s) for sub-paths, for FR1 and FR2 respectively.  Proposal2: Exact fixed initial phase pattern(s) is FFS, for FR1 and FR2 respectively. |
| R4-2000895 | CAICT | The sensitivity value at the [80th] percentile of the CCDF of the all the recorded data measured over the full sphere around UE is defined as the FR2 MIMO OTA requirement. |
| R4-2002069 | Spirent Communications | **Observation 1**: Thresholding of 30dB significantly reduces the number of taps to 1 tap in InO CDL-A, and three taps for UMi CDL-C.  **Proposal 1**: Adopt an approximate 30 dB threshold to limit the number of Spatially filtered taps  **Proposal 2 and 3:** Select improved DoT values of: InO CDL-A, DoT = 135 deg, UMi CDL-C, DoT = 100 deg, for use at all FR2 frequencies. |
| R4-2002070 | Spirent Communications | TP for DoT selection for FR2 channel model |
| R4-2002149 | Keysight Technologies UK Ltd | TP for Clarification of Beam Forming Weights |
| R4-2002150 | Keysight Technologies UK Ltd | Proposal 1: Keep the random initial phases as defined in [1] |
| R4-2002156 | Keysight Technologies UK Ltd | Observation 1: The number of spatial samples defined in wavelength becomes small as the test frequency decreases.  Proposal 1: For the lowest four test frequencies, i.e., 617, 722, and 836.5 and 1575.42 MHz, adopt a spatial as λ/15 and λ/4 for first the quadrant of test zone circumference (270◦-180◦) and the remaining three quadrants, respectively.  Proposal 2: For the highest five test frequencies, i.e., 1800, 2132.50, 2450, 3600 and 4700 MHz, adopt the spatial sampling as λ/10 and λ/2 for first quadrant of test zone circumference (270◦-180◦) and the remaining three quadrants, respectively, i.e., same as proposed in [2] |

## Open issues summary

### Sub-topic 2-1 Performance metrics

**Issue 2-1: Performance metrics**

* Proposals
  + Option 1: define FR2 MIMO OTA performance metric as the averaging of the measured sensitivity at the test points within “MIMO OTA spherical coverage”, where the “MIMO OTA spherical coverage” means the spherical coverage in terms of MIMO OTA sensitivity rather than EIS.
  + Option 2: The sensitivity value at the [80th] percentile of the CCDF of the all the recorded data measured over the full sphere around UE is defined as the FR2 MIMO OTA requirement.
* Recommended WF
  + TBA

### Sub-topic 2-2 Channel models

**Issue 2-2-1: Direction of Travel**

* Proposal

The UE travelling direction (**v, **v) are as follows for FR2:

* (135°,90°) for InO CDL-A channel model
* (100°,90°) for UMi CDL-C channel model
* Recommended WF
  + TBA

**Issue 2-2-2: initial phases for channel models**

* Proposals
  + Option 1: Define fixed initial phase pattern(s) for sub-paths, for FR1 and FR2 respectively. Exact fixed initial phase pattern(s) is FFS
  + Option 2: Keep the random initial phases as defined in [1]
* Recommended WF
  + TBA

**Issue 2-2-3: Beam Forming Weights**

* Proposal
  + Include the proposed changes to the channel model coefficient equations in TR38.827. in R4-2002149
* Recommended WF
  + TBA

### Sub-topic 2-3 others

**Issue 2-3-1: spatial sampling points for FR1 spatial correlation validation**

* Proposals
* Proposal 1: For the lowest four test frequencies, i.e., 617, 722, and 836.5 and 1575.42 MHz, adopt a spatial as λ/15 and λ/4 for first the quadrant of test zone circumference (270◦-180◦) and the remaining three quadrants, respectively.
* Proposal 2: For the highest five test frequencies, i.e., 1800, 2132.50, 2450, 3600 and 4700 MHz, adopt the spatial sampling as λ/10 and λ/2 for first quadrant of test zone circumference (270◦-180◦) and the remaining three quadrants, respectively, i.e., same as proposed in [2]
* Recommended WF
  + TBA

**Issue 2-3-2: FR2 dynamic testing**

* Proposals
* Proposal 1: A scenario where at least UE orientation is rotating over time during a test iteration should be considered for dynamic geometry-based MIMO OTA Testing. Other scenarios are FFS.
* Proposal 2: For UE orientation rotation-based tests, the following aspects will be discussed.
* A common framework for RRM/RLM and/or Demod tests
* How to implement UE orientation rotation in 3D MPAC system
* How to define performance requirements

Whether and how to cope with many different UE implementations especially in terms of beam pattern

* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Samsung | Sub topic 2-1:   * Issue 2-1:   + Option 1: All the [36] test points will be measured, but not all the [36] measurement results are counted in the performance metric, because many test points can not reach even 70% throughput outage. A rule to preclude the exception points are necessary and “MIMO OTA spherical coverage” corresponding to the percentile of each power class is reasonable for performance metric.   + Option 2: Assume option 2 will count 80% of [36] test points in performance metric for PC3, there is achievable SNR range issue though. The upper limit of SNR range at 20%-tile (i.e. 80% of whole sphere) will be too low to achieve required throughput outage.   Sub topic 2-2:   * Issue 2-2-1: * Issue 2-2-2: * Issue 2-2-3:   Sub topic 2-3:   * Issue 2-3-1: * Issue 2-3-2: Even static MIMO OTA test is facing challenging SNR condition, the situation will be even worse for dynamic geometry-based test. Moreover, UE rotation is not a typical user scenario, and it can not address the need of industry. We prefer to concentrate on the static MIMO OTA.   Others: |
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### CRs/TPs comments collection

*NR MIMO OTA is a close-to-finalize SI, suggest to focus on finalizing the text proposals for TR.*

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| **CR/TP number** | **Comments collection** |
| R4-2000895 | Samsung: It seems only applicable for PC3, there is achievable SNR range issue though. The upper limit of SNR range at 20%-tile (i.e. 80% of whole sphere) will be too low to achieve required throughput outage. It will be better to align test points for performance metric to the percentile of each power class, e.g., 50% test points for PC3. |
| Company B |
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| R4-2002070 | Company A |
| Company B |
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| R4-2002149 | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

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

*Suggestion on WF/LS assignment*

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| --- | --- | --- |
|  | **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*

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

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

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

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

## Refrenece

1. R4-1916174, WF on FR2 MIMO OTA, CAICT, Spirent, RAN4#93, Nov. 2019
2. Meeting Report, RAN#86, Dec. 2019