**3GPP TSG-RAN WG4 Meeting # 100-e R4-210XXXX**

**Electronic Meeting, 16th – 27th Aug., 2021**

**Agenda item:** 9.2.1(related proposals), 9.2.4, 9.2.5

**Source:** Moderator (OPPO)

**Title:** Email discussion summary for [100-e] [333] FR1\_TRP\_TRS\_Part2

**Document for:** Information

# Introduction

*Contributions submitted to AI 9.2.4* UE with multiple antennas test methodology and *AI 9.2.5* Others of FR1 TRP TRS WI *and related to multiple antenna topics in AI 9.2.1* General and work plan *are captured in this email discussion. According to the RAN plenary #91-e arrangement, this is the first meeting for technical discussion. Test strategy and methodology on multiple antennas and test time reduction will be discussed.*

# Topic #1: Test methodology for UE with multi-antenna

 *The following multi-antenna technics will be discussed in this section.*

* *UL Transmit Diversity:* This task will start when RAN4 concludes on UL Transmit Diversity of SA
* *Transmit Antenna Switch*
* *Multi Antenna Receivers*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2112610 | Xiaomi | **Observation 1**：One possible test method for antenna switching is to measure the EIRP with each antenna separately and save the highest value as the result of that specific test point and calculate the TRP in the last.**Proposal**: It is proposed to study a new TRP limit representing “one virtualized antenna” for UE with multi-antenna to reflect the gain of antenna switching. |
| R4-2112861 | CMCC | **Proposal 2**: TRP test methodology of multiple antenna UE with TAS function should be studied sustainably in RAN4. |
| R4-2112863 | CMCC, Xiaomi | **Observation 1**: The TRP test results are relatively stable based on this methodology. Using one hardware in the same one chamber, the differences of TRP results among multiple tests ranges $\pm o.5dB$.**Observation 2**: TRP with Tx antenna switching on is better than the TRP with any one antenna locked, which means TAS does bring some benefit and enhance the Tx performance. In the meanwhile, UE does not switch to the best antenna at some positions.**Observation 3**: There are two test configurations need further study which have impact on TRP performance according to differences among UE TAS algorithm. One is the test delay of every test direction, another is the RSRP of SSB in center of teat zone.**Proposal 1**: This methodology can be treated as baseline to measure TRP with UE Tx antenna switching on.**Proposal 2**: The detail of test configurations needs further study and companies are encouraged to share views to improve this methodology. |
| R4-2113913 | OPPO | **Observation 1**: the hardware implementation of traditional SISO OTA test system will introducing measurement deviation with Tx switching function ON because of the uplink path and the measurement path inconsistent artificially.**Observation 2**: the software adaptation with different Tx switching optimization strategy leads different UE’s behaviour even in the same measurement environment.**Proposal 1**: Currently keep the function OFF as a common approach for UE TRP OTA test.**Proposal 2**: Test solutions which can solve the problems mentioned above on hardware and/or software are highly encouraged. |
| R4-2113986 | ROHDE & SCHWARZ | **Observation 1**: Rx diversity is already covered with current OTA test systems and procedure.**Observation 2**: test system implementations on anechoic chambers are capable of presenting the right conditions to test Tx switching without the need for a test mode.**Proposal 1**: UE vendors to clarify at high-level what mechanisms are used in UE’s to control Tx antenna switching. |
| R4-2114531 | Huawei, HiSilicon | **Obsevation 1**: for Tx antenna switching based on downlink Rx signal level or uplink received power, it is difficult to simulate in the chamber the same switching mechanism that DUT will perform in real in-field environment. Therefor it lacks the rationality for “functon on” test.**Observation 2**: pure proximity senor based solution is expected to perform the same for “function on” and “function off” tests. **Observation 3**: In case of multiple Rx antenna, the most common implementation is to keep them all active, relying on baseband combination algorithms for optimal combined performance, i.e. receive diversity.**Proposal 1**: aodpt “Function Off” for Tx antenna switching. Where all candidate Tx antennas should be tested, the best TRP value out of the tested Tx antennas should be used.**Proposal 2**: In case of multiple Rx antenna, keep all antenas active and use receive diversity in the test.**Proposal 3**: for implementations that physically select different Rx antannas according to different circumstances, apply same principle as “Tx antenna switching”, i.e. “Function Off” with minimum requirement being satisfied by the antennas with the best TRS performance. It should be noted that no limit on the maximum number of Rx antenna for one test should be imposed. |

## Open issues summary

### Sub-topic 1-1: Tx antenna switch ON/OFF

**Issue 1-1: Function OFF or ON for Tx antenna switching?**

* Proposal 1: adopt Transmit Antenna Switch function OFF under current SISO OTA methodology
* Proposal 2: TRP test methodology for TAS function ON should be studied sustainably in RAN4
* Recommended WF
	+ TBA

### Sub-topic 1-2: Test Methodology for Tx antenna switch function ON

**Issue 1-2-1: Candidate solutions for TRP measurement with Tx antenna switch function ON**

* Option 1: measure the EIRP with each antenna separately and save the highest value as the result of that specific test point, then calculate the TRP (Xiaomi)
* Option 2: the communication tester is connected to the test antenna to provide the DL signal at the same time it performs power measurements (CMCC, ROHDE & SCHWARZ)
* Option 3: others
* Recommended WF
	+ TBA

**Issue 1-2-2: Factors those influence the Tx antenna switch mechanism**

* Option 1: UE vendors to clarify at high-level what mechanisms are used in UE’s to control Tx antenna switching (ROHDE & SCHWARZ)
* Option 2: Views on methodology improvement are encouraged to refine the test configurations (CMCC)
* Option 3: others
* Recommended WF
	+ TBA

**Issue 1-2-3: Metrics for evaluating radiated performance of Tx antenna switch**

* Option 1: study a new TRP limit representing “one virtualized antenna” for UE with multi-antenna to reflect the gain of antenna switching
* Option 2 (from moderator): new metrics are not needed
* Option 3: FFS is needed
* Recommended WF
	+ TBA

### Sub-topic 1-3: Test Methodology for multi antenna receivers

**Issue 1-3-1: Is Rx diversity already covered with current OTA test systems and procedure?**

* Option 1: Yes.
* Option 2: No.
* Option 3: FFS is needed
* Recommended WF
	+ TBA

**Issue 1-3-2: Test methodology/configuration for multi antenna receivers**

* Proposal 1: keep all antennas active and use receive diversity in the test.
* Proposal 2: for implementations that physically select different Rx antennas according to different circumstances, apply “Function Off” with minimum requirement being satisfied by the antennas with the best TRS performance.
* Proposal 3: It should be noted that no limit on the maximum number of Rx antenna for one test should be imposed.
* Proposal 4: others
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

**Sub-topic 1-1: Tx antenna switch ON/OFF**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Issue 1-1: Function OFF or ON for Tx antenna switching?Since current OTA test system cannot get stable results on DUT with Tx antenna switch ON, it is recommended to keep the function OFF as a common approach for UE TRP OTA test. Furthermore, as a enhancement, methodology for function ON should be studied. |
| MediaTek | 1. Use “force antenna method” to do test shall be the baseline before we have solid & stable test method for “TAS ON”;
2. solid and stable test method for “TAS ON” should be studied.
 |
| CMCC | Issue 1-1: Function OFF or ON for Tx antenna switching?Test methodology for TAS on should be studied. |
| R&S | Issue 1-1: Function OFF or ON for Tx antenna switching?Several companies have provided very similar approaches to enable Tx antenna switching testing with function ON. Therefore, we think Proposal 2 is the preferred option. |
| Qualcomm | **Issue 1-1: Function OFF or ON for Tx antenna switching?**We share the similar view as OPPO. In the current stage, we should use “TAS OFF” as the baseline for FR1 TRP/TRS measurement since this is the mature approach. We are open to further study the method for “TAS ON” but prefer to have it as 2nd priority. |
| Samsung | **Issue 1-1: Function OFF or ON for Tx antenna switching?**Agree to use “TAS OFF” as baseline in current stage. It seems that the exact interpretation of TAS OFF is needed (test each Tx antenna respectively and choose better one?). |
| Huawei, HiSilicon | **Issue 1-1: Function OFF or ON for Tx antenna switching?**We prefer proposal 1. Agree with Samsung that interpretation is needed. Our understanding is “*all candidate Tx antennas should be tested, the best TRP value out of the tested Tx antennas should be used.*”Regarding proposal 2, the feasibility needs to be studied first, to justify the feasibility to correctly model the in-field environment in the chamber. |

**Sub-topic 1-2: Test Methodology for Tx antenna switch function ON**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Issue 1-2-1: Candidate solutions for TRP measurement with Tx antenna switch function ONOption 2 is preferred. Option 1 costs more test time and need specific test mode configuration.Issue 1-2-2: Factors those influence the Tx antenna switch mechanismBoth Option 1 and Option 2 are needed. A list of factors which may affect antenna switch scheme can be made like below. Then, we can select factors that need to be considered from the list.* Near body sensor
* Downlink power detection
* USIM card distinguishing
* Upper business
* …

Issue 1-2-3: Metrics for evaluating radiated performance of Tx antenna switchThe required metrics need to reflect the performance with Tx antenna switch ON. So, it is recommended to postpone discussing this topic when we have a clearer picture of the enhanced test system. |
| MediaTek | **Issue 1-2-1: Candidate solutions for TRP measurement with Tx antenna switch function ON**We are a little confused on Option1, it is much like TAS OFF method (force antenna method), in our understanding; however, it is put in TAS ON sub-topic currently.About Option2: we are interested on the method idea, deeper studies and more data would be fine before adopt it**Issue 1-2-3: Metrics for evaluating radiated performance of Tx antenna switch**We support Option2. TAS function is a UE capability, so maybe no need to introduce new metrics, it much like “the UE has TAS function, so the fundamental TRP performance is better than the UE w/o TAS”.  |
| CMCC | **Issue 1-2-1: Candidate solutions for TRP measurement with Tx antenna switch function ON**Support Option2 as baseline to be further studied. **Issue 1-2-3: Metrics for evaluating radiated performance of Tx antenna switch**Agree with OPPO. A reasonable test method with UE TAS on should be clarified first. |
| R&S | Issue 1-2-1: Candidate solutions for TRP measurement with Tx antenna switch function ONWe support option 2. Based on the inputs in R4-2112863, a “dwell time” per point could be considered to ensure the switching state is stable before performing the power measurement.Option 1 still requires N measurements (being N the number of Tx antennas) and the final result would overestimate the actual radiated performance of the device under realistic conditions.Issue 1-2-2: Factors those influence the Tx antenna switch mechanismThere is no conflict between Option 1 and Option 2. We agree with OPPO in listing the factors and then decide on those that might affect the results. E.g.: USIM card wouldn’t be considered since these tests are performed with tests USIM cards, and thus no tuning for dedicated operator is considered. Issue 1-2-3: Metrics for evaluating radiated performance of Tx antenna switchOption 2 is preferred. A new metric, as proposed in Option 1, combining the results from several TRP tests for each Tx Antenna would overestimate the actual radiated performance of the device under realistic condition. |
| Qualcomm | **Issue 1-2-1: Candidate solutions for TRP measurement with Tx antenna switch function ON**More clarifications are needed for option 1. Option 2 can be a start but need more date to verify the feasibility and accuracy of solution.**Issue 1-2-3: Metrics for evaluating radiated performance of Tx antenna switch**We support option 1. We need to discuss the term of “TRP with TAS ON” first. Traditionally, TRP is used to indicate the antenna radiated performance in a static stage while with TAS ON, we are measuring the optimal envelope of radiation performance of several antennas. That is a different concept from TRP. So we support to define a new metric to evaluate radiated performance with TAS ON.  |
| Samsung | **Issue 1-2-1: Candidate solutions for TRP measurement with Tx antenna switch function ON**Is option 1 the same as TAS OFF? It seems that the exact interpretation of TAS OFF in issue 1-1 is needed.**Issue 1-2-3: Metrics for evaluating radiated performance of Tx antenna switch**Option 3. We agree with Qualcomm that it is new concept compared with traditional TRP, further study is needed. |
| Huawei, HiSilicon | **Issue 1-2-1: Candidate solutions for TRP measurement with Tx antenna switch function ON**Regarding option1, same feeling as MTK and Samsung, it looks like our understanding for TAS offRegarding option2, we think it is not a comprehensive solution, the strength of DL signal is not the only method for UE TAS, as discussed in Issue 1-2-2. |

**Sub-topic 1-3: Test Methodology for multi antenna receivers**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Issue 1-3-1: Is Rx diversity already covered with current OTA test systems and procedure?Option 1. Multi antenna receiving in diversity mode is already activated in previous test methodology.Issue 1-3-2: Test methodology/configuration for multi antenna receiversSupport Proposal 1 and Proposal 3. |
| MediaTek | Issue 1-3-2: Test methodology/configuration for multi antenna receiversSupport Proposal 1 and Proposal 3. We believe the intention of test is to confirm the UEs pass the min requirement, so the UE actually can use more Rx antennas to achieve potential better performance, it’s up to UE implementation. |
| R&S | Issue 1-3-1: Is Rx diversity already covered with current OTA test systems and procedure?We support option 1. Any further discussion of how multiple Rx antennas affect the performance is part of the requirement definition work, to be handled under the performance part of the WI.Issue 1-3-2: Test methodology/configuration for multi antenna receiversWe support Proposal 1. |
| Qualcomm | Issue 1-3-2: Test methodology/configuration for multi antenna receiversWe support proposal 1 and different requirements should be defined for different Rx antenna number such as 2Rx, 4Rx. |
| Samsung | Issue 1-3-1: Is Rx diversity already covered with current OTA test systems and procedure?We support option 1 (yes). Issue 1-3-2: Test methodology/configuration for multi antenna receiversWe support Proposal 1 and 3. Agree with MediaTek that number of Rx antennas are up to UE implementation. |
| Huawei, Hisilicon | Issue 1-3-1: Is Rx diversity already covered with current OTA test systems and procedure?Support option 1 (yes)Issue 1-3-2: Test methodology/configuration for multi antenna receiversSupport proposal 1 and 3. Same understanding as MTK and Samsung. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

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

### CRs/TPs

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

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

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

## Discussion on 2nd round (if applicable)

# Topic #2: Test time reduction

 *The following aspects for test time reduction will be discussed in this section.*

* *Reduce EN-DC combinations*
* *Reduce SA test time*
* *Other techniques to reduce the FR1 OTA test time*

*Only one related contribution R4-2114026 is submitted, which combined with SA TRP TRS methodology proposals. In this meeting, the contribution will be treated in thread 332 FR1\_TRP\_TRS\_Part1. From moderator’s perspective, it is suggested that proposals on test time reduction should be submitted in dedicated contributions in the following meetings.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2114026 | Huawei | **Proposal 3**: Multiple probe approach could be considered for measurement time reduction. |

## Open issues summary

### Sub-topic 2-1

**Issue 2-1: TBA**

* Proposals
	+ Option 1: TBA
	+ Option 2: TBA
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

**Sub topic 2-1**

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

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

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

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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

# Recommendations for Tdocs

## 1st round

**New tdocs**

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

**Existing tdocs**

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

Notes:

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

## 2nd round

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

Notes:

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

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
| MediaTek Inc. | Ting-Wei Kang | ting-wei.kang@mediatek.com |
| Rohde & Schwarz | Jose M. Fortes Lopez | Jose.Fortes@rohde-schwarz.com |
| Qualcomm | Bin Han | binhan@qti.qualcomm.com |
| Samsung | Bozhi Li | bozhi.li@samsung.com |
| Huawei | Hui Lin | Linhui20@huawei.com |

Note:

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