**3GPP TSG-RAN WG4 Meeting # 101-bis-e R4-2202956**

**Electronic Meeting, 17th – 25th Jan., 2022**

**Agenda item:** 6.2.2.3, 6.2.2.4

**Source:** Moderator (OPPO)

**Title:** Email discussion summary for [101-bis-e] [326] FR1\_TRP\_TRS\_Part2

**Document for:** Information

# Introduction

*Contributions submitted to AI 6.2.2.3 UE with multiple antennas test methodology and AI 6.2.2.4 Test time reduction of FR1 TRP TRS WI are captured in this email 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*
* *Transmit Antenna Switch*
* *Multi Antenna Receivers*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2200786 | Qualcomm Incorporated | **Proposal 1:** To define a new figure of metric for the UE radiated performance with TAS ON. The requirement similar to EIRP spherical covaege could be an example.  **Proposal 2:** RAN4 to study the corresponding test methodology. The test solution should resue the current test ecosystem as much as possible. |
| R4-2201284 | OPPO | **Proposal:** consider the influenced factors with the recommended priorities in the below table.   |  |  |  |  | | --- | --- | --- | --- | | **Factor ID** | **Potential Influence factors** | **Priority** | **Note** | | Factor 1 | Downlink Rx signal | High | High priority. Further study is needed to refine the procedure of test method to make the UE worked under effective Tx antenna switch state. | | Factor 2 | Near-body/object sensor | Low | Low priority. | | Factor 3 | USIM card setting | Low | Low priority. PLMN should be checked to ensure Tx antenna switch function worked in correct status. | | Factor 4 | Base station signalling | TBD | The mechanism of base station signalling impact on Tx antenna switch need to be further clarified and discussed. | | Factor 5 | Particular optimization algorithms | TBD |  | | Factor 6 | Efficacy of the TAS ON methodology (i.e. ability to rank devices based on lab test to be correlated to ranking based on field performance) | NA | The efficacy of the TAS ON methodology is the same as that of TRP TRS methodology. | |
| R4-2201286 | OPPO | **Proposal:** discuss the test methodology based on the above two test methods as a start point. |
| R4-2201285 | OPPO | TP to TR 38.834 on multi antenna |

## Open issues summary

### Sub-topic 1-1: Figure of Metric for the UE radiated performance with TAS ON

* Proposal 1: To define a new figure of metric for the UE radiated performance with TAS ON. The requirement similar to EIRP spherical coverage could be an example.
* Proposal 2: RAN4 to study the corresponding test methodology. The test solution should resue the current test ecosystem as much as possible.
* Recommended WF
  + TBA

### Sub-topic 1-2: Priorities of the influenced factors on TAS ON

* Proposal: consider the influenced factors with the recommended priorities in the below table.

|  |  |  |  |
| --- | --- | --- | --- |
| **Factor ID** | **Potential Influence factors** | **Priority** | **Note** |
| Factor 1 | Downlink Rx signal | High | High priority. Further study is needed to refine the procedure of test method to make the UE worked under effective Tx antenna switch state. |
| Factor 2 | Near-body/object sensor | Low | Low priority. |
| Factor 3 | USIM card setting | Low | Low priority. PLMN should be checked to ensure Tx antenna switch function worked in correct status. |
| Factor 4 | Base station signalling | TBD | The mechanism of base station signalling impact on Tx antenna switch need to be further clarified and discussed. |
| Factor 5 | Particular optimization algorithms | TBD |  |
| Factor 6 | Efficacy of the TAS ON methodology (i.e. ability to rank devices based on lab test to be correlated to ranking based on field performance) | NA | The efficacy of the TAS ON methodology is the same as that of TRP TRS methodology. |

### Sub-topic 1-3: Test methodology for UE with Tx Diversity

* Proposal: discuss the test methodology based on the two proposed test methods as a start point.

## Companies views’ collection for 1st round

### Open issues

**Sub-topic 1-1: Figure of Metric for the UE radiated performance with TAS ON**

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| --- | --- |
| **Company** | **Comments** |
| R&S | We don’t think a new metric is required since the proposed method for TAS ON would effectively measure the transmit radiated performance (i.e. TRP) while the UE adapts environment (e.g. DL direction, user proximity, etc.) in the same way it would be in the field.  In our understanding, this is very similar to the receive radiated performance (i.e. TRS) measured with all receivers active, and thus combining the radiated performance of all antennas at the same time instead of measuring each antenna/receiver at a time. |
| MediaTek | About proposal1:  We understand Qualcomm’s intention on introduce kind of “EIRP spherical coverage” to reflect TAS ON behavior. However, while LTE/FR1 OTA performance much like TRP based because of use case and UE architecture, currently, we still prefer to seek other way to reflect TAS ON performance.  About proposal2:  We are fine for the conceptual proposal. |
| Qualcomm | For proposal 1:  We would like to clarify our point is the metric of TRP should be based on the TAS OFF. We are open to discuss the new metric for TAS ON. EIRP spherical coverage is an example. Note that it is true TRP is the typical metric for FR1 but EIRP spherical coverage with a high target percentage like top 80% can help to verify the TAS ON performance. |
| Apple | If Factor 6 is equated with "same as that of TRP TRS methodology," then we don't see any distinction between the proposed TAS ON methodology and the baseline TRP TRS methodology we have with TAS OFF. We agree with R&S and also suggest that this TAS ON methodology is not needed. |
| OPPO | We echo R&S’s view. The metric of TRP can be used for evaluating UE transmit performance with TAS ON. We did not define new metrics for receiving performance with all receivers active either.  We also open for further discussion on other metrics to reflect TAS ON performance. |
| Xiaomi | Suggest not to have a new figure of merit. Using the same FoM can clearly reflect the benefit of TAS ON which directly compared to single antenna case. |
| Samsung | We understand the proposal to introduce new metric because the TRP with TAS on is different from conventional understanding. However this issue is about terminology rather than performance metric.  On the other hand, since there is already TAS OFF test, after introducing TAS on method, UE need to test both? or TAS on method is just for reference? |
| vivo | Prefer not to define a new FoM. |

**Sub-topic 1-2: Priorities of the influenced factors on TAS ON**

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| --- | --- |
| **Company** | **Comments** |
| R&S | We agree with the analysis and prioritization in R4-2201284.  One other comment to “Factor 1: Downlink Rx signal” is that we have already mentioned such adaptation of the procedure to ensure the switching state is stable before performing the power measurement by introducing a dwell or wait time between the change in DL direction and the power measurement. Similar approach is already implemented in FR2 testing with the so called BEAM\_SELECT\_WAIT\_TIME. |
| MediaTek | We have no special concern on this proposal, and think “Factor 1: Downlink Rx signal” is important. About R&S’s proposal on “dwell or wait time between the change in DL direction and the power measurement”, it sounds make sense for us. |
| OPPO | As proponent, we support the proposal.  Regarding Apple’s comment on this subtopic is shown in subtopic of 1-1, we make response to Apple here:  We believe that there is misunderstanding on our proposal. “the same as that of TRP TRS methodology” does not express the meaning that the methodology for TAS ON is the same as methodology for TAS OFF. It means, from the whole sentence, TAS ON methodology has the same efficacy with TAS OFF methodology. We have illustrated our observation in the contribution R4-2201284, that “we find out that the discussed methodology for TAS ON is based on current TRP TRS methodology with the same way to calculate TRP and TRS, and further specifications on test environment and procedure requirement and implementation.”  Additionally, I don’t think R&S’s comments express that TAS ON methodology is not needed. |
| Samsung | Agree with OPPO that method for TxD is different from that of TAS  Besides the wait time, how to configure the DL power to trigger antenna switch is also need to consider. |

**Sub-topic 1-3: Test methodology for UE with Tx Diversity**

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| **Company** | **Comments** |
| R&S | Test method A and B are actually what has been proposed as TAS OFF and TAS ON method respectively, and the remark about the test time is very interesting since the TAS ON method will effectively reduce the test time.  Regarding the comparison to the conducted power results, the remarks are not completely correct.  - TAS OFF / Method A performs the measurement per antenna, which is similar to the conducted testing, but the radiated power measurements (or the TRP) are not sum up into a single value, but the highest TRP is typically take to compare with the requirements.  - TAS ON / Method B would be actually closer to the conducted results since the individual EIRP measurements at each point is the sum of the radiated power for all active antenna (in case there is more than one antenna transmitting). |
| MediaTek | We understand the “concept” of Method A & B.  Before we have confidence on what would be happened by Method B, maybe Method A concept can be the baseline, kike how we treat TAS OFF/ON discussion. Of course, details Method A & B shall be further discussed. |
| Qualcomm | Need further discussion. For method B, it is possible that the TRP is varying due to the phase changing from two Tx antennas. |
| Apple | For UEs employing Tx diversity, we should consider that in the field the radiated power received by the base station is a function of the UE's total EIRP from both Tx antennas, which depends on the phase relationship between the two UE Tx antennas. This phenomenon has been observed in prior TxD discussions in the RAN4 RF session. We think that the TxD TRP metric can represent an average radiated performance of the device over all angles of departure. In our understanding, only Method B can quantify this, since Method A removes the effect of phase between the UE Tx antennas by measuring TRP per antenna. Furthermore, by summing TRP in power domain, Method A assumes that the UE Tx antennas have 0 degree phase difference in all directions of radiation, which is not possible for practical devices implementing transparent tx diversity, in our understanding. |
| OPPO | Both of the methods are on the table for further discussion and improvement. We slightly prefer method B which is normal UE work mode. The phase difference changing between two Tx chain needs to be further studied. |
| Xiaomi | We agree that method B is more realistic. However, as pointed out by QC and Apple, we cannot avoid the phase difference of the two antennas. If we can keep the phase difference unchanged, then method B seems OK. However, we might need further analysis of the phase consistency of TxD. |
| Samsung | As long as the radiation pattern is not varying with time, test method B is more preferred. |
| vivo | More discussion is needed. The core requirement of TxD in main session is still under discussion, impacts should be considered. |

### 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.*

|  |  |
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| **CR/TP number** | **Comments collection** |
| R4-2201285 | vivo: first, suggest to update the title of E.2 as “Test methodology and configurations for UE with Tx antenna switch On”. Second, the test method and configuration for TRS with multi-antenna is described in the main clauses, the “E.3 Test methodology and configurations for UE with multi antenna receivers” should be removed to avoid misunderstanding. |
| 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.*

|  |  |
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|  | **Status summary** |
| **Sub-topic 1-1: Figure of Metric for the UE radiated performance with TAS ON** | *7 companies commented on this topic. The majority (5 companies) prefers not to introduce new Figure of Metric for TAS ON UEs.*  *Tentative agreements:*   * *RAN4 do not define new Figure of Metric for the UE transmit radiated performance with TAS ON.*   *Recommendations for 2nd round:*   * Reflect the agreement in the WF. |
| **Sub-topic 1-2: Priorities of the influenced factors on TAS ON** | *5 companies commented on this topic. 3 companies agree with the proposal, especially high priority for “Factor 1: Downlink Rx signal”.*  *As further discussion, One company proposes the procedure to ensure the switching state stable by introducing a dwell or wait time between the change in DL direction and the power measurement. Beside the stable state of the UE, one company points out that the proper DL power to trigger antenna switch need to be considered.*  *Tentative agreements:*   * *Update the table of the influenced factors with priority as below.*  |  |  |  | | --- | --- | --- | | **Factor ID** | **Potential Influence factors** | **Priority** | | Factor 1 | Downlink Rx signal | High | | Factor 2 | Near-body/object sensor | Low | | Factor 3 | USIM card setting | Low | | Factor 4 | Base station signalling | TBD | | Factor 5 | Particular optimization algorithms | TBD | | Factor 6 | Efficacy of the TAS ON methodology (i.e. ability to rank devices based on lab test to be correlated to ranking based on field performance) | NA |  * *A dwell or wait time between the change in DL direction and the power measurement can be introduced to ensure the switching state stable in the measurement procedure.*   *Recommendations for 2nd round:*   * Reflect the agreement in the WF. |
| **Sub-topic 1-3: Test methodology for UE with Tx Diversity** | *8 companies commented on this topic. 5 companies think that the methods for TxD need further discussion. One company supports Method A to be the baseline before having enough confidence on Method B, while 4 companies prefer Method B together with concerns on phase difference and radiation pattern changing for Method B.*  *Tentative agreements:*   * *Further discussion the test method for TxD UEs with Method A and Method B as a start point.* * *Phase difference changing in TxD is FFS.*   *Recommendations for 2nd round:*   * Reflect the agreement in the WF. |

### 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** |
| R4-2201285 | *revised the TP according to comment* |

## 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*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2200980 | vivo | **Proposal 1:** Adopt Single Point Offset test method as one of the alternative test methodologies to reduce TRP TRS OTA test time. |

## Open issues summary

### Sub-topic 2-1 Signle Point Offset method to reduce TRP TRS OTA test time

* Proposal: Adopt Single Point Offset test method as one of the alternative test methodologies to reduce TRP TRS OTA test time.
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

**Sub topic 2-1 Single Point Offset method to reduce TRP TRS OTA test time**

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| --- | --- |
| **Company** | **Comments** |
| R&S | We agree with the proposal, although another side condition need to be considered for Single Point Offset method.  As highlighted in R4-2200980, this method is widely used for OTA testing under the condition that different protocols/mode use equivalent channels for testing, but it also has to be ensured that the same antenna state is used in both modes. Modern UEs implement different sorts of antenna tuning in order to accommodate the challenging operation among different bands like required for Carrier Aggregation and, most recently, Dual Carrier operations. In such implementations, there might be are antenna tuning states that affect the radiation pattern, and thus the corresponding TRP / TRS measurements. |
| AT&T | Until the set of test conditions are clear for TRP and TRS OTA, it is not necessary to consider alternative test methods. Alternative test methods are valuable when many aspects of the UE antenna state are known when testing multiple modes of operation. As we know that we are only testing NR and agreeing to guidelines to limit testing to a single EN-DC combination, it is not clear that single-point offset testing is needed. |
| OPPO | The proposal gives a good point to consider test time reduction for TRP TRS. As R&S point out, the assumption is that antenna state for both modes is not changed. It means that Single Point Offset method can be used necessarily based on UE’s declaration. |
| vivo | We support the proposal. |

### CRs/TPs comments collection

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

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

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub topic 2-1 Single Point Offset method to reduce TRP TRS OTA test time** | *4 companies commented on this topic. No consensus on the topic. One company supports the proposal, one company thinks it is not necessary to introduce alternative test methods currently. Two companies think that there is side condition needed to make sure the antenna state for both modes is not changed.*  *Recommendations for 2nd round:*   * The single point offset method can be further discussed. |

### 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 FR1 TRP TRS for UE with multi-antenna | OPPO |  |
|  |  |  |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-2200786 | Discussion on TAS ON test methodology | Qualcomm Incorporated | Noted |  |
| R4-2201284 | On the influence factors of Tx antenna switch | OPPO | Noted |  |
| R4-2201286 | Consideration on Tx Diversity | OPPO | Noted |  |
| R4-2201285 | TP to TR 38.834 on multi antenna | OPPO | Revised |  |
| R4-2200980 | Discussion on alternative test method for TRP TRS testing time reduction | vivo | Noted |  |

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

|  |  |  |
| --- | --- | --- |
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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)