**3GPP TSG-RAN WG4 Meeting #109 R4-2318136**

**Chicago, USA, Nov. 2023**

**Agenda item:** 8.7.5

**Source:** Moderator (Qualcomm)

**Title:** Topic summary for [109][130] FR2\_multiRx\_UERF\_part1

**Document for:** Information

# Introduction

Agenda items : 8.7.1, 8.7.1.x.

UE RF requirements discussion is treated in topic #1. pCRs and dCRs are treated in topic #2

# Topic #1: UE RF requirements

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318361 | Sony, Ericsson | Observation 1: The core requirement shall ensure a common minimum performance that all UEs must meet and distinguish good UE implementations from bad ones. Therefore, setting a uniform test environment for all UEs is critical.  Observation 2: From the perspective of ensuring the UE minimum performance in real life, 90° offset can be seen as a mean value for all real-life AoA offsets (0°-180°), and defining the minimum requirement at 90° offset can also somewhat represent the average performance in real life.  Observation 3: Using 90° AoA offset to set a core requirement can also ensure the RF requirement is UE implementation agnostic and does not preclude any UE implementations.  Observation 4: If the AoA offset is declared by UE, only the performance under a favorable propagation condition can be tested, instead of under a representative propagation scenario as defined in the specification. That UEs can only meet a requirement with a single declared AoA suggests that the feature may not be feasible for handhelds to operate in the field properly.  Observation 5: If the AoA offset is declared by UE, the core requirements will be tightly connected to specific UE implementation, which is not UE implementation agnostic anymore.  Observation 6: Benchmarking is challenging without a specified offset, then the requirement at the declared AoA offset would have to be very tight.  Observation 7: The "or combination" hides the failed test results and alters the trend of results, implying that the results with such a data combination method do not provide sufficient physical meaning.  Observation 8: A single-point calibration at the spherical coverage point may sufficiently represent the worst-case scenario in terms of UE performance since the top part of the CDF curve does not substantially impact the percentage of "go" or "no-go."  Observation 9: The calibration at the REFSENS point may better represent the UE performance in real life as some margin in spherical coverage can be obtained.  Observation 10: The impact of polarization imbalance affects the shape of the radiation pattern after the calibration, which does not necessarily lead to a poorer performance of spatial coverage.  Observation 11: Since very conservative UE performance has been assumed by calibrating the simulation model to the 50% EIS, it is sufficient to cover all the possible RF impairment, and no additional impairment is needed to add on top of the calibration.  Observation 12: When considering a more realistic UE performance by calibrating the simulation model towards the REFSENS point, a significantly better coverage percentage can be observed than the results obtained by calibrating the simulation model with 50% EIS.  Observation 13: based on the aggreed condition Min (same, adjacent, opposite), the core requiremetn at 90° AoA offset can defined as 12.5%.  Proposal 1: The AoA offsets should be defined in the specification, and 90° can be used.  Proposal 2: If RAN4 eventually agrees to define the AoA offset based on the UE declaration, it is critical that RAN4 strive to define the value with a high bar without further diluting the core requirement since the UE performance will be only tested under a favorable propagation condition.  Proposal 3: It is proposed not to perform any "logic combination" on the data from +offset and -offset but to treat them as two test points.  Proposal 4: The calibration scheme can ensure sufficient margin, and there is no need to explicitly include additional RF impairment on top of the calibration scheme.  Proposal 5: Defining the core requirement as 12.5% for 90° AoA offset. |
| R4-2318492 | Nokia, Nokia Shanghai Bell | Proposal 1: We suggest using Option 1 which based on UE declared AoA offsets and the corresponding reference requirements for each AoA offset.  Proposal 2: Use arithmetic mean combining approach to determine the regional probability.  Proposal 3: RAN4 to agree that AoA offset to be declared by the UE.  Proposal 4: RAN4 to define the multi-Rx requirement as shown in Table 1 below. The values F30, F60, F90, F120, F150 need to be agreed based on companies’ simulation results.   |  |  | | --- | --- | | AoA Separation (degrees) | Probability (%) | | 30 | F30 | | 60 | F60 | | 90 | F90 | | 120 | F120 | | 150 | F150 | |
| R4-2318686 | Apple | Proposal 1: The simulated starting UE orientations need to be from the 9 starting UE orientation options per annex J of TS38.101-2.  Proposal 2: Either the baseline calibration method or the alternative method to use in the simulation is left to companies’ discretion.  Proposal 3: It is proposed to not consider results of calibrating against only the legacy receiver sensitivity requirement when defining the final requirement.  Proposal 4: The two methods will lead to different UE requirements for the same UE implementation while having no impact on UE real performance.  Proposal 5: The option of specifying requirements for AoA offsets including 30/60/90/120/150 is better in terms of 1) Providing better requirement value 2) Allowing maximum UE implementation flexibility.  Proposal 6: For small AoA offsets (i.e., 30 and 60 degrees), consider 3dB SINR drop to account for lower spatial rejection between AoA1 and AoA2 for specifying requirement. |
| R4-2318771 | Qualcomm Incorporated | Observation 1: A real UE has margin over the UE used in simulation because the RAN4 SINR estimation method detailed in WF R4-2314668 is more conservative compared to the SINR in a true LMMSE implementation.  Observation 2: A real UE has margin over the UE used in simulation because of generally superior gain drop with competitive 4x1 modules.  Observation 3: A real UE has margin over the UE used in simulation because of generally superior REFSENS compared to requirement.  Proposal 1: Average across simulated UE RF performance projections submitted to RAN4#108Bis to derive the requirement.  Proposal 2: RAN4 to consider allowing a fourth option for each alignment option. The fourth option involves rotation of orientation2, option 2 or orientation 1 about the normal to the largest face (screen) by 180 degrees |
| R4-2318812 | LG Electronics | Proposal 1: Consider the simulation results in Table 2.1 and Table 2.2 for UE RF requirement. Table 2.1: Pass ratio (%) with ‘arithmetic mean’   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | 30o | 60o | 90o | 120o | 150o | 180o | | panels facing opposite directions | 0.0 | 1.7 | 9.8 | 19.2 | 20.0 | 23.0 | | panels in adjacent sides | 4.1 | 8.1 | 12.5 | 12.3 | 14.1 | 14.3 | | panels in same side | 9.4 | 6.5 | 10.7 | 3.3 | 0.0 | 0.0 |   Table 2.2: Pass ratio with ‘OR’   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | 30o | 60o | 90o | 120o | 150o | 180o | | panels facing opposite directions | 0.0 | 3.3 | 19.6 | 38.4 | 39.9 | 46.3 | | panels in adjacent sides | 8.2 | 16.3 | 24.9 | 24.5 | 28.2 | 28.6 | | panels in same side | 18.8 | 13.0 | 21.5 | 6.6 | 0.0 | 0.0 |  Proposal 2: Consider ’OR combining’ for UE RF requirement. |
| R4-2318983 | vivo | Observation 1: When the orientation of the z-axis is changed, the UE performance will be different.  Observation 2: When the initial UE orientation changed with z-axis rotation, the performance of UE will also be different, except when the rotation angle is 90°,180°.  Observation 3: If the rotation angle of z-axis is taken into account, UE initial orientation will be infinite.  Proposal 1: The RF requirement for multi-Rx is only derived from current 9 initial orientation.  Proposal 2: Use declared AoA offset with arithmetic mean combining as the final solution for requirement construction. |
| R4-2319267 | Samsung | Observation 1: further simulation alignment is needed before deriving requirement values.  Observation 2: simulation data larger than or equal to 50% at 150deg for OR combining is questionable.  Observation 3: simulation data larger than or equal to 40% at 150deg for arithmetic mean combining is questionable.  Proposal 1: If there are simulation results without involving sufficient impairment, additional margin should be considered in final spec derivation to account for that  Observation 4: 2AoA spherical coverage based on go-no-go metric is more sensitive to H&V polarization imbalance than legacy average EIS based metric, and simulation shows up to 4~9% degradation.  Observation 5: simulation results varies among different implementations for same panel placement, especially performance difference occurs between metal housing and plastic housing, even calibration is already performed.  Proposal 2: if different implementations are involved (e.g. metal and plastic), the worst performance data should be selected as final simulation results  Observation 6: if the requirement is defined for fixed 1 AoA offset, AoA offset 30, 60, 120, 150 and 180 are not feasible, and for 90deg the requirement would be likely around 9% for OR combining or 5% for arithmetic mean combining  Proposal 3: define a requirement for each candidate AoA offset rather than for just 1 fixed AoA offset.  Proposal 4: stick to previous agreement, i.e. to adopt OR combining.  Observation 7: CDF percentile based approach is common practice to derive requirement in TRP TRS and MIMO OTA work items  Observation 8: Even the average approach was adopted in some cases, addition of implementation margin and negotiation on top of averaged value are also common practice in RAN4  Proposal 5: as starting point, if data processing is per-implementation (each contribution providing more than one set of simulation results), then CDF percentile based approach should be used; if data processing is per-contribution (each contribution providing only single set of simulation results for worst case), then average approach can be adopted.  Observation 9: the simulation results are similar among narrow angles [30, 90], and also similar among wide angles [120, 150].  Proposal 6: the requirement spec value can be selected from the two alternatives:   * Alt 1: one spec value for narrow angles [30, 90] and another spec value for wide angles * Alt 2: different spec value for each angle   Proposal 7: introduce the definition of new suffix K in Table 4.3-1 of TS 38.101-2 as following:   * Table 4.3-1: Definition of suffixes  |  |  | | --- | --- | | Clause suffix | Variant | | None | Single Carrier | | A | Carrier Aggregation (CA) | | B | Dual-Connectivity (DC) | | C | Supplement Uplink (SUL) | | D | UL MIMO | | K | Multiple AoA/AoD | | NOTE: Suffix D in this specification represents either polarized UL MIMO or spatial UL MIMO. RF requirements are same. If UE supports both kinds of UL MIMO, then RF requirements only need to be verified under either polarized or spatial UL MIMO. | | |
| R4-2319565 | ZTE Corporation | Proposal 1: Arithmetic mean should be adopted as combining method for the test result of AoA+ pair and AoA- pair.  Observation 1: The simulation result of the best coverage percentage among all the UE implementation for every AoA offset should be adopted as the UE RF requirement.  Observation 2: For small AoA offset, additional margin can be introduced to the RF requirement.  Proposal 2: Define RF requirement for each candidate AoA offset and each AoA offset corresponds to one requirement value of coverage percentage. |
| R4-2320078 | Huawei, HiSilicon | Proposal 1: Adopt the “OR combining” for the 2 AoA simultaneous reception spherical coverage requirement’s metric computation.  Proposal 2: AoA offset would be declared by UE instead of being specified in standard for Multi-Rx core requirements’ verification. |
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## Open issues summary

*(continued…)*

### Requirement proposal

There is lack of consensus on combining method (‘OR vs arithmetic mean’) and AoA offset (‘specified vs. UE declared’), and furthermore no significant movement in company views on these parameters compared to previous meetings. The discussions on the individual parameters have previously resulted in deadlock.

On the data set:

1. Updated data from LGE, Apple, Nokia included
2. One company argues to retain only the worst performer if a company has provided multiple, as condition to agree to averaging (R4-2319267). In light of the agreed reference implementation types in R4-2317593, the recommendation is modified to retain only the worst performer *for each UE reference implementation*. This principle is used to trim the data set (In one case, offline discussion with a company helped choose their variants to retain in the averaging pool.)
3. Some companies point out that the RAN4 calibration method bakes into the requirement large margins for the agreed 2 4x1-module agreement, and the requirement so derived will already be inclusive.

The proposal now is to try the ’package’ approach based on the UE reference implementation types by AoA offset agreed in WF R4-2317593. The options are created based on averaging across new data set (see above) in a way that spreads out the pain points.

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| **Proposed WF: RAN4 to choose from the 2 options below to complete the WI:**  **Option 1:** UE vendor declared offset, arithmethic mean combining, requirement in table below. (see ’summary\_UEdeclaredAoAoffset’, from attached worksheet)   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | AoA offset (degrees) => | 30 | 60 | 90 | 120 | 150 | | Old Method Requirement (%) | 18.8 | 16.1 | 16.6 | 22.4 | 29.7 | | Requirement by limiting companies to one proposal per implementation (%) | 19.2 | 17.0 | 16.9 | 24.0 | 31.2 |   **Option 2:** AoA offset specified as 90⁰, OR combining, requirement is 22.3 %. (see ’summary\_specifiedAoAoffset’, from attached worksheet)   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | AoA offset (degrees) => | 30 | 60 | 90 | 120 | 150 | | Old Method Requirement (%) | 4.6 | 9.2 | 22.3 | 19.9 | 14.6 | | Requirement by limiting companies to one proposal per implementation (%) | 3.6 | 9.0 | 23.9 | 21.4 | 15.1 | |

***Discussion:***

Samsung: regarding the proposals, for combining method, the most promising is the UE declare + or combining. There is no reason to rule it out. Secondly about the data processing, if all companies’ simulations are based on the worst case, it is fine to take the average. It is not proper to do averaging since not all the companies are based on worst case. We prefer to use CDF approach. Thirdly, about the angle, we have discussed that we usually consider 30, 60 and 90 we propose to consider the 90dB with margin also. We prefer to move one set of simulation results.

Huawei: we can consider CDF approach.

OPPO: our preference is the UE declaration + OR combining. Regarding CDF approach, we cannot get the enough data to process CDF curve.

Vivo: first for the package, the network vendor and UE vendors have different request. We do not want to add one more option. The current two options would be enough. For the data processing, some company’ data could be taken out. For CDF, it is not usually used but we are fine to use it as one of options and compare the results from CDF and ones from average.

Sony: Regarding data combination, why should we adopt OR combining? It has no physical meaning. We should go with average approach. For CDF, we have not enough data. After performing calibration, it is hard to conclude which one is the worst case. We should count the Sony and Ericsson as two sources.

Ericsson: on the issue discussed for AoA, we propose to use fixed offset as baseline to allow the bench mark to allow different implementations. On top of that we can consider. We do not understand to calibrate according to other requirements. We should avoid the difficulty of all the combinations. In the end, we should verify UE works in the real field.

Apple: when we have disagreement, it is better for us to have step back. We seek to achieve the agreements in this meeting. Firstly we have this OR mean combining approach. For each combining approach the requirements would be different. Secondly, when looking at the results, some results deviate significantly from others. We could remove the best and worst results. In terms to counting two or one company, I worry about that it will set the precedence in RAN4 to account the joint companies for the simulation results. Regarding the additional margins, 30 and 60 are proper. We are open to 90.

Sony: Support Ericsson. And support comments from Apple. Counting Sony and Ericsson as two sources, we have precedence. But we are OK to count the result as one and OK to remove the best and worst ones to achieve the numbers.

Nokia: OK with Option 1.

**Agreement:**

* Use Option 1 as the baseline
  + FFS on the values
    - CDF approach can be considered for deriving the requirements
  + The values should be part of package for agreement on Option 1.

### Additional margin for 30⁰ and 60⁰ AoA offsets

‘For small AoA offset, additional margin can be introduced to the RF requirement.’

**Proposal : For small AoA offsets (i.e., 30 and 60 degrees), consider 3dB SINR drop to account for lower spatial rejection between AoA1 and AoA2 for specifying requirement.**

*Discussion:*

Apple: my approach is slightly different. It does not mean to increase downlink power. We just change the criterion and use the same exercise. For 30 degree the difference is 3.5% points by using 3dB. We are OK to further reduce.

Moderator: we need discuss more details in the ad hoc.

Samsung: We support this proposal and also propose to consider it for 90.

# Topic #2: pCRs and dCRs

*CR wording discussion consolidated here.*

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318501 | vivo Japan KK | TR 38.751v1.2.0 for UE RF requirement for NR FR2 multi-Rx chain DL reception |
| R4-2318685 | Apple | On associated UE capability for RF requirement |
| R4-2318687 | Apple | TP on NTC vs. ETC for TR 38.751 |
| R4-2318688 | Apple | TP on Annex <A>:Simulation results for TR 38.751 |
| R4-2318770 | Qualcomm Incorporated | Feature CR for FR2 multi-Rx |
| R4-2318984 | vivo | TP to 38.751 on further evaluation of gain difference between V-pol and H-pol |
| R4-2318985 | vivo | TP to 38.751 on RF requirement construction |

## Open issues summary

### Feature CR

*Sub-topic description: See R4-2318770:*

* Recommended WF: Revise to capture any agreements and treat later in the meeting.

Discussion:

### UERF requirements and requiring support of 4L in DL

*From R4-2318685:*

* Currently the RF requirement is verified assuming the UE supports one layer for each AoA. So UE support of 4L DL MIMO is not verified.
* In real field, even when the UE supports 4L DL MIMO, the likelihood of UE being configured with 4L DL MIMO depends on a number of factors including AoA offset, channel conditions, etc. There is no guarantee that the UE can always be configured with 4L DL MIMO.
* On the other hand, if a UE can support two AoAs and only 1L DL MIMO in each AoA, there seems to be no reason to discourage such UE from supporting two AoAs because some benefits such as increased robustness against beam blocking can be attained. To this point, it is worth mentioning that in the objective of the WID, it is stated “• Introduce necessary requirement(s) for enhanced FR2-1 UEs with simultaneous DL reception with two different QCL TypeD RSs on single component carrier with up to 4 layer DL MIMO”
* If a UE supports 4L DL MIMO, even though the capability is not mandated for meeting the RF requirement, can and should be verified through demodulation tests.

*Proposal:*

**Proposal 1: Remove the “4L per CC in DL” capability in the feature CR for UE meeting the RF requirement. If the UE supports 4 layer DL MIMO, its performance should be verified through demodulation tests.**

*Discussion:*

Samsung: we can have further discussions.

### R4-2318685 – CR wording change

There could be UEs supporting both single DCI and multi-DCI, so a wording change of “either of” to “at least one of” is preferred.

**Proposal: Change wording in CR from “either of” to “at least one of”, in area excerpted below:**

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Description automatically generated

*WF:* agree to proposal

*Discussion:*

### R4-2318687: TP on NTC vs. ETC for TR 38.751

*Gist of proposal:* *(NTC verification). Similar TP was submitted in previous meeting.*

Recommended WF: discuss and refine offline. See subfolder under [130]

Discussion:

### R4-2318688: TP on Annex <A>:Simulation results for TR 38.751

*Gist of proposal:* *(extensive changes).*

*Recommended WF:* discuss and refine offline, pending availability of document in word format. See subfolder under [130]

*Discussion:*

### R4-2318984: TP to 38.751 on further evaluation of gain difference between V-pol and H-pol

*Gist of proposal:* *Capture WF contents and technical analysis presented on the subject. Similar TP was submitted in previous meeting.*

* Recommended WF: discuss and refine offline. See subfolder under [130]

*Discussion:*

### R4-2318985: TP to 38.751 on RF requirement construction

*Gist of proposal:* *Capture proposals from 108Bis.*

Recommended WF: discuss and refine offline. See subfolder under [130]

Discussion: