**3GPP TSG-RAN WG4 Meeting # 99-e R4-2108706**

**Electronic Meeting, 19th – 27th May 2021**

**Agenda item:** 13.2

**Source:** Moderator (Ericsson)

**Title:** Email discussion summary for [99-e][337] LS\_reply\_ITU-R

**Document for:** Information

# Introduction

This e-mail thread covers two ongoing LS exchanges with different ITU-R WPs:

1. At last RAN plenary RAN4 was tasked (RP-210789) to consider a test signal proposed by ITU-R WP 1C in R4-2100004.
2. At RAN4#98, antenna parameters were sent in LS to ITU-R WP 5D. In R4-2106354 additional information is provided to better reflect base stations deployed in networks. The intention is to send the information to ITU-R WP 5D.

This thread is split up into two corresponding topics:

1. Test signal
2. Antenna model extension

# Topic #1: Test signal

In R4-2100004, ITU-R WP 1C request RAN4 to consider the feasibility to introduce a test signal to facilitate in-field OTA testing of unwanted emission.

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2109392  R4-2111019 | Nokia, Nokia Shanghai Bell | Observation 1: Test signal does not guarantee accurate measurement of unwanted emissions in the field.  Observation 2: Test signal for emission measurement in the field may have impacts across 3GPP working groups, impact on network performance and network energy consumption  Observation 3: Multiple alternative options exist which could enable similar possible benefits as a dedicated test signal but without associated drawbacks  Observation 4: It is preferable not the specify a test signal  Proposal 1: Agree the draft LS provided in the Annex. |
| R4-2109873 | Ericsson | Observation 1-1: Experience related to measure TRP would be of great interest for in-field testing.  Observation 2-1: The proposed test signal breaks the idea to have a lean carrier.  Observation 2-2: Already available signals can be used to allocate resources in the frequency domain.  Observation 2-3: The test signal will potentially limit scheduling to generate multiple layers transmission.  Observation 3-1: Maximum configured base station output power can be generated by downloading dummy data.  Observation 3-2: This approach provides more flexibility in terms of measurement time required to measure unwanted emission TRP levels.  Some detailed issues regarding the proposed test signal have been identified together with some alternative approaches. At the end of the contribution a draft LS to ITU-R WP 1C is prepared for discussion. |
| R4-2110613 | ZTE Corporation | Observation 1: Both option 3 and option 4 are feasible in practice and have no impacts on other group.  Observation 2: In-filed OTA testing will introduce much larger testing uncertainty compared with OTA testing in controlled anechoic chamber; |
| R4-2110637 | Huawei, HiSilicon | Proposal 1: It is recommended that normal operation in peak traffic approach and provoking traffic approach are used for in-field TRP test. |

## Open issues summary

### Sub-topic 1-1

Sub-topic description: Collect more relevant technical information required to better understand the test signal concept to be able to analyze the RAN4 impact.

**Issue 1-1: RAN4 specific issues related to proposed test signal**

* Proposals
  + Option 1: Define a standardized test signal
  + Option 2: Use proprietary test signal
* Recommended WF
  + Collect background information together with RAN4 view on preferred solution to be captured in LS to ITU-R WP 1C.

### Sub-topic 1-2

Sub-topic description: In relation to the request from ITU-R WP 1C, some alternative solutions relevant for measuring unwanted emission have been proposed in RAN4. The intention with this sub-topic is to collect feedback and maybe even more alternative approaches.

**Issue 1-2: Alternative approaches not requiring dedicated test signal**

* Proposals
  + Option 1: Normal operation
  + Option 2: Normal operation and fixed measurement location
  + Option 3: Proprietary test configuration
  + Option 4: Provoking traffic
* Recommended WF
  + Collect information in a draft LS response to ITU-R WP 1C

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Sub topic 1-1: Its good to collect technical background information on what implications the proposed test signal would give. The test signal as it is proposed will have impact on other RAN groups.  Sub topic 1-2: We think option 4 is really promising. When data is scheduled, situations where are RE in frequency is allocated will occur. Therefore, we suggest to if there is no load in the network. The load can be created by a test UE.  ….  Others: An idea would be to merge information from Nokia LS with Ericsson LS into common LS. |
| Nokia | Sub topic 1-1: Prefer to use alternative approaches considering the issues involved with using dedicated test signal.  Sub topic 1-2: Prefer option 1, option 2, and option 4; option 3 make it difficult to compare measurements from different vendors.  ….  Others: Agree that Nokia LS and Ericsson LS would be merged. |
| Huawei | Sub topic 1-1: the dedicated test signal will have impact to other RAN working group, so we also prefer to use alternative approaches discussed in Sub topic 1-2.  Sub topic 1-2: we support Option 1, 2 and 4. Option 3 Vendor specific test configuration may result in diverse solutions to the same problem and make it difficult to compare measurements from different vendors. Hence it is not recommended. |
| ZTE | Sub topic 1-1: Option 1 is more preferred, for the option 2, it’s possible to be implemented;  Sub topic 1-2:  Fine with option 1, 2 and 4. However for the option 3, sometimes the proprietary test configuration e.g. specific traffic load would be requested by operators for compliance testing, then different BS vendors could have different implementation method to configure that. |

### 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** |
|  | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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|  | **Status summary** |
| **Sub-topic #1** | *Tentative agreements: Merge draft LS in R4-2109392 and R4-2109873*  *Candidate options: Work to collect technical information related to proposed test signal and alternative approaches in LS to ITU-R*  *Recommendations for 2nd round: Focus on LS drafting.* |

### 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.*

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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)

# Topic #2: Antenna model extension

At the meeting RAN4#98 antenna parameters was provided in LS to ITU-R WP 5D in R4-2103104. The antenna parameters do not reflect AAS base stations deployed in networks. Therefore, additional information has been provided in R4-2106354 with the intention to send an additional LS to ITU-R WP 5D with information more relevant for sharing studies.

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2107607 | Qualcomm | Observation 1: The extended sub-array antenna model is compatible with the defined RF requirements derived in RAN4 for FR2 deployments.  Observation 2: The extended sub-array antenna model leads to same radiated energy as the baseline model.  Observation 3: The extended sub-array antenna model is compatible with the defined RF requirements derived in RAN4 for FR1 deployments. |
| R4-2108900 | Spark NZ | Based on the above simulations, the following conclusions are made:  1. The elevation pattern of a URA with sub arrays will suffer from grating lobes.  2. On the other hand if the intention of the sub arrays is to increase array gain and reduce elevation beamwidth then an equivalent array (12x8) that is based on equal number of vertical antenna elements has a very close correspondence to the ( 4x8) URA made from sub arrays . This equivalent array does not suffer from grating lobes.  3. ITU R M 2101 at present does not account for an array that is made from sub arrays. No matter how trivial or substantial a modification is, to do so this recommendation will have to undergo modified the 5D process of modifying recommendations and if opened for modification there will be many unforeseen and unintended consequences. It is strongly advised that we do not proceed along this line.  4. We should instead adopt the equivalent model as per (2) above.  5. The terminology of sub arrays is misleading and confusing. Consider a MxN URA made from cross pol elements, this could also be two sub arrays one per polarization. Here the word sub array has a different meaning from the use of sub array as given in [1]. It is best to call the sub array in [1] as a logical element. |
| R4-2109872 | Ericsson, Nokia, Qualcomm | AAS base stations have evolved since the introduction of support for AAS in 3GPP specifications. Consequently, a model extension is considered to capture radiation pattern characteristics for different types of AAS base stations. The model extension adds an intermediate stage where vertical sub-arrays are modelled before the array factor applied.  The parameterized antenna model with the proposed extension together with the appropriate parameters provides a method for flexible modelling of different base stations including sub-array solutions.  At the end of this contribution a draft LS to ITU-R WP 5D and ECC PT1 is prepared to give additional information on antenna parameters for the frequency range 1710 to 4990 MHz and frequencies around 6 GHz. |
| R4-2110648 | Huawei, HiSilicon | Observation 1: For the sub-array with fixed tilt implementation, the model extension proposed in [2] can represent the antenna characteristics better.  Observation 2: For the sub-array with phase controller implementation, the existing single element model can be reused with some clarification since it can represent the antenna characteristics well. |

## Open issues summary

The current antenna model defined in TR 37.840 models only array antennas with single element configurations. Now when ITU-R WP 5D is evaluating measurement results from real base stations there is a need to update the antenna model to better reflect AAS base station deployed in networks.

### Sub-topic 2-1

Sub-topic description: An antenna model extension is proposed to support sub-array geometries.

**Issue 2-1: Antenna model extension**

* Proposals
  + Clarify unclear definitions in antenna model extension
  + Agree on antenna model extension to support sub-array geometries
* Recommended WF
  + Capture antenna model extension in LS to ITU-R WP 5D

### Sub-topic 2-2

Sub-topic description: For sharing studies in ITU-R WP 5D relevant antenna parameters are required. A relevant and representable parameter set for wide area base station using sub-arrays have been presented.

**Issue 2-2: Antenna parameter sets**

* Proposals
  + Agree on antenna parameters for Macro Rural, Macro Suburban and Macro Urban
* Recommended WF
  + Capture antenna parameter sets in LS to ITU-R WP 5D

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Sub topic 2-1: The proposed extension of the model adds vertical subarrays which are commonly used for wide area BS. It seems that we need to improve some definitions and terminology to avoid misunderstands. Let’s work on improvements to the draft LS to make the model description better.  Sub topic 2-2: Parameter sets for base station operation up to 4990 MHz have been presented in R4-2109872. Maybe we need to fine tune the parameters, which we can do during the drafting process. We need clarify how the previous communicated parameters shall be used for small base station types. We need also to find a solution on how to communicate parameters related to 6 GHz. A solution could be to state that RAN4 is working on parameters sets for 6 GHz, but they will be communicated later when RAN4 have decided on proper parameter sets.  ….  Others: At the end of this meeting we need to produce a LS to ITU-R for base stations below 4.990 GHz, to be able to also provide measurement results in ITU-R WP 5D in June. |
| Nokia | Sub topic 2-1: Support proposals and recommended WF  Sub topic 2-2: Support proposals and recommended WF  ….  Others: |
| Intel | Sub topic 2-1: We support the proposals and recommended WF by the moderator.  Sub topic 2-2: We support the proposals and recommended WF by the moderator. |
| Qualcomm | Sub topic 2-1: We support the proposals and recommended WF  Sub topic 2-2: We support the proposals and recommended WF |
| Huawei | Sub topic 2-1: for the proposed extension, we need to update the definition and its applicability. E.g. it applies for AAS sub-array antenna geometries with fixed sub-array down-tilt for frequency range 1710 to 4990 MHz. For other frequency ranges, M.2101 and associated parameters that have been sent to the 5D are still valid. Hence the text for 6GHz part should be removed.  Sub topic 2-2: As comment above, the proposed extension is only applicable to AAS below 5GHz. For 6GHz and other ranges we can clarify that M.2101 still applies. |
| ZTE | Sub topic 2-1:  The above formula is not correct, it should be    Where B could be 1, A could be 2 or 3 for vertical sub-array.  Sub topic 2-2: we need to address the sub-topic 2-1 firstly. |
| Ericsson | About the ZTE equations. It seems that the proposal from ZTE is to update the array factor formula to include the sub-array for both vertical and horizontal domain. Too keep the model extension simple it was previously decided to just have support for sub-arrays in the vertical domain. Also, the reason to add an intermediate stage between the element and array was to keep the model extension simple and small. The proposed change from ZTE results in a larger change to currently used models in TR 37.842 and M.2101, therefore we suggest keeping the set of equations proposed in draft LS. In the end the end results will be the same. |
| ZTE | To Ericsson, it’s fine for us to use the simpler antenna modelling proposed by Ericsson. In addition, the extended AAS model with sub-array can reflect the actual AAS used by 5G NR BS, so it should be included in LS to 5D. |

### 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.*

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| **CR/TP number** | **Comments collection** |
| R4-2109872 | Spark:  There seem to be many questions in the simulations provided:  Fig 2-3 : This is the vertical sub array patterns of multiple stacked elements, but the text says it is made up Guassian radiators. The vertical HPBW of a single element as given in Table 2-3 with values in Table 2-4 should be 60 or 65 degrees. But in Fig 2-3 the HPBW of a single element is 120 degrees?  The subarray should be as per row 3 of Table 2-3 where the element pattern is given in rows 1 and 2. It seems this is not the case in Fig 2-3  In Fig 2-2- left figure- the beam patterns for 3GPP parameter set ( black line) are symmetric around the main lobe but for cases A,B,C are not symmetric. They should be symmetric as there is nothing in the equation in the 4th row of Table 2-3 to result in an un symmetric pattern.  Regardless of the above the inter subarray distance is shown in Table 2-4. Take the case of case B, when the inter sub array distance is 2.1 lambda. This will result in grating lobes at angles given by  (d/lamda)= 1/(1 + mod ( sin (theta)))- see Van Trees ie 43 degrees either side of the main lobe. This is independent of per element pattern and is only determined by spacing. Likewise for other inter sub array distance Grating lobes typically have the same amplitude as the main lobe but it is hard to read the fig and determine what is a side lobe and what is a grating lobe  There are some errors in Table 2-4. What is written as dv should be dvsub?  M 2101 will need to be modified for the sub array extension. Once it is opened for modifications it is un chartered territory as others may bring other modifications! |
| Ericsson:  The values used for single element beamwidth is 90 degrees in Figure 2-3. Reading the scale carefully I get 90 degrees in the plot for the single element. Then the beam gets narrower for sub-arrays which is expected.  In Figure 2-2, the plots are not symmetrical due to sub-array pre-set down-tilt. If the pre-set down tilt is set to zero, the pattern will be symmetrical for the bore-sight direction.  The criteria for location of grating lobes can be found in any antenna textbooks. We didn’t see the need to put it here. Maybe we can add it in a note in the LS.  Regarding dv,sub in Table 2-4, it’s not an error. We decided to select new parameters for the sub-array to get as little impact on the antenna model as possible.  On M.2101, it for ITU-R to decide what to do. In RAN4 we eventually may need to capture the model extension in TR 37.842 and TR 38.921.  RAN4 have been tasked to provide input to ITU-R. Unfortunately, the previously communicated parameters for wide area base station didn’t reflect real implementations. With the extension to the model, the vertical radiation pattern can be modelled correctly. |
| Huawei: some text proposal for the draft LS to 5D is proposed in the annex of R4-2110648, which should be considered. |

## Summary for 1st round

### Open issues

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| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:* Send LS to ITU-R with information about antenna model extension  *Candidate options:* Improve quality of draft LS based on feedback.  *Recommendations for 2nd round:* Work on draft LS |

### 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** |
| Draft LS on feedback on LS from ITU-R WP 1C related to in-field unwanted emission testing | Ericsson | To: RAN |
| Draft LS to ITU-R and CEPT on extension of IMT array antenna model to support sub-array structures | Ericsson, Nokia, Qualcomm | To: ITU-R WP 5D and ECC PT1, Cc: RAN |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-2109392  R4-2111019 | Draft reply LS to TSG RAN on unwanted emission field testing | Nokia, Nokia Shanghai Bell | Noted |  |
| R4-2109873 | Draft LS on feedback on LS from ITU-R WP 1C related to in-field unwanted emission testing | Ericsson | Noted |  |
| R4-2110613 | Discussion on in-field OTA testing | ZTE Corporation | Noted |  |
| R4-2110637 | AAS TRP in-field test | Huawei, HiSilicon | Noted |  |
| R4-2107607 | On the impact of sub-array antenna modelling in coexistence studies | Qualcomm CDMA Technologies | Noted |  |
| R4-2108900 | Comments on Antenna Model | Spark NZ Ltd | Noted |  |
| R4-2109872 | Draft LS to ITU-R and CEPT on extension of IMT array antenna model to support sub-array structures | Ericsson, Nokia, Qualcomm | Noted |  |
| R4-2110648 | AAS model extension | Huawei, HiSilicon | Noted |  |

## 2nd round

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| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-2108650 | LS to ITU-R and CEPT on extension of IMT array antenna model to support sub-array structures | Ericsson, Nokia, Qualcomm | Revised in R4-2108080 | To: ITU-R WP 5D and ECC PT1, Cc: RAN |
| R4-2108080 | LS to ITU-R and CEPT on extension of IMT array antenna model to support sub-array structures | Ericsson, Nokia, Qualcomm | Agreeable | To: ITU-R WP 5D and ECC PT1, Cc: RAN |
| R4-2108649 | LS on Test methods for over-the-air TRP field measurements of unwanted emissions from IMT radio equipment utilizing active antennas | Ericsson | Agreeable | To: RAN |