TSG-RAN Working Group 4 (Radio) meeting #98-bis-ER4-2106125

Electronic Meeting, 12th – 20th April 2021

**Source:** Ericsson

**Title:** WF on OTA in-field testing and antenna model information to ITU-R

**Agenda item:** 12.2

**Document for:** Approval

# Introduction

At RAN4#98-bis-E meeting two draft LS to ITU-R and CEPT was discussed.

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 last RAN4, 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 and CEPT.

In this contribution a way-forward to summarize the discussion and give guidance for further discussion next meeting is captured.

# In-field testing

From the discussion summary in [1], the following have been captured:

1. RAN4 have no explicit experience of in-field OTA testing. However, the experience from OTA base station conformance testing is valuable also for in-field OTA testing. For unwanted emission testing, methodologies for TRP measurements apply also for in-field testing.
2. The RAN4 task is to focus on the need of the test signal and how it will affect TRP measurements in field. The test signal will have impact on other RAN groups, e.g. the physical layer impact needs to be considered in RAN1.
3. During the discussion some alternative test approaches without the need to introduce a dedicated test signal for unwanted emission testing was identified.

The following questions to ITU-R WP 1C regarding the test signal description was identified:

1. How is the test signal enabled? Or is it supposed to be always enabled?
2. Is the test signal supposed to be transmitted synchronously in a network?
3. What is the intended beam pattern for the test signal?

The following questions for further discussion internally in RAN was identified:

1. How will the test signal affect interference e.g. different base stations, between MIMO layers, etc.?
2. How will the test signal affect power saving modes?
3. How will the test signal beam pattern affect network performance?

Based on the discussion summary in [1] the following way-forward with guidance for next meeting was created:

1. Further identify missing information relevant to better understand the need and consequences of proposed implementation of test signal.
2. Study alternative approaches to measure unwanted emission TRP levels in-field to avoid drawbacks of test signal approach.
3. The way-forward encourage companies to provide more technical input concerning the proposed test signal and on alternative approaches described in [2] or other potential alternative approaches.

# Antenna model extension

From the discussion summary [1] the following have been captured:

1. An extension to the antenna model in TR 37.840 was presented in [3]. The model extension is described in Annex A.1.
2. Parameters relevant for the frequency band 1710 to 4990 MHz is captured in Annex A.2.
3. Co-existence impact was studied for FR2 in [3]. It can be concluded that RAN4 co-existence is not affected by the extended antenna model for FR2.

Based on the discussion summary in [1] the following way-forward with guidance for next meeting was created:

1. Further consider the impact on RAN4 co-existence.
2. Further discuss the antenna model extension to support sub-arrays geometries.
3. Further discuss relevant antenna parameter sets.

# References

[1] R4-2105999, “Email discussion summary for [98-bis-e][328] LS\_reply\_ITU-R”, Ericsson

[2] R4-2106356, “Draft LS on feedback on LS from ITU-R WP 1C related to in-field unwanted emission testing”, Ericsson

[3] R4-2106354, “Draft LS to ITU-R and CEPT on extension of IMT array antenna model to support sub-array structures”, Ericsson, Nokia, Qualcomm

Annex A:

# A.1 Model extension

An extended version of the AAS array antenna model is created to support vertical sub-array geometries. The model equations are summarized in Table A.1-1.

**Table A.1-1: Extended AAS model**

| **Description** | **Equation** |
| --- | --- |
| Peak normalized element radiation pattern | $$A\left(θ,φ\right)=-min\left[-\left(-min\left[12\left(\frac{φ}{φ\_{3dB}}\right)^{2},A\_{m}\right]-min\left[12\left(\frac{θ-90}{θ\_{3dB}}\right)^{2},SLA\_{v}\right] \right),A\_{m}\right]$$ |
| Peak gain normalized element radiation pattern | $$A\_{E}\left(θ,φ\right)=G\_{E,max}+A\left(θ,φ\right)$$ |
| Sub-array excitation | $$w\_{m}=\frac{1}{\sqrt{M\_{sub}}}exp\left(j2π\left(m-1\right)\frac{d\_{v,sub}}{λ}sin\left(θ\_{subtilt}\right)\right)$$ |
| Sub-array radiation pattern | $$A\_{sub}\left(θ,φ\right)=A\_{E}\left(θ,φ\right)+10log\_{10}\left(\left|\sum\_{m=1}^{M\_{sub}}w\_{m}v\_{m}\right|^{2}\right)$$, where$$v\_{m}=exp\left(j2π\left(m-1\right)\frac{d\_{v,sub}}{λ}cos\left(θ\right)\right)$$ |
| Array excitation | $$w\_{m,n}=\frac{1}{\sqrt{MN}}exp\left(j2π\left(\left(m-1\right)\frac{d\_{v}}{λ}sin\left(θ\_{etilt}\right)-\left(n-1\right)\frac{d\_{h}}{λ}cos\left(θ\_{etilt}\right)sin\left(φ\_{escan}\right)\right)\right)$$ |
| Composite array radiation pattern | $$A\_{A}\left(θ,φ\right)=A\_{sub}\left(θ,φ\right)+10log\_{10}\left(\left|\sum\_{m=1}^{M}\sum\_{n=1}^{N}w\_{m,n}v\_{m,n}\right|^{2}\right)$$, where$$v\_{m,n}=exp\left(j2π\left(\left(m-1\right)\frac{d\_{v}}{λ}cos\left(θ\right)+\left(n-1\right)\frac{d\_{h}}{λ}sin\left(θ\right)sin\left(φ\right)\right)\right)$$ |

# A.2 Parameter sets

In Table A.2-2, representable parameter sets relevant for an AAS base station operating within 1710 to 4990 MHz are provided.

**Table A.2-2: Beamforming antenna characteristics supporting subarray structures for IMT in 1710 – 4990 MHz**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Macro Rural | Macro suburban | Macro urban |
| **1** | **Base station Antenna Characteristics** |
| 1.1 | Antenna pattern  | Refer to Recommendation [ITU-R M.2101](https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2101-0-201702-I%21%21PDF-E.pdf)with sub-array extension |
| 1.2 | Element gain (dBi) (Note 2) | 6.4 | 6.4 | 6.4 |
| 1.3 | Horizontal/vertical 3 dB beam width of single element (degree)  | 90º for H65º for V | 90º for H65º for V | 90º for H65º for V |
| 1.4 | Horizontal/vertical front‑to‑back ratio (dB) | 30 for both H/V | 30 for both H/V | 30 for both H/V |
| 1.5 | Antenna polarization  | Linear ±45º | Linear ±45º | Linear ±45º |
| 1.6 | Antenna sub-array configuration (Row × Column) (Note 4) | 4 × 8 elements | 4 × 8 elements | 4 × 8 elements |
| 1.7 | Horizontal/Vertical radiating element/sub-array spacing  | 0.5 of wavelength for H, 2.1 of wavelength for V | 0.5 of wavelength for H, 2.1 of wavelength for V | 0.5 of wavelength for H, 2.1 of wavelength for V |
| 1.7a | Number of element rows in sub-array | 3 | 3 | 3 |
| 1.7b | Vertical element separation in sub-array | 0.7 of wavelength of V | 0.7 of wavelength of V | 0.7 of wavelength of V |
| 1.7c | Vertical element separation in array | 2 x 0.7 of wavelength | 2 x 0.7 of wavelength | 2 x 0.7 of wavelength |
| 1.8 | Array Ohmic loss (dB) (Note 2) | 2 | 2 | 2 |
| 1.9 | Conducted power (before Ohmic loss) per antenna element (dBm) (Note 3)  | 25 | 25 | 25 |
| 1.10 | Base station horizontal coverage range (degrees) | +/-60 | +/-60 | +/-60 |
| 1.11 | Base station vertical coverage range (degrees) (Note 1) | 90-100 | 90-100 | 90-100 |
| 1.12 | Mechanical down-tilt (degrees) (Note 5) | 6 | 6 | 6 |

Note 1: The vertical coverage range is given for the elevation angle θ, defined between 0° and 180° as
in [ITU-R M.2101](https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2101-0-201702-I%21%21PDF-E.pdf).

Note 2: The element gain in row 1.2 includes the loss given in row 1.8.

Note 3: The conducted power per sub-array assumes 4x8x2 sub-arrays (i.e. power per H/V polarized element).

Note 4: 4 × 8 means there are 4 vertical and 8 horizontal radiating sub-arrays.

Note 5: Mechanical down-tilt is implemented as an electrical pre-set subarray down-tilt angle.

Note 6 : due to larger vertical spacing in the array ( ie twice that of the sub array for 3 element subarray), there will be grating lobes beyond a look angle of 23.6 degrees obtained from using the well known equation ( d/(lambda) = 1 + sin ( theta). Here d/lambda will be 1.4

For frequencies below 5 GHz only array antennas using sub-array as described in Table A.2-1 needs to be considered, and for frequencies around 6 GHz both single element and sub-array configuration could be considered. For urban small cell and micro cell deployments single element parameters can be considered.

The antenna parameters presented above holds complementary information to previously communicated LS on IMT parameters.