TSG-RAN Working Group 4 (Radio) meeting #99-ER4-2108650

Electronic Meeting, 19th – 27th May 2021

**Title: LS to ITU-R and CEPT on extension of IMT array antenna model to support sub-array structures**

**Response to: LS RP-200042 on Parameters of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-23 from ITU-R Working Party 5D**

**Release: -**

**Work Item: -**

**Source: TSG RAN WG4**

**To: ITU-R WP 5D and ECC PT1**

**Cc: TSG RAN**

**Contact person: Torbjörn Elfström**



**Send any reply LS to: 3GPP Liaisons Coordinator,** **mailto:3GPPLiaison@etsi.org**

**Attachments:**

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# 1 Overall description

RAN WG4 received the incoming LS from ITU-R Working Party 5D on Parameters of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-23 ([Att. 7.4 to 5D/134](https://www.itu.int/dms_ties/itu-r/md/19/wp5d/c/R19-WP5D-C-0134%21H07%21MSW-E.docx)). In R4-2103104 information was updated. As an addition, RAN4 has discussed an extension to the AAS array antenna model to support sub-arrays with fixed sub-array down-tilt. A sub-array is a radiating element constituted by multiple elements passively combined to a single RF transmission line, which is connected to a single transceiver branch.

The intention with the AAS model extension is to provide a tool to better represent and adapt radiation pattern characteristics for base station with AAS sub-array antenna geometries commonly used for operating within 1710 to 4990 MHz. For AAS antenna geometries with individual element excitation, the existing AAS model defined 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) and parameters in previously communicated LS apply.

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

**Table 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 | $$w\_{m,n}=\frac{1}{\sqrt{MN}}exp\left(j2π\left(\left(m-1\right)\frac{d\_{v}}{λ}sin\left(θ\_{etilt}\right)-\left(n-1\right)\frac{d\_{h}}{λ}cos\left(θ\_{etilt}\right)sin\left(φ\_{escan}\right)\right)\right)$$Where *M* and *N* is corresponding to (Row × Column) in Table 1-2, row 1.6. |
| 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$$v\_{m,n}=exp\left(j2π\left(\left(m-1\right)\frac{d\_{v}}{λ}cos\left(θ\right)+\left(n-1\right)\frac{d\_{h}}{λ}sin\left(θ\right)sin\left(φ\right)\right)\right)$$Where *M* and *N* is corresponding to (Row × Column) in Table 1-2, row 1.6. |

In Table 1-2, representable parameter sets relevant for an AAS base station operating within 1710 to 4990 MHz are provided.

**Table 1-2: 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 Table 1-1 |
| 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 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 ($d\_{v,sub}$) | 0.7 of wavelength of V | 0.7 of wavelength of V | 0.7 of wavelength of V |
| 1.7c | Pre-set sub-array down-tilt (degrees) | 3 | 3 | 3 |
| 1.8 | Array Ohmic loss (dB) (Note 2) | 2 | 2 | 2 |
| 1.9 | Conducted power (before Ohmic loss) per sub-array (dBm) (Note 3)  | 28 | 28 | 28 |
| 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)  | 3 | 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 and is per polarization.

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: For the case of 3 elements per sub array, dv will be 2.1 wavelengths. The use of sub-arrays will result in grating lobes either side of the main lobe.

For urban small cell and micro cell deployments only parameters for antennas with single element structures should be considered, as previously communicated LS on IMT parameters.

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

# 2 Actions

**To ITU-R WP 5D and ECC PT1**

**ACTION:** 3GPP TSG RAN asks ITU-R WP 5D and ECC PT1 to take into account the above information concerning AAS array antenna modelling and IMT AAS array antenna parameters for consideration.

# 3 Dates of next TSG RAN WG 4 meetings

TSG RAN4 Meeting #100-E 16 – 27 August, 2021 Online

TSG RAN4 Meeting #101-E 1 – 12 November, 2021 Online