TSG-RAN Working Group 4 (Radio) meeting #111R4-2410576

Fukuoka, Japan, 20th to 24th May 2024

**Title: LS on Parameters for 4400 to 4800 MHz of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-27**

**Response to: LS R4-2400333 on Parameters of terrestrial component of IMT for sharing and compatibility studies in the frequency bands 4 400-4 800 MHz, 7 125-8 400 MHz and 14.8-15.35 GHz**

**Release: Rel-19**

**Work Item: FS\_NR\_IMT\_4400\_7125\_14800MHz**

**Source: TSG RAN WG4**

**To: ITU-R WP 5D**

**Cc: RAN**

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

**Attachments:** -

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-27 ([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)) and would like to thank for the opportunity to give input on this topic.

For the three frequency ranges, RAN WG4 identified the following estimated completion dates for the work:

* **4400 to 4800 MHz** Estimated date for completion: **May 2024 (RAN WG4#111)**
* **7125 to 8400 MHz** Estimated date for completion: **August 2024 (RAN WG4#112)**
* **14800 to 15350 MHz** Estimated date for completion: **November 2024 (RAN WG4#113)**

It should also be noted that November 2024 is a challenging RAN WG4 deadline and RAN WG4 may need more time to complete parameters at 14800 to 15350 MHz.

RAN4 is developing a technical report (TR 38.922) on the IMT parameters described in this LS, which will be published end of 2024.

The bands within 4400 MHz to 4800 MHz is part of what in 3GPP is defined as *Frequency Range 1* (FR1) and the 5G RF parameters for the bands are specified in 3GPP specifications TS 38.104 for the BS and TS 38.101-1 for the UE. The recommended IMT technology related parameters for the frequency range 4400 to 4800 MHz are given in Annex 1 of this LS with references to those two specifications. The following should be noted:

* Where AAS and non-AAS limits may be expressed differently, there are separate entries in table 1. AAS limits always apply Over-the-Air (OTA).
* In the BS specification TS 38.104, non-AAS BS are identified as *BS Type 1-C*, while AAS BS are identified as *BS Type 1-H* or *BS Type 1-O* for the bands.
* Deployment related parameters are documented in [ITU-R M.2292](http://www.itu.int/pub/R-REP-M.2292).

The recommended IMT antenna characteristics are given in Annex 2 of this LS. The following should be noted:

* Parameters are interdependent and derived as a package, based on deployment scenarios and other requirements.
* There is no beam forming assumed for the UE in the frequency ranges covered. UEs are therefore not included in the table.
* For fixed beam antennas (i.e., non-AAS base station), antenna parameters in [ITU-R M.2292](http://www.itu.int/pub/R-REP-M.2292) apply.

2 Actions

**To ITU-R WP5D**

**ACTION:** 3GPP RAN4 asks ITU-R WP 5D to consider following information:

* The work plan indicating estimated completion dates for the different frequency ranges.
* The information provided for 4400 to 4800 MHz in Annex 1 and Annex 2.

3 Dates of next TSG RAN WG 4 meetings

TSG-RAN4 Meeting #112 Maastricht, EU 19-23 August

TSG-RAN4 Meeting #112-bis TBD, China 14-18 October

TSG-RAN4 Meeting #113 Orlando, US 18-22 November

ANNEX 1

**IMT technology-related and deployment-related parameters for bands between 1710 and 4990 MHz**

**Table 1: IMT technology related parameters in 1710 – 4990 MHz**

|  |  | **IMT**  |
| --- | --- | --- |
| **No.** | **Parameter** | **Base station (non-AAS)** | **Base station(AAS)** | **Mobile station** |
| **1** | **Duplex Method** | TDDSee [1], § 5.2. | TDD See [2], § 5.2. |
| **2** | **Channel bandwidth (MHz)** | See [1], § 5.3.5. | See [2], § 5.3.5. |
| **3** | **Signal bandwidth (MHz)** | See [1], § 5.3.2. Signal bandwidth = NRB x SCS x 12. | See [2], § 5.3.2. Signal bandwidth = NRB x SCS x 12. |
| **4** | **Transmitter characteristics** |  |  |
| 4.1 | Power dynamic range (dB) | See [1], § 6.3.3. | See [2], § 6.2.1 (UE max output power) and §6.3.1 (UE min output power). |
| 4.2 | Spectral mask (dB) | See [1], § 6.6.4. | See [1], § 9.7.4. | See [2], § 6.5.2.2. |
| 4.3 | ACLR  | See [1], § 6.6.3. | See [1], § 9.7.3. | See [2], § 6.5.2.4. |
| 4.4 | Spurious emissions | See [1], § 6.6.5. | See [1], § 9.7.5. | See [2], § 6.5.3. |
| 4.5 | Maximum output power | See [1], § 6.2. | See [1], § 9.3. | See [2], § 6.2.1. |
| **5** | **Receiver characteristics** |  |  |  |
| 5.1 | Noise figure (dB) | 5 dB (Wide Area BS)10 dB (Medium Range BS)13 dB (Local Area BS)For BS class definitions, see [1], § 4.4 | 9 dB |
| 5.2 | Sensitivity (dBm) | See [1], § 7.2.2. | See [1], § 10.3.2. | See [2], § 7.3. |
| 5.3 | Blocking response  | See [1], § 7.5 and § 7.4.2. | See [1], § 10.6and § 10.5.2. | See [2], § 7.6 and § 7.7. |
| 5.4 | ACS  | See [1], § 7.4.1. | See [1], § 10.5.1. | See [2], § 7.5. |
| 5.5 | SINR operating range (dB) | See below “SINR operating range and mapping function” |

References used in the Table:

[1] 3GPP TS 38.104 v.18.5.0, “NR; Base Station (BS) radio transmission and reception”

[2] 3GPP TS 38.101-1 v.18.5.0, “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”

**SINR operating range and mapping function**

The following equations approximate the throughput over a channel with a given SINR, when using link adaptation:

$$Throughput \left(SINR\right) [bps/Hz] =\left\{\begin{array}{c}0 for SINR\leq SINR\_{MIN} \\α∙S\left(SINR\right) for SINR\_{MIN}<SINR<SINR\_{MAX} \\α∙S\left(SINR\_{MAX}\right) for SINR \geq SINR\_{MAX} \end{array}\right.$$

Where:

* $S\left(SINR\right)$: Shannon bound, $S(SINR) =log\_{2}(1+SINR) [bps/Hz]$;
* $α$: Attenuation factor, representing implementation losses;
* $SINR\_{MIN}$: Minimum SINR of the code set [dB];
* $SINR\_{Max}$: Maximum SINR of the code set [dB];

The SINR values specified in Table 2 below are in dB but must be converted to linear scale in the formula above.

The parameters, $SINR\_{MIN}$ and $SINR\_{MAX}$ can be chosen to represent different modem implementations and link conditions. The parameters proposed in Table 2 represent a baseline case, which assumes:

* 1:1 antenna configurations
* AWGN channel model
* Link Adaptation (see Table 2 for details of the highest and lowest rate codes)
* No HARQ

**Table 2: Parameters describing baseline Link Level performance for 5G NR**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter**  | **DL**  | **UL**  | **Notes**  |
| $$α$$ | 0.6  | 0.4  | Represents implementation losses  |
| $SINR\_{MIN}$ [dB] | -10  | -10  | Based on QPSK, 1/8 rate (DL) & 1/5 rate (UL)  |
| $SINR\_{Max}$ [dB] | 30  | 22  | Based on 256QAM 0.93(DL) & 64QAM 0.93 (UL)  |

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ANNEX 2

**Antenna characteristics for IMT AAS base stations**

The extended version of the AAS array antenna model supports vertical sub-array geometries with fixed sub-array down-tilt. The model equations are summarized in Table 3.

**Table 3: 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 4, 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 4, row 1.6. |

Considering base stations are optimized for various factors including performance, cost, and coverage, it is expected that sub array configurations are relevant where a set of physical antenna elements are combined to form a logical element. The model comprises of a basic element pattern which is then combined appropriately based on the equations to form the sub array pattern and the composite pattern. Since dual polarized elements are used in typical base stations, each polarization separately is considered in the models. The models are selected so that they are simple and representative to model BS performance with sufficient confidence. The element pattern is based on a simple gaussian beam which has a flat sidelobe level. The Gaussian pattern is sufficiently wide and cover most of the regions of interest, especially in the elevation domain. Thus, the extended antenna model with sub arrays is recommended to represent the beamforming capability of IMT base stations in considered frequency ranges.

**Table 4:** **Beamforming antenna characteristics for IMT in 1710 to 4990 MHz**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | **Rural** | **Macro suburban** | **Macro urban** | **Small cell outdoor/Micro urban** | **Small cell indoor/Indoor urban** |
| **1** | **Base station Antenna Characteristics** |
| 1.1 | Antenna pattern  | Table 3 | Refer to Recommendation in ITU-R M.2101 | N/A |
| 1.2 | Element gain (dBi) (Note 2) | 6.4 | 6.4 | 6.4 | 6.4 | N/A |
| 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 | 90º for H65º for V | N/A |
| 1.4 | Horizontal/vertical front‑to‑back ratio (dB) | 30 for both H/V | 30 for both H/V | 30 for both H/V | 30 for both H/V | N/A |
| 1.5 | Antenna polarization  | Linear ±45º polarized sub-array | Linear ±45º polarized sub-array | Linear ±45º polarized sub-array | Linear ±45º polarized sub-array | N/A |
| 1.6 | Antenna array configuration (Row × Column) (Note 4) | 4 × 8  | 4 × 8  | 4 × 8  | 8 × 8  | N/A |
| 1.7 | Horizontal/Vertical radiating sub-array or element spacing (Note 5) | 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 | 0.5 of wavelength for H, 0.7 of wavelength for V | N/A |
| 1.7a | Number of element rows in sub-array | 3 | 3 | 3 | N/A | N/A |
| 1.7b | Vertical element separation in sub-array ($d\_{v,sub}$) | 0.7 of wavelength for V | 0.7 of wavelength for V | 0.7 of wavelength for V | N/A | N/A |
| 1.7c | Pre-set sub-array down-tilt (degrees) (Note 6) | 3 | 3 | 3 | N/A | N/A |
| 1.8 | Array Ohmic loss (dB) (Note 2) | 2 | 2 | 2 | 2 | N/A |
| 1.9 | Conducted power (before Ohmic loss) per sub-array or element (dBm) (Note 3) | 28 | 28 | 28 | 16 | N/A |
| 1.10 | Base station horizontal coverage range (degrees) | +/-60 | +/-60 | +/-60 | +/-60 | N/A |
| 1.11 | Base station vertical coverage range (degrees) (Note 1) | 90-100 | 90-100 | 90-100 | 90-120 | N/A |
| 1.12 | Mechanical down-tilt (degrees) | 3 | 6 | 6 | N/A | N/A |
| 1.13 | Maximum base station output power/sector (e.i.r.p.) (dBm) (Note 7) | 72.2 | 72.2 | 72.2 | 61.5 | N/A |

Note 1: The vertical coverage range is given in global coordinate system, i.e., 90° being at the horizon. This range includes the mechanical down-tilt given in row 1.12.

Note 2: The element gain in row 1.2 includes the loss given in row 1.8 and is per polarization.

Note 3: Conducted power values are per polarization. The conducted power per sub-array assumes 4 × 8 sub-arrays and 2 polarizations for the rural, suburban and urban macro cases; the conducted power per element assumes 8 × 8 elements and 2 polarizations for the small cell outdoor/micro urban case.

Note 4: 4 × 8 means there are 4 rows and 8 columns of radiating sub-arrays for rural, macro suburban and macro urban cases. 8 × 8 means there are 8 rows and 8 columns of radiating elements for the small cell outdoor/micro urban case.

Note 5: For the case of 3 elements per sub-array, vertical sub-array spacing will be 2.1 wavelengths.

Note 6: The pre-set sub array down-tilt is a fixed design parameter for a base station. It is envisaged as a passive fixed (non-varying) electrical tilt within the sub-array elements.

Note 7: The maximum base station e.i.r.p per sector is calculated as total power (including power from two orthogonal polarizations).

Note 8: Mechanical down-tilt is handled by a coordinate system transformation described in 3GPP TR 36.814 section A.2.1.6.2.

Note 9: $θ\_{etilt}$ and $φ\_{escan}$ is the BS array antenna beam steering direction used in Table 3, they should be set so that the beam steering direction is within the vertical and horizontal coverage ranges in row 1.11 and row 1.10, respectively.

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