3GPP TSG-RAN WG4 Meeting #111 R4-2410575

Fukuoka, Japan, May 20-24, 2024

Agenda Item: 10.3.6

Source: Ericsson

Title: WF on IMT parameters study

Document for: Approval

# 1 Introduction

ITU-R WP5D sent a LS [1] to 3GPP RAN seeking information on terrestrial component IMT-2030 parameters to be used for sharing and compatibility studies in preparation for WRC-27, for frequency ranges 4400 to 4800 MHz, 7125 to 8400 MHz, and 14800 to 15350 MHz.

In the 3GPP RAN4#110-bis meeting, the Work Plan [2] for delivery of information to ITU-R LS for those respective frequency ranges was agreed, following a phase approach to send information in 3 phases as below -

* **Track 1:** 4400 to 4800 MHz, the estimated date for completion **is latest by May 2024 (RAN4#111)**.
* **Track 2:** 7125 to 8400 MHz, the estimated date for completion **is latest by August 2024 (RAN4#112).**
* **Track 3:** 14800 to 15350 MHz, the estimated date for completion **is latest by November 2024 (RAN4#113).**

This document captures the agreements for all the three frequency ranges based on the ad-hoc minutes [4,5] and online session, to facilitate discussions in the following meetings.

# 2 IMT parameters for 4400 to 4800 MHz frequency range

**Issue 1-1: Text corrections / updates**

**Agreements:**

* Correct SNIR to SINR (Spark, R4-2407021, CATT)
* Use linear SINR, not dB SINR in the log equation (Spark, R4-2407021)
* Add a sentence to note 9 on the antenna parameters where the ranges of $θ\_{etilt}$ and $φ\_{escan}$ can be found (Spark, R4-2407021)
* Slightly modify the first statement in Annex 2 to avoid using the wording ‘is created’. (Nokia- R4-2407435)
* Refer to M.2101 instead of Table 3 for Small cell outdoor/Micro urban in Row 1.1. (Nokia- R4-2407435)
* Remove ‘sub-’ in row heading of row 1.6. (Nokia- R4-2407435)
* Remove ‘/elements’ in row 1.6 and Note 4 and clarify the meaning of ‘8x8 elements’ in Note 4. (Nokia- R4-2407435)
* Add ‘or element’ into row heading of row 1.7. (Nokia- R4-2407435)
* Change row 1.9 to per antenna sub-array or element and change the values and Note 3 accordingly. (Nokia- R4-2407435)
* Add a statement in Note 1 to clarify ‘This range includes the mechanical downtilt given in row 1.12.’. (Nokia- R4-2407435)
* Replace ‘dv’ with ‘vertical sub-array spacing’ in Note 5. (Nokia- R4-2407435)
* Further qualify the terms ‘θ\_etilt and φ\_escan’ in Note 9. (Nokia- R4-2407435)
* Change the conducted power to per sub-array/element (Huawei, R4-2404903)
* Remove’ used in the coexistence study’ in Note 9 (Huawei, R4-2404903)

**Agreement:**

* Refer to the TR in the LS
	+ RAN4 is developing a technical report (TR 38.922) on the IMT parameters described in this LS, which will be published later in the year

# 3 IMT parameters for 7125 to 8400 MHz frequency range

**Sub-topic 2-1 General / system issues**

**Issue 2-1: Duplex mode**

**Agreement:**

* Do not include SBFD in the LS, but add information in the TR. Add a reference to the TR in the LS

**Issue 2-3: Typical channel bandwidth**

**Agreement:**

* Mention 100MHz as typical bandwidth in the LS
	+ FFS whether to mention wider bandwidths may be possible in future in the LS
* Describe other possibilities for bandwidth in the TR, mentioning that additional specification effort needed for >100MHz

**Issue 2-4: Typical signal bandwidth**

Outcome of discussion (Not agreed):

Option 1: 273 RB, 30k SCS as 38.104

Option 2: Quote formula of RBs \* SCS without number of RBs

Option 3: Directly quote the signal bandwidth in MHz

**Issue 2-6: Deployment scenarios**

**Agreement:**

* Confirm Urban macro and urban micro should be considered
	+ This is based on assumed antenna size that is sufficient for 450m or lower ISD for urban macro

**Sub-topic 2-2 BS parameters**

**Issue 2-7: Emissions mask**

**Agreement:**

* AAS BS:
	+ Use n104 unwanted emissions mask
	+ [Aim to use 100MHz for delta\_obue, conclude feasibility until RAN4#112]
* Non-AAS BS:
	+ [n104 unwanted emissions mask for IMT response]
		- Double check on whether there are any concerns towards sharing by RAN4#112 and in case concerns are identified, consider n96 if needed to resolve concerns

**Issue 2-10: Noise figure**

**Agreement:**

* Follow 38.820, i.e., 6dB WA, 11dB MR, 14dB LA for noise figure of BS

**Issue 2-11: Sensitivity**

* Proposals
	+ Option 1: As for n104 in 38.104 (CMCC, Samsung, Nokia)

**Agreement:**

* Agree on option 1.
	+ Capture it in the TR only.

**Issue 2-14: BS antenna array parameters**

**Agreement:**

|  |  | **~~Rural macro~~****~~(If it’s available)~~****~~Parameters proposed by ZTE~~** | **Suburban macro** | **Urban macro** | **Urban small cell (outdoor)/Micro cell**  | **Indoor (small cell)** |
| --- | --- | --- | --- | --- | --- | --- |
| **1** | **Base station antenna characteristics** |
| 1.6 | Antenna array configuration (Row × Column) (Note 4) | ~~8 × 8 elements~~ | Option 1: 8 × 16 (Nokia, Ericsson, Huawei, Spark)Option 2: 8 x 8 (ZTE, Samsung)  | Option 1: 8 × 16 (Nokia, Ericsson, Huawei, Cable Labs)Option 2: 8 x 8 (ZTE, Samsung) | 8 × 8 | 4 × 4 |
| 1.7a | Number of element rows in sub-array, *Msub* |  | Option 1: 4 (Nokia, Spark, Cable Labs, Charter)Option 2: 3 (Ericsson, Huawei, Samsung)  | Option 1: 4 (Nokia, Spark, Cable Labs, Charter)Option 2: 3 (Ericsson, Huawei, Samsung) | N/A | N/A |

**Agreement:**

* Remove the rural macro scenario from the table.
* non-AAS can be used for Urban small cell/Micro cell scenario
* non-AAS can be used for indoor scenario
* FFS on where to capture the above two bullets

**Sub-topic 2-3 UE parameters**

**Issue 2-15: Maximum output power**

**Tentative agreement:**

* Capture 23dBm as typical maximum output power in the LS to ITU.
	+ Other output powers are not precluded and refer to TR
* Capture 20dBm, 23dBm, 26dBm, and higher power classes in TR

# 4 IMT parameters for 14800 to 15350 MHz frequency range

**Issue 3-1: Simulation scenarios**

**Agreement:**

* 1st priority urban macro
* 2nd priority indoor
* 3rd priority dense urban

**Issue 3-3: ISD**

**Agreement:**

* For indoor, agree 20m
* For outdoor, consider both 450m (1st priority) and 350 (2nd priority) until August.
	+ Also other ISD not precluded as 3rd priority than 450 and 350.

**Issue 3-4: Percentage indoor users for urban macro**

**Agreement:**

* Keep both options

**Issue 3-5: Co-ordinated and un-coordinated for outdoor**

**Agreement:**

* Both co-ordinated and un-coordinated

**Issue 3-6: Co-ordinated and un-coordinated for indoor**

**Agreement:**

* Only co-ordinated

**Issue 3-7: Pathloss model**

**Agreement:**

* Follow 38.901

**Issue 3-6: BS antenna array size**

**Agreement:**

Per polarization, for simulation only:

* 2048 (Sub Array size 8)
* 1536 (Sub Array size 4)
* Array size and Sub Array size for the response will be decided later, taking into account feasibility

**Issue 3-7: BS antenna array other parameters**

**Agreement:**

* 0.7 spacing in vertical domain is for simulation assumptions, double check for reply

**Issue 3-8: UE type**

**Agreement:**

For simulations, consider both options.

* FR1 like
	+ RX diversity gain: [5] dB assuming 4RX
	+ TX: 0dBi omnidirectional
	+ Power: 23 dBm, 26dBm
* FR2 like
	+ Two panels (one in each direction) 2x2 antenna
		- 5dBi element gain. Array gain comes on top
		- Power: 23 dBm TRP

**Issue 3-9: BS output power**

**Agreement:**

* Assume 43dBm BS power for simulations

**Issue 3-10: Bandwidth**

**Agreement:**

* For number of UEs per slot:
	+ 1 UE per slot as 1st priority
	+ 3 UE per slot as 2nd priority

**Issue 3-11: BS noise factor**

**Agreement:**

* For simulations, assume 8dB

**Issue 3-11: UE noise factor**

**Agreement:**

* 11dB for simulations. Actual noise factor for reply will be decided based on feasibility.

**Issue 3-12: UL SNR target**

**Agreement:**

* 15dB

# References

1. R4-2400333, “ITU-R WP5D LS 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”.
2. R4-2405874, “Work Plan on IMT parameters relevant for sharing and compatibility for 4400 to 4800 MHz, 7125 to 8400 MHz, and 14800 to 1530 MHz frequency ranges”, 3GPP RAN4#110-bis, Ericsson
3. R4-241056, “LS on Parameters for 4400 to 4800 MHz of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-27”, 3GPP RAN4#111, Ericsson
4. R4-2410568, “Ad-hoc minutes for [111][127] FS\_NR\_IMT”, 3GPP RAN4#111, Moderator (Ericsson)
5. R4-24xxxxx, “2nd Ad-hoc minutes for [111][127] FS\_NR\_IMT”, 3GPP RAN4#111, Moderator (Ericsson)

# Annex

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**

**Contact person: Torbjörn Elfström**



**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