|  |  |
| --- | --- |
| **Radiocommunication Study Groups** |  |
|  |  |
|  |  |
|  | **Revision 2 toDocument 5D/TEMP/422-E** |
| **18 June 2021** |
| **English only** |
| SWG Sharing Studies |
| Characteristics of terrestrial component of IMT for sharing and compatibility studies in preparation for WRC-23 |
|  |

**1 Introduction**

This document includes technical and operational characteristics of terrestrial component of IMT for sharing and compatibility studies in preparation for various WRC-23 agenda items in the following frequency bands:

– 470-694 MHz, 694-960 MHz;

– 1 710–1 885 MHz, 1 885-1 980 MHz, 2 010-2 025 MHz, 2 110-2 170 MHz and 2 500‑2 690 MHz;

– 3 300-3 400 MHz (3 300-3 315 MHz and 3 385-3 400 MHz), 3 600-3 800 MHz, 4 800‑4 990 MHz;

– 6 425-7 025 MHz, 7 025-7 125 MHz; and

– 10.0-10.5 GHz.

In some cases, IMT deployments in border areas between the territories of concerned neighbouring countries may consider adjustments of base station configurations contained in this document (e.g., larger antenna down tilts, lower antenna heights, sector azimuth restrictions, and other aspects to reduce emissions into a neighbouring country as well as lower user density), for purposes of cross-border discussions between administrations. Such deployment situations may be utilized in technical studies for discussions between those concerned neighbouring countries. Noting that this deployment situation is of a bilateral nature between countries, specific parameters values are not included in this document. Therefore, in case those studies addressing such situations were provided, the parameters values used in the studies and explanation should be provided together with the studies for further consideration, as appropriate.

**2 Abbreviations and acronyms**

|  |  |
| --- | --- |
| 3GPP | Third Generation Partnership Project |
| AAS | Advanced/Active antenna system |
| ACLR | Adjacent channel leakage ratio |
| ACS | Adjacent channel selectivity |
| AWGN | Additive white Gaussian noise |
| BS | Base station |
| DL | Downlink |
| Dl | Deployment density values for large area  |
| Ds | Density value for outdoor hotspot (i.e. density of UEs or BS) |
| e.i.r.p. | Equivalent isotopically radiated power |
| FDD | Frequency Division Duplex |
| H/V | Horizontal/Vertical |
| HARQ | Hybrid Automatic Repeat Request |
| *I/N* | Interference-to-noise ratio |
| IMT | International Mobile Telecommunications |
| IMT-2020 | International Mobile Telecommunications (IMT) for 2020 and beyond |
| NR | New radio |
| NRB | Transmission bandwidth configuration, expressed in resource blocks |
| QAM | Quadrature amplitude modulation |
| QPSK | Quadrature Phase Shift Keying |
| Ra | Ratio of hotspot areas to areas of cities/built areas/districts |
| Rb | Ratio of built areas to total area of region in study |
| RB | Resource block |
| SCS | Sub-carrier spacing |
| SDL | Supplemental downlink |
| SINR | Signal-to-interference-plus-noise ratio |
| TDD | Time division duplex |
| UE | User equipment (user terminal) |
| UL | Uplink |

**3 Characteristics of terrestrial component of IMT**

**3.1 IMT-2020 specification related parameters**

TABLE 1

**IMT-2020 specification related parameters in 470-4 990 MHz**

| **No.** | **Parameter** | **Base station (non-AAS)** | **Base station (AAS)** | **Mobile station** |
| --- | --- | --- | --- | --- |
| 1 | Duplex Method | FDD / TDDSee (1), § 5.2. (Note X) | FDD / TDDSee (2), § 5.2.(Note X) |
| 2 | Channel bandwidth (MHz) | See (1), § 5.3.5 (Note X) | See (2), § 5.3.5 (Note X) |
| 3 | Signal bandwidth | Derived from channel bandwidth, see (1), § 5.3.2. Signal bandwidth = *NRB* × SCS × 12. | Derived from Channel bandwidth, see (2), § 5.3.2. Signal bandwidth = *NRB* × SCS × 12. |
| 4 | Transmitter characteristics |  |  |
| 4.1 | Power dynamic range (dB) | Depends on Channel bandwidth, See (1), § 6.3.3, Table 6.3.3.2-1. | See (2), § 6.2.1 (UE max output power) and § 6.3.1 (UE min output power, depends on Channel bandwidth,). |
| 4.2 | Spectral mask (dB) | Category A: See (1), § 6.6.4.2.1 (Wide Area BS), § 6.6.4.2.3 (Medium Range BS), § 6.6.4.2.4 (Local Area BS).Category B (Note Z): See (1), § 6.6.4.2.2 (Wide Area BS), § 6.6.4.2.3 (Medium Range BS), § 6.6.4.2.4 (Local Area BS).(Note Y) | Category A and B (Note Z): See (1), § 9.7.4.2.(With reference to §6.6.4.2, where the same basic limits apply as for non-AAS BS.) | See (2), § 6.5.2.2, Table 6.5.2.2-1. |
| 4.3 | ACLR | See (1), § 6.6.3.2, Table 6.6.3.2-1. | See (2), § 6.5.2.4.1. |
| 4.4 | Spurious emissions | Category A: See (1), § 6.6.5, Table 6.6.5.2.1-1.Category B (Note Z):See (1), § 6.6.5, Table 6.6.5.2.1-2 | See (2), § 6.5.3.1. |
| 4.5 | Maximum output power  | Deployment specific – see section 3.2.1 | See (2), § 6.2.1, Table 6.2.1-1.(Note X) |
| 5 | Receiver characteristics |
| 5.1 | Noise figure (dB) | 5 dB (Macro cell scenario)10 dB (Micro cell scenario)13 dB (Indoor small cell scenario)(Note Y) | 9 dB |
| 5.2 | Sensitivity (dBm) | Depends on channel bandwidth and BS class, see (1), § 7.2.2. | Depends on channel bandwidth and BS class, see (1), § 10.3.2. | Depends on operating band, see (2), § 7.3.2, Table 7.3.2-1. |
| 5.3 | Blocking response | See (1), § 7.5.2, Table 7.5.2-1 and § 7.4.2, Tables 7.4.2.2-1, 7.4.2.2‑2 and 7.4.2.2-3. | See (1), § 10.6.2, Table 10.6.2.1-1and § 10.5.2, Tables 10.5.2.2-1, 10.5.2.2-2 and 10.5.2.2-3. | Depends on operating band, see (2), § 7.6, Tables 7.6.2-2 and 7.6.2-4, 7.6.3-2 and 7.6.3-4 for blocking levels. |
| 5.4 | ACS | See (1), § 7.4.1.2. | See (1), § 10.5.1.2. | See (2), § 7.5, Table 7.5-1 and 7.5-2. |
| 5.5 | SINR operating range (dB) | See below “SINR operating range and mapping function” |
| Note X – Typical values of duplex method, channel bandwidth and max output power for both non-AAS and AAS IMT stations in different frequency bands are provided in Section 3.2.1.Note Y – Wide Area Base Stations are characterised by requirements derived from Macro Cell scenarios, Medium Range Base Stations are characterised by requirements derived from Micro Cell scenarios and Local Area Base Stations are characterised by requirements derived from Pico Cell scenario, see (1), § 4.4.Note Z – Category B limits are limits defined and adopted by some countries (see Recommendation ITU-R SM.329) and could be used for compatibility analysis if required for specific deployments.References used in the Table (The excerpts of these references are available in the Annexes of this document.):(1) [3GPP TS 38.104 v.16.6.0](http://www.3gpp.org/ftp/Specs/archive/38_series/38.104/38104-g60.zip) (2020-12), “NR; Base Station (BS) radio transmission and reception”.(2) [3GPP TS 38.101-1 v.16.6.0](http://www.3gpp.org/ftp/Specs/archive/38_series/38.101-1/38101-1-g60.zip) (2020-12), “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 (dB), when using link adaptation:

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

where:

 *S*(*SINR*) Shannon bound, *S*(*SINR*) =log2(1 + 10*SINR*/10) (bps/Hz);

 α Attenuation factor, representing implementation losses;

 *SINRMIN* Minimum SINR of the code set, dB;

 *SINRMAX* Maximum SINR of the code set, dB.

The parameters α, *SINRMIN* and *SINRMAX* 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 |
| *SINRMIN*, dB | −10 | −10 | Based on QPSK, 1/8 rate (DL) & 1/5 rate (UL) |
| *SINRMAX*, dB | 30 | 22 | Based on 256-QAM, 0.93 rate (DL) & 64-QAM, 0.93 rate (UL) |

TABLE 3-1

**IMT-2020 specification related parameters in 6 425-7 125 MHz and 10-10.5 GHz**

| **No.** | **Parameter** | **Base station (AAS)** | **Mobile station** |
| --- | --- | --- | --- |
| 1 | Duplex Method | TDD | TDD |
| 2 | Channel bandwidth (MHz) | 100 MHz (typical) | 100 MHz (typical) |
| 3 | Signal bandwidth (MHz) | To be specified. Will be derived from Channel bandwidth, see (1), § 5.3.2. | To be specified. Will be derived from Channel bandwidth, see (2), § 5.3.2.  |
| 4 | Transmitter characteristics |  |  |
| 4.1 | Power dynamic range (dB) | 0 dB | 56 dB |
| 4.2 | Spectral mask (dB) | Category A: (Note 1)See Table 3-2 (Wide Area BS) (ΔfOBUE = 100 MHz)Category B: (Note 1)See Table 3-3 (Wide Area BS) (ΔfOBUE = 100 MHz) | See Table 3-4 |
| 4.3 | ACLR (dB)  | @6 425-7 125 MHz: 38 dB@10-10.5 GHz: 37 dB | @6 425-7 125 MHz: 26 dB@10-10.5 GHz: 24 dB |
| 4.4 | Spurious emissions | Category A: (Note 1)See (1), § 6.6.5, Table 6.6.5.2.1-1.Category B: (Note 1) @6425-7125 MHzSee (1), § 6.6.5, Table 6.6.5.2.1-2.@10-10.5 GHz: See Table 3-5 | See (2), § 6.5.3. |
| 4.5 | Maximum/typical output power (dBm) | Defined by the conducted power per antenna element, see entry 1.9 in Table 10 for typical values. | 23 dBm |
| 5 | Receiver characteristics |  |  |
| 5.1 | Noise figure (dB) | @6 425-7 125 MHz:6 dB (Wide Area BS)11 dB (Medium Range BS)14 dB (Local Area BS)@10-10.5 GHz7 dB (Wide area BS)12 dB (Medium Range BS)15 dB (Local Area BS)For BS class definitions, see (1), § 4.4 | 9-13 dB |
| 5.2 | Sensitivity (dBm) | To be specified | To be specified |
| 5.3 | Blocking response  | In-band blocking level: -43 dBm (Wide Area BS)-38 dBm (Medium Range BS)-35 dBm (Local Area BS)Interferer type: 20 MHz DFT-S-OFDM NR signal, 15 kHz SCS, 100 RB.Out-of-band blocking level:-15 dBm, Interferer type: CW ΔfOOB = 100 MHz (Note 2) | See (2), §7.6, Tables 7.6.2-4 and 7.6.3-4  |
| 5.4 | ACS  | @6 425-7 125 MHz: 42 dB@10-10.5 GHz: 40 dB  | @6 425 – 7 125 MHz: 32 dB@10-10.5 GHz: 31 dB  |
| 5.5 | SINR operating range (dB) | See “SINR operating range and mapping function” |
| Note 1 – Base station operating band unwanted emissions define all unwanted emissions in the supported downlink operating band plus the frequency ranges extending ΔfOBUE above and ΔfOBUE below each band. Base station unwanted emissions outside of this frequency range are limited by the spurious emissions requirement.Note 2 – Base station in-band blocking applies in the supported uplink operating band plus the frequency ranges extending ΔfOOB above and ΔfOOB below each band, excluding the downlink frequency range in case of an FDD operating band. Out-of-band blocking applies from 1 MHz to 12.75 GHz, excluding the in-band blocking frequency range, but including the downlink frequency range in case of an FDD operating band. Requirements are defined assuming a receiver desensitization of 6 dB.References used in the Table (The excerpts of these references are available in the Annexes of this document.):(1) [3GPP TS 38.104 v.16.6.0](http://www.3gpp.org/ftp/Specs/archive/38_series/38.104/38104-g60.zip) (2020-12), “NR; Base Station (BS) radio transmission and reception”.(2) [3GPP TS 38.101-1 v.16.6.0](http://www.3gpp.org/ftp/Specs/archive/38_series/38.101-1/38101-1-g60.zip) (2020-12), “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone” |

TABLE 3-2

**AAS BS Spectral mask (Operating band unwanted emissions limits)
for 6 425-7 125 MHz and 10-10.5 GHz operation (Category A)**

| **Frequency offset of measurement filter ‑3dB point from the carrier frequency, Δf** | **Basic limits** | **Measurement Bandwidth** |
| --- | --- | --- |
| 0 MHz ≤ Δ*f* < 50 MHz | $$-7dBm-\frac{7}{50}\left(\frac{f\\_offset}{MHz}-0.05\right)$$ | 100 kHz |
| 50 MHz ≤ Δ*f* < min(100 MHz, Δ*fmax*) | −14 dBm | 100 kHz |
| 100 MHz ≤ Δ*f* ≤ Δ*f*max | −13 dBm | 1 MHz |
| NOTE: Δ*fmax* is equal to *f*\_*offsetmax* minus half of the bandwidth of the measuring filter, where *f\_offsetmax* is the offset to the frequency Δ*fOBUE* = 100 MHz outside the downlink operating band. |

TABLE 3-3

**AAS BS Spectral mask (Operating band unwanted emissions limits)
for 6 425-7 125 MHz and 10-10.5 GHz operation (Category B)**

| **Frequency offset of measurement filter −3 dB point from the carrier frequency, Δ*f*** | **Basic limits** | **Measurement bandwidth** |
| --- | --- | --- |
| 0 MHz ≤ Δ*f* < 50 MHz | $$-7dBm-\frac{7}{50}\left(\frac{f\\_offset}{MHz}-0.05\right)$$ | 100 kHz |
| 50 MHz ≤ Δ*f* < min(100 MHz, Δ*fmax*) | −14 dBm | 100 kHz |
| 100 MHz ≤ Δ*f* ≤ Δ*fmax* | −15 dBm | 1 MHz |
| NOTE: Δ*fmax* is equal to *f*\_*offsetmax* minus half of the bandwidth of the measuring filter, where *f\_offsetmax* is the offset to the frequency Δ*fOBUE* = 100 MHz outside the downlink operating band. |

TABLE 3-4

**Mobile station Spectral mask for 6 425-7 125 MHz and 10-10.5 GHz operation**

|  |  |
| --- | --- |
|  | **Spectrum emission limit (dBm) / Channel bandwidth** |
| Δ*fOOB*(MHz) | 20MHz | 25MHz | 30MHz | 40MHz | 50MHz | 60MHz | 70MHz | 80MHz | 90MHz | 100MHz | Measurement bandwidth |
| ± 0-1 | −10 | −10 | −10 | −10 |  |  |  |  |  |  | 1% channel bandwidth |
| ± 0-1 |  |  |  |  | −21 | −21 | −21 | −21 | −21 | −21 | 30 kHz |
| ± 1-5 | −7 | −7 | −7 | −7 | −7 | −7 | −7 | −7 | −7 | −7 | 1 MHz |
| ± 5-105 | See (2), § 6.5.2.2, Table 6.5.2.2-1 |

TABLE 3-5

**AAS BS radiated Tx spurious emission limits for 10-10.5 GHz operation (Category B)**

| **Frequency range**  | **Limit** | **Measurement Bandwidth** |
| --- | --- | --- |
| 30 MHz – 1 GHz | −36 dBm | 100 kHz |
| 1 GHz – 18 GHz | −30 dBm | 1 MHz |
| 18 GHz – 26 GHz | −20 dBm | 10 MHz |

**3.2 Deployment characteristics**

There is a range of frequency bands where IMT will need to be studied for WRC-23 agenda items, and for which IMT parameters/characteristics need to be provided for use in such studies. These include agenda items where sharing and compatibility studies may be conducted in relation to the possible identification of the terrestrial component of IMT in certain frequency bands. There are also a number of WRC-23 agenda items that are considering the introduction of other services in or adjacent to frequency bands that are already identified for IMT and where sharing and compatibility studies will need to be conducted with terrestrial IMT as the interfered-with.

For the purposes of providing such IMT parameters, the frequency bands to be studied for WRC-23 are divided into a number of frequency ranges, i.e. below 1 GHz, 1-3 GHz, 3-6 GHz, 6-8 GHz and 10-11 GHz, for which IMT parameters could be considered the same for the purpose of sharing and compatibility studies.

In many cases, the values of these parameters vary within a range, but to facilitate sharing and compatibility studies, wherever possible, a single value has been chosen that is representative for use in the studies.

**3.2.1 Deployment related parameters**

For each frequency band to be studied, IMT characteristics are required for typical deployment environments in which IMT will be deployed in that band. IMT parameters was developed for typical deployment environments for frequency ranges: below 1 GHz, 1-3 GHz, 3-6 GHz, 6-8 GHz and 10‑11 GHz, respectively. This does not imply that no IMT base stations will be deployed in these bands in other environments, however their numbers will be relatively small. In case studies are provided for IMT deployment environments other than those of typical ones, then parameters values and associated explanation and justification should be given together with the results of studies.

These typical deployment environments are categorised in terms of the type of area in which the IMT network / base stations are deployed (urban / suburban / rural), the type of network / base stations (macro / small cell) and whether the base stations are outdoors or indoors.

Regarding antenna characteristics to be used in sharing and compatibility studies for different frequency bands, antenna characteristics for AAS base stations are provided in Tables 9 and 10, whereas for non-AAS base stations, antenna characteristics in Recommendation ITU-R F.1336 are provided in Tables 4-1, 5-1 and 6-1. The application of AAS or non-AAS base stations for the respective frequency ranges are as follows:

– Below 1 GHz: non-AAS only

– 1-3 GHz: non-AAS and AAS (noting AAS parameters in Table 9 are only for frequencies above 1 710 MHz)

– 3-6 GHz: non-AAS and AAS

– 6-8 GHz: AAS only

– 10-10.5 GHz: AAS only

For IMT user equipment, there is no beam forming assumed for the frequency ranges considered in this document, and hence only non-AAS parameters should be used.

**3.2.1.1 Below 1 GHz**

Tables 4-1 and 4-2 provide the deployment-related parameters of IMT systems for the frequency bands below 1 GHz. In these frequency bands, implementation of AAS is not considered in IMT base and mobile stations.

TABLE 4-1

**Deployment-related parameters for bands below 1 GHz**

|  | **Urban/suburban macro** | **Rural macro** |
| --- | --- | --- |
| **Base station characteristics/Cell structure** |
| Cell radius  | 0.5-5 km (typical value to be used in sharing studies for urban macro 1.5 km and for suburban macro 3 km) | > 5 km (typical value to be used in sharing studies 8 km) |
| Antenna height  | 30 m | 30 m (see Note 1) |
| Sectorization | 3 sectors | 3 sectors |
| Downtilt  | 3 degrees | 3 degrees |
| Frequency reuse | 1 | 1 |
| Antenna pattern | Recommendation ITU-R F.1336 (*recommends* 3.1) *ka* = 0.7 *kp* = 0.7 *kh* = 0.7 *kv* = 0.3Horizontal 3 dB beam width: 65 degreesVertical 3 dB beam width: determined from the horizontal beam width by equations in Recommendation ITU-R F.1336. Vertical beam widths of actual antennas may also be used when available. |
| Antenna polarization | Linear/±45 degrees | Linear/±45 degrees |
| Below rooftop base station antenna deployment | Urban: 20%Suburban: 0% | 0% |
| Feeder loss | 3 dB | 3 dB |
| Typical channel bandwidth  | 10 MHz | 10 MHz |
| Maximum base station output power (Report ITU-R M.2292) | 46 dBm in 10 MHz | 46 dBm in 10 MHz |
| Maximum base station antenna gain (Report ITU-R M.2292) | 15 dBi | 15 dBi |
| Maximum base station output power/sector (e.i.r.p.) | 58 dBm in 10 MHz | 58 dBm in 10 MHz |
| Network loading factor (base station load probability X%) (see Section 3.4 below and Rec. ITU-R M.2101 Annex 1, section 3.4.1 and 6) | 20%, 50% | 20%, 50% |
| TDD / FDD / SDL | FDD / SDL | FDD / SDL |
| Note 1 – In macro rural cases in various regions, typical antenna heights could vary depending on the notion of rural territory, i.e. population density, actual distribution of settlements, infrastructure availability, etc. |

TABLE 4-2

**UE parameters for bands below 1 GHz**

|  | **Urban/suburban macro** | **Rural macro** |
| --- | --- | --- |
| **User terminal characteristics** |
| Indoor user terminal usage (Report ITU-R M.2292) | 70% | 50% |
| Indoor user terminal penetration loss | Rec. ITU-R P.2109 | Rec. ITU-R P.2109 |
| User equipment density for terminals that are transmitting simultaneously (Note 1) | 3 UEs per sector | 3 UEs per sector |
| UE height (Note 2) | 1.5 m | 1.5 m |
| Average user terminal output power | Use transmit power control | Use transmit power control |
| Typical antenna gain for user terminals | −3 dBi | −3 dBi |
| Body loss  | 4 dB | 4 dB |
| Transmit power control |
| Power control model | Refer to Recommendation ITU-R M.2101 Annex 1, section 4.1 |
| Maximum user terminal output power, PCMAX | 23 dBm | 23 dBm |
| Power (dBm) target value per RB, P0\_PUSCH (Note 3) | −92.2 | −92.2 |
| Path loss compensation factor, (same as “balancing factor” mentioned in Rec. ITU-R M.2101) | 0.8 | 0.8 |
| Note 1 – UEs share equally the channel bandwidth, i.e. each UE is allocated 1/3 of the channel bandwidth (see Rec. ITU-R M.2101, section 3.4.1, item 1e-f.).Note 2 – In principle, indoor UEs are distributed over different floors of the building. It should be noted that the number of floors of buildings vary within the environment and among the countries. Moreover, the number of floors of buildings is not related to Macro BS antenna height (parameter given in the Table). In particular in small cities, sub-urban and rural areas, many or most of antennas are installed on masts. Therefore, for outdoor BSs, indoor UEs are assumed to be modelled on the ground floor for the sharing study.Note 3 – The target power is defined per Resource Block (RB), considering 180 kHz RB bandwidth corresponding to 15 kHz subcarrier spacing. |

**3.2.1.2 1-3 GHz**

Tables 5-1 and 5-2 provide the deployment-related parameters of IMT systems for the frequency bands between 1 and 3 GHz. AAS is implementable in IMT base stations in the frequency bands above about 1 710 MHz (see Table 9), and for these bands both AAS and antenna characteristics in Recommendation ITU-R F.1336 are considered for IMT base stations, whereas for frequency bands below 1 710 MHz only non-AAS antenna characteristics are considered. Implementation of AAS is not considered in IMT user equipment / mobile stations.

TABLE 5-1

**Deployment-related parameters for bands between 1 and 3 GHz**

|  | **Urban/suburban macro** | **Rural macro** | **Small cell (outdoor)/Micro cell** | **Indoor (small cell)** |
| --- | --- | --- | --- | --- |
| **Base station characteristics/Cell structure** |
| Cell radius / Deployment density (for bands between 1 and 2 GHz) (Report ITU-R M.2292) | 0.25-1 km urban / 0.5-3 km suburban(typical value to be used in sharing studies for urban macro 0.5 km and for suburban macro 1 km) | > 3 km(typical value to be used in sharing studies 5 km) | 1-3 per urban macro cell<1 per suburban macro site | Depending on indoor coverage/ capacity demand |
| Cell radius / Deployment density (for bands between 2 and 3 GHz) (Report ITU-R M.2292) | 0.2-0.8 km urban / 0.4-2.5 km suburban (typical value to be used in sharing studies for urban macro 0.4 km and for suburban macro 0.8 km) | > 2 km(typical value to be used in sharing studies 4 km) | 1-3 per urban macro cell<1 per suburban macro site | Depending on indoor coverage/ capacity demand |
| Antenna height (Report ITU-R M.2292) | 25 m urban / 30 m suburban (1-2 GHz)20 m urban / 25 m suburban (2-3 GHz) | 30 m | 6 m | 3 m |
| Sectorization | 3 sectors | 3 sectors | Single sector | Single sector |
| Non-AAS BS downtilt (Report ITU-R M.2292) (Note 1) | 10 degrees urban / 6 degrees suburban | 3 degrees | n.a. | n.a. |
| Frequency reuse | 1 | 1 | 1 | 1 |
| Non-AAS BS antenna pattern (Note 1) | Recommendation ITU-R F.1336 (*recommends* 3.1)  *ka* = 0.7 *kp* = 0.7 *kh* = 0.7 *kv* = 0.3Horizontal 3 dB beamwidth: 65 degreesVertical 3 dB beamwidth: determined from the horizontal beamwidth by equations in Recommendation ITU-R F.1336.Vertical beamwidths of actual antennas may also be used when available. | Recommendation ITU-R F.1336 (omni: *recommends* 2) |
| Non-AAS BS antenna polarization (Note 1) | Linear/±45 degrees | Linear/±45 degrees | Linear | Linear |
| Indoor base station deployment | n.a. | n.a. | n.a. | 100% |
| Indoor base station penetration loss | n.a. | n.a. | n.a. | Rec. ITU-R P.2109 |
| Below rooftop base station antenna deployment (Report ITU-R M.2292) | Urban: 30% (1-2 GHz), 50% (2-3 GHz)Suburban: 0% | 0% | 100% | n.a. |
| Non-AAS BS feeder loss (Note 1) | 3 dB | 3 dB | n.a. | n.a. |
| Typical channel bandwidth | 10 or 20 MHz | 10 or 20 MHz | 10 or 20 MHz | 10 or 20 MHz |
| Maximum Non-AAS BS output power (in 10 or 20 MHz) (Report ITU-R M.2292) (Note 1) | 46 dBm | 46 dBm | 35 dBm | 24 dBm |
| Maximum Non-AAS BS antenna gain (Report ITU-R M.2292) (Note 1) | 16 dBi | 18 dBi | 5 dBi | 0 dBi |
| Maximum Non-AAS BS output power/sector (e.i.r.p.) (Note 1) | 59 dBm | 61 dBm | 40 dBm | 24 dBm |
| Network loading factor (base station load probability X%) (see section 3.4 below and Rec. ITU-R M.2101 Annex 1, section 3.4.1 and 6) | 20%, 50% | 20%, 50% | 20%, 50% | 20%, 50% |
| Average Non-AAS BS power/sector (e.i.r.p.) taking into account activity factor (Note 1) | Use Rec. ITU-R M.2101 (see section 3.4 below) | Use Rec. ITU-R M.2101 (see section 3.4 below) | Use Rec. ITU-R M.2101 (see section 3.4 below) | Use Rec. ITU-R M.2101 (see section 3.4 below) |
| TDD / FDD | Depending on band | Depending on band | Depending on band | Depending on band |
| BS TDD activity factor | 75% | 75% | 75% | 75% |
| Note 1 – This parameter is only applicable for non-AAS base stations. Antenna characteristics for AAS base stations (for frequency bands above 1 710 MHz) are provided in Table 9. |

TABLE 5-2

**UE parameters for bands between 1 and 3 GHz**

|  | **Urban/suburban macro** | **Rural macro** | **Small cell (outdoor)/Micro cell** | **Indoor (small cell)** |
| --- | --- | --- | --- | --- |
| **User terminal characteristics** |
| Indoor user terminal usage (Report ITU-R M.2292) | 70% | 50% | 70% | 100% |
| Indoor user terminal penetration loss | Rec. ITU-R P.2109 | Rec. ITU-R P.2109 | Rec. ITU-R P.2109 | Rec. ITU-R P.2109 |
| User equipment density for terminals that are transmitting simultaneously (Note 1) | 3 UEs per sector | 3 UEs per sector | 3 UEs per sector | 3 UEs per sector |
| UE height (Note 2) | 1.5 m | 1.5 m | 1.5 m | 1.5 m |
| Average user terminal output power | Use transmit power control | Use transmit power control | Use transmit power control | Use transmit power control |
| Typical antenna gain for user terminals | −3 dBi | −3 dBi | −3 dBi | −3 dBi |
| Body loss  | 4 dB | 4 dB | 4 dB | 4 dB |
| UE TDD activity factor | 25% | 25% | 25% | 25% |
| **Transmit power control** |
| Power control model | Refer to Recommendation ITU-R M.2101 Annex 1, section 4.1 |
| Maximum user terminal output power, PCMAX | 23 dBm | 23 dBm | 23 dBm | 23 dBm |
| Power (dBm) target value per RB, P0\_PUSCH (Note 3) | −92.2 | −92.2 | −87.2 | −87.2 |
| Path loss compensation factor,  (same as “balancing factor” mentioned in Rec. ITU-R M.2101) | 0.8 | 0.8 | 0.8 | 0.8 |
| Note 1 – UEs share equally the channel bandwidth, i.e. each UE is allocated 1/3 of the channel bandwidth (see Rec. ITU-R M.2101, Section 3.4.1, item 1e-f.). In sharing studies, it is assumed that the AAS BS beamforms towards each UE using the entire array.Note 2 – In principle, indoor UEs are distributed over different floors of the building. It should be noted that the number of floors of buildings vary within the environment and among the countries. Moreover, the number of floors of buildings is not related to Macro BS antenna height (parameter given in the Table). In particular in small cities, sub-urban and rural areas, many or most of antennas are installed on masts. Therefore, for outdoor BSs, indoor UEs are assumed to be modelled on the ground floor for the sharing study.Note 3 – The target power is defined per Resource Block (RB), considering 180 kHz RB bandwidth corresponding to 15 kHz subcarrier spacing. |

**3.2.1.3 3-6 GHz**

Tables 6-1 and 6-2 provide the deployment-related parameters of IMT systems for the frequency bands between 3 and 6 GHz. Implementation of AAS (see Table 9) as well as antenna characteristics in Recommendation ITU-R F.1336 are considered for IMT base stations in these frequency bands. For IMT user equipment / mobile stations, implementation of AAS is not considered.

TABLE 6-1

**Deployment-related parameters for bands between 3 and 6 GHz**

|  | **Rural****(optional, see Note A below)** | **Urban/suburban macro** | **Small cell (outdoor)/Micro cell** | **Indoor (small cell)** |
| --- | --- | --- | --- | --- |
| **Base station characteristics/Cell structure** |
| Cell radius / Deployment density (non-AAS)  | 1.2 km / isolated BSs or a cluster of four BSs with the density of 0.001-0.006 BSs/km2 (Note 2) | Typical cell radius 0.3 km urban / 0.6 km suburban | 1-3 per urban macro cell<1 per suburban macro site | Depending on indoor coverage/ capacity demand |
| Cell radius / Deployment density (AAS)  | 1.6 km / isolated BSs or a cluster of four BSs with the density of 0.001-0.006 BSs/km2 (Note 2) | Typical cell radius 0.4 km urban / 0.8 km suburban(10 BSs/km2 urban / 2.4 BSs/km2 suburban (Note 2)) | 1-3 per urban macro cell<1 per suburban macro site | Depending on indoor coverage/ capacity demand |
| Antenna height  | 35 m | 20 m urban / 25 m suburban | 6 m | 3 m |
| Sectorization | 3 sectors | 3 sectors | Single sector | Single sector |
| Non-AAS BS downtilt (Note 1) | 3 degrees | 10 degrees urban / 6 degrees suburban | n.a. | n.a. |
| Frequency reuse | 1 | 1 | 1 | 1 |
| Non-AAS BS antenna pattern (Note 1) | Recommendation ITU-R F.1336 (*recommends* 3.1) *ka* = 0.7 *kp* = 0.7 *kh* = 0.7 *kv* = 0.3Horizontal 3 dB beamwidth: 65 degreesVertical 3 dB beamwidth: determined from the horizontal beamwidth by equations in Recommendation ITU-R F.1336. Vertical beamwidths of actual antennas may also be used when available. | Recommendation ITU-R F.1336 (*recommends* 3.1) *ka* = 0.7 *kp* = 0.7 *kh* = 0.7 *kv* = 0.3Horizontal 3 dB beamwidth: 65 degreesVertical 3 dB beamwidth: determined from the horizontal beamwidth by equations in Recommendation ITU-R F.1336. Vertical beamwidths of actual antennas may also be used when available. | Recommendation ITU-R F.1336 (omni: *recommends* 2) |
| Non-AAS BS antenna polarization | Linear/±45 degrees | Linear/±45 degrees | Linear | Linear |
| Indoor base station deployment | n.a. | n.a. | n.a. | 100% |
| Indoor base station penetration loss | n.a. | n.a. | n.a. | Rec. ITU-R P.2109 |
| Below rooftop base station antenna deployment  | 0% | Urban: 50%Suburban: 0% | 100% | n.a. |
| Non-AAS BS feeder loss (Note 1) | 3 dB | 3 dB | 3 dB | 3 dB |
| Typical channel bandwidth | 40 or 80 or 100 MHz | 40 or 80 or 100 MHz | 40 or 80 or 100 MHz | 40 or 80 or 100 MHz |
| Maximum Non-AAS BS output power (Note 1) | 52 dBm in 40 MHz55 dBm in 80 MHz56 dBm 100 MHz | 49 dBm in 40 MHz52 dBm in 80 MHz53 dBm in 100MHz  | 24 dBm in 40 or 80 or 100MHz  | 24 dBm in 40 or 80 or 100MHz |
| Maximum Non-AAS BS antenna gain (Note 1) | 18 dBi | 18 dBi | 5 dBi | 0 dBi |
| Maximum Non-AAS BS output power/sector (e.i.r.p.) (Note 1) | 67 dBm in 40 MHz70 dBm in 80 MHz71 dBm in 100 MHz | 64 dBm in 40 MHz67 dBm in 80 MHz68 dBm in 100 MHz | 29 dBm in 40 or 80 or 100 MHz | 24 dBm in 40 or 80 or 100 MHz |
| Network loading factor (base station load probability X%) (see section 3.4 below and Rec. ITU-R M.2101 Annex 1, section 3.4.1 and 6) | 50% | 20%, 50% | 20%, 50% | 20%, 50% |
| Average Non-AAS BS power/sector (e.i.r.p.) taking into account activity factor (Note 1) | Use Rec. ITU-R M.2101 (see section 3.4 below) | Use Rec. ITU-R M.2101 (see section 3.4 below) | Use Rec. ITU-R M.2101 (see section 3.4 below) | Use Rec. ITU-R M.2101 (see section 3.4 below) |
| TDD / FDD | TDD | TDD | TDD | TDD |
| BS TDD activity factor | 75% | 75% | 75% | 75% |
| Note 1 – This parameter is only applicable for non-AAS base stations. Antenna characteristics for AAS base stations (for frequency bands above 1710 MHz) are provided in Table 9.Note 2 – 1 BS = 1 sector in 3-sector cell. |

Note A to Table 6-1 above:
For the 3-6 GHz range, contiguous coverage is not expected in this frequency range in rural areas, and any such base stations that may exist in small numbers will be isolated installations at specific locations, and therefore, the rural deployment environment may or may not be included in the sharing and compatibility studies, depending on the area of study.

TABLE 6-2

**UE parameters for bands between 3 and 6 GHz**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Rural** **(optional, see Note A above)** | **Urban/suburban macro** | **Small cell (outdoor)/Micro cell** | **Indoor (small cell)** |
| **User terminal characteristics** |
| Indoor user terminal usage  | 50% | 70% | 70% | 100% |
| Indoor user terminal penetration loss | Rec. ITU-R P.2109 (traditional building) | Rec. ITU-R P.2109 | Rec. ITU-R P.2109 | Rec. ITU-R P.2109 |
| User equipment density for terminals that are transmitting simultaneously (Note 1) | 3 UEs per sector | 3 UEs per sector | 3 UEs per sector | 3 UEs per sector |
| UE height (Note 2) | 1.5 m | 1.5 m | 1.5 m | 1.5 m |
| Average user terminal output power | Use transmit power control | Use transmit power control | Use transmit power control | Use transmit power control |
| Typical antenna gain for user terminals | −4 dBi | −4 dBi | −4 dBi | −4 dBi |
| Body loss  | 4 dB | 4 dB | 4 dB | 4 dB |
| UE TDD activity factor | 25% | 25% | 25% | 25% |
| **Transmit power control** |
| Power control model | Refer to Recommendation ITU-R M.2101 Annex 1, section 4.1 |
| Maximum user terminal output power, PCMAX | 23 dBm | 23 dBm | 23 dBm | 23 dBm |
| Power (dBm) target value per RB, P0\_PUSCH (Note 3) | −92.2 | −92.2 | −87.2 | −87.2 |
| Path loss compensation factor,  (same as “balancing factor” mentioned in Rec. ITU-R M.2101) | 0.8 | 0.8 | 0.8 | 0.8 |
| Note 1 – UEs share equally the channel bandwidth, i.e. each UE is allocated 1/3 of the channel bandwidth (see Rec. ITU-R M.2101, Section 3.4.1, item 1e-f.). In sharing studies, it is assumed that the AAS BS beamforms towards each UE using the entire array.Note 2 – In principle, indoor UEs are distributed over different floors of the building. It should be noted that the number of floors of buildings vary within the environment and among the countries. Moreover, the number of floors of buildings is not related to Macro BS antenna height (parameter given in the Table). In particular in small cities, sub-urban and rural areas, many or most of antennas are installed on masts. Therefore, for outdoor BSs, indoor UEs are assumed to be modelled on the ground floor for the sharing study.Note 3 – The target power is defined per Resource Block (RB), considering 180 kHz RB bandwidth corresponding to 15 kHz subcarrier spacing. |

**3.2.1.4 6-8 GHz**

Tables 7-1 and 7-2 provide the deployment-related parameters of IMT systems for the frequency bands between 6 and 8 GHz. Implementation of AAS (see Table 10) is considered for IMT base stations in these frequency bands. Implementation of AAS is not considered in IMT user equipment / mobile stations.

TABLE 7-1

**Deployment-related parameters for bands between 6 and 8 GHz**

|  | **Urban/suburban macro** | **Small cell (outdoor)/Micro cell** | **Indoor (small cell)** |
| --- | --- | --- | --- |
| Deployment density (Note 1) | 10 BSs/km2 urban / 2.4 BSs/km2 suburban (Note 2, 3) | 1-3 per urban macro cell<1 per suburban macro site | Depending on indoor coverage/capacity demand |
| Antenna height | 18 m urban / 20 m suburban | 6 m | 3 m |
| Sectorization | 3 sectors | Single sector | Single sector |
| Frequency reuse | 1 | 1 | 1 |
| Indoor base station deployment | n.a. | n.a. | 100% |
| Indoor base station penetration loss | n.a. | n.a. | Rec. ITU-R P.2109 |
| Below rooftop base station antenna deployment | Urban: 65%Suburban: 15% | 100% | n.a. |
| Typical channel bandwidth | 100MHz | 100 MHz | 100 MHz |
| Network loading factor (base station load probability X%) (see section 3.1.4 below and Rec. ITU-R M.2101 Annex 1, section 3.4.1 and 6) | 20%, 50% | 20%, 50% | 20%, 50% |
| TDD / FDD | TDD | TDD | TDD |
| BS TDD activity factor | 75% | 75% | 75% |

NOTE for table 7-1:

For the 6-8 GHz range, contiguous coverage is not expected in this frequency range in rural areas, and any such base stations that may exist in small numbers will be isolated installations at specific locations, and therefore, the rural deployment environment may or may not be included in the sharing and compatibility studies.

If the rural deployment environment is modelled in a sharing study, it should assume the BS density (per sector) of 0.001 - 0.006 BS per km2 as well as the below rooftop base station antenna deployment of 0%. Other parameters for the rural deployment should be the same as the suburban parameters found in the column for urban/suburban macro for base station in Table 7-1, for UE in Table 7-2 and for AAS in Table 10 (macro suburban).

Considerations should be given that the above BS density (per sector) values should be applied for the rural areas of the entire coverage area of the interfered system that is under study (e.g., the entire satellite footprint), taking into account the size of this entire coverage area, and the chosen value should be given together with the results of studies. These BS density (per sector) values have been derived for an area of around 100 000-500 000 km2 and some initial analysis subject to further verification showed it could be applicable up to 2 000 000 km2.

For studies involving IMT deployments over smaller or larger areas, including the case where mixed environments of urban, sub-urban and rural are considered in the satellite footprint, it may not be appropriate to assume that IMT base stations will be deployed at the same density as the above across the whole area, and thus, the deployment density values may need to be adjusted. This adjustment should be explained together with the results of studies.

It should be noted that the 'Ra, Rb methodology' described in Section 3.3 needs to be further developed in order to fully accommodate the rural deployment scenario.

TABLE 7-2

**UE parameters for bands between 6 and 8 GHz**

|  | **Urban/suburban macro** | **Small cell (outdoor)/Micro cell** | **Indoor (small cell)** |
| --- | --- | --- | --- |
| Indoor user terminal usage | 70% | 70% | 100% |
| Indoor user terminal penetration loss | Rec. ITU-R P.2109 | Rec. ITU-R P.2109 | Rec. ITU-R P.2109 |
| User equipment density for terminals that are transmitting simultaneously (Note 1) | 3 UEs per sector | 3 UEs per sector | 3 UEs per sector |
| UE height (Note 2) | 1.5 m | 1.5 m | 1.5 m |
| Average user terminal output power | Use transmit power control | Use transmit power control | Use transmit power control |
| Typical antenna gain for user terminals | −4 dBi | −4 dBi | −4 dBi |
| Body loss  | 4 dB | 4 dB | 4 dB |
| UE TDD activity factor | 25% | 25% | 25% |
| Power control model | Refer to Recommendation ITU-R M.2101 Annex 1, section 4.1 |
| Maximum user terminal output power, PCMAX | 23 dBm | 23 dBm | 23 dBm |
| Power (dBm) target value per RB, P0\_PUSCH (Note 3) | −92.2 | −87.2 | −87.2 |
| Path loss compensation factor,  (same as “balancing factor” mentioned in Rec. ITU-R M.2101) | 0.8 | 0.8 | 0.8 |

**3.2.1.5 10-11 GHz**

Tables 8-1 and 8-2 provide the deployment-related parameters of IMT systems for the frequency bands between 10 and 11 GHz. Implementation of AAS (see Table 10) is considered for IMT base stations in these frequency bands. Implementation of AAS is not considered in IMT user equipment / mobile stations.

TABLE 8-1

**Deployment-related parameters for bands between 10 and 11 GHz**

|  | **Urban/suburban hotspot (outdoor)** | **Indoor** |
| --- | --- | --- |
| **Base station characteristics/Cell structure** |
| Deployment density (Note 1) | 30 BSs/km2 urban / 10 BSs/km2 suburban | Depending on indoor coverage/capacity demand |
| Antenna height | 6 m | 3 m |
| Sectorization | Single sector | Single sector |
| Downtilt  | See Table 10 | See Table 10 |
| Frequency reuse | 1 | 1 |
| Indoor base station deployment | n.a. | 100% |
| Indoor base station penetration loss | n.a. | Rec. ITU-R P.2109 |
| Below rooftop base station antenna deployment | 100% (Note 2) | n.a. |
| Typical channel bandwidth | 100 MHz | 100 MHz |
| Network loading factor (base station load probability X%) (see section 3.1.4 below and Rec. ITU-R M.2101 Annex 1, section 3.4.1 and 6) | 20%, 50% | 20%, 50% |
| TDD / FDD | TDD | TDD |
| BS TDD activity factor | 75% | 75% |

Note to Table 8-1 above:

For the 10-11 GHz range, the typical deployment is urban and suburban hotspots, both outdoors and indoors. There will be occasional roof-mounted base stations, in particular in suburban areas, however this will not be typical deployment. For the sharing and compatibility studies in the frequency bands between 10 and 11 GHz, if the 'isolated outdoor suburban open space hotspot' deployment scenario is studied, the suburban hotspot technical characteristics should be used, except that antenna height = 15 m, below rooftop base station antenna deployment = 0 % and single isolated BS.

TABLE 8-2

**UE parameters for bands between 10 and 11 GHz**

|  | **Urban/suburban hotspot (outdoor)** | **Indoor (small cell)** |
| --- | --- | --- |
| **User terminal characteristics** |
| Indoor user terminal usage | 5% | 100% |
| Indoor user terminal penetration loss | Rec. ITU-R P.2109 | Rec. ITU-R P.2109 |
| User equipment density for terminals that are transmitting simultaneously (Note 1) | 3 UEs per sector | 3 UEs per sector |
| UE height (Note 2) | 1.5 m | 1.5 m |
| Average user terminal output power | Use transmit power control | Use transmit power control |
| Typical antenna gain for user terminals | −4 dBi | −4 dBi |
| Body loss  | 4 dB | 4 dB |
| UE TDD activity factor | 25% | 25% |
| **Transmit power control** |
| Power control model:  | Refer to Recommendation ITU-R M.2101, Annex 1, section 4.1 |
| Maximum user terminal output power, PCMAX | 23 dBm | 23 dBm |
| Power (dBm) target value per RB, P0\_PUSCH (Note 3) | −95 | −95 |
| Path loss compensation factor,  (same as “balancing factor” mentioned in Rec. ITU-R M.2101) | 1 | 1 |
| Note 1 – UEs share equally the channel bandwidth, i.e. each UE is allocated 1/3 of the channel bandwidth (see Rec. ITU-R M.2101, Section 3.4.1, item 1e-f.). In sharing studies, it is assumed that the AAS BS beamforms towards each UE using the entire array.Note 2 – In principle, indoor UEs are distributed over different floors of the building. It should be noted that the number of floors of buildings vary within the environment and among the countries. Moreover, the number of floors of buildings is not related to Macro BS antenna height (parameter given in the Table). In particular in small cities, sub-urban and rural areas, many or most of antennas are installed on masts. Therefore, for outdoor BSs, indoor UEs are assumed to be modelled on the ground floor for the sharing study.Note 3 – The target power is defined per Resource Block (RB), considering 180 kHz RB bandwidth corresponding to 15 kHz subcarrier spacing. |

**3.2.1.6 Antenna characteristics for IMT-2020 AAS base stations**

Antenna characteristics for IMT-2020 AAS base stations are given in below Tables 9 and 10. Those parameters are interdependent and derived as a package, based on deployment scenarios and other requirements.

TABLE 9

**Beamforming antenna characteristics for IMT in 1 710-4 990 MHz**

|  |  | **Rural macro** | **Suburban macro** | **Urban macro** | **Urban small cell (outdoor)/Micro cell**  | **Indoor (small cell)** |
| --- | --- | --- | --- | --- | --- | --- |
| **1** | **Base station antenna characteristics** |
| 1.1 | Antenna pattern  | Refer to the extended AAS model in Table A of Annex 3 | Refer to section 5 of 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)  | N/A |
| 1.2 | Element gain (dBi) (Note 1) |  6.4 |  6.4 | 6.4 | 6.4 | N/A |
| 1.3 | Horizontal/vertical 3 dB beam width of single element (degree)  | 90º for H 65º for V | 90º for H 65º 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 | Linear ±45º | Linear ±45º | Linear ±45º | N/A |
| 1.6 | Antenna array configuration (Row × Column) (Note 2) |  4 × 8 elements |  4 × 8 elements |  4 × 8 elements | 8 × 8 elements | N/A |
| 1.7 | Horizontal/Vertical radiating element/sub-array spacing, *dh* /*dv*  | 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, *Msub* | 3 | 3 | 3 | N/A | N/A |
| 1.7b | Vertical radiating element spacing in sub-array, *dv,sub* | 0.7 of wavelength of V | 0.7 of wavelength of V | 0.7 of wavelength of V | N/A | N/A |
| 1.7c | Pre-set sub-array down-tilt, *θsubtilt* (degrees) | 3 | 3 | 3 | N/A | N/A |
| 1.8 | Array Ohmic loss (dB) (Note 1) | 2 | 2 | 2 | 2 | N/A |
| 1.9 | Conducted power (before Ohmic loss) per antenna element/sub-array (dBm) (Note 5, 6)  | 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) (Notes 3, 4, 7) | 90-100 | 90-100 | 90-100 | 90-120 | N/A |
| 1.12 | Mechanical downtilt (degrees) (Note 4) | 3 | 6 | 6 | 10 | N/A |
| 1.13 | Maximum base station output power/sector (e.i.r.p.) (dBm) | 72.28 | 72.28 | 72.28 | 61.53 | N/A |
| Note 1: The element gain in row 1.2 includes the loss given in row 1.8 and is per polarization. This means that this parameter in row 1.8 is not needed for the calculation of the BS composite antenna gain and e.i.r.p. Note 2: For the small/micro cell case, 8 × 8 means there are 8 vertical and 8 horizontal radiating elements. For the extended AAS model case, 4 × 8 means there are 4 vertical and 8 horizontal radiating sub-arrays.Note 3: The vertical coverage range is given in global coordinate system, i.e. 90° being at the horizon.Note 4: The vertical coverage range in row 1.11 includes the mechanical downtilt given in row 1.12.Note 5: The conducted power per element assumes 8 × 8 × 2 elements for the micro/small cell case, and 4 x 8 x 2 sub-arrays for the macro case (i.e. power per H/V polarized element). Note 6: In sharing studies, the transmit power calculated using row 1.9 is applied to the typical channel bandwidth given in Table 5-1 and 6-1 respectively for the corresponding frequency bands.Note 7: In sharing studies, the UEs that are below the base station vertical coverage range can be considered to be served by the “lower” bound of the electrical beam, i.e. beam steered towards the max. coverage angle. A minimum BS-UE distance along the ground of 35m should be used for urban/suburban and rural macro environments, 5 m for micro/outdoor small cell, and 2 m for indoor small cell/urban scenarios. |

TABLE 10

**Beamforming antenna characteristics for IMT in 6 425-10 500 MHz**

|  |  |  | **Macro suburban** | **Macro urban** | **Small cell outdoor/Micro urban** | **Small cell indoor/Indoor 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) Annex 1, section 5 |
| 1.2 | Element gain (dBi) (Note 1) |  | 6.4 | 5.5 | 5.5 | 5.5 |
| 1.3 | Horizontal/vertical 3 dB beamwidth of single element (degree)  |  | 90º for H65º for V | 90º for H90º for V | 90º for H90º for V | 90º for H90º 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 | 30 for both H/V |
| 1.5 | Antenna polarization  |  | Linear ±45º | Linear ±45º | Linear ±45º | Linear ±45º |
| 1.6 | Antenna array configuration (Row × Column) (Note 2) |  | 16 × 8 elements | 16 × 8 elements | 8 × 8 elements | 4 × 4 elements |
| 1.7 | Horizontal/Vertical radiating element spacing  |  | 0.5 of wavelengthfor H, 0.7 of wavelength for V | 0.5 of wavelength for H, 0.5 of wavelength for V | 0.5 of wavelength for H, 0.5 of wavelength for V | 0.5 of wavelength for H, 0.5 of wavelength for V |
| 1.8 | Array Ohmic loss (dB) (Note 1) |  | 2 | 2 | 2 | 2 |
| 1.9 | Conducted power (before Ohmic loss) per antenna element (dBm) (Note 9) |  | 22(Note 5) | 22(Note 5) | 16(Note 6) | 9(Note 7) |
| 1.10 | Base station maximum coverage angle in the horizontal plane (degrees) |  | ±60 | ±60 | ±60 | N/A(Note 8) |
| 1.11 | Base station vertical coverage range (degrees) (Notes 3, 4, 10) |  | 90-100 | 90-120 | 90-120 | N/A(Note 8) |
| 1.12 | Mechanical downtilt (degrees) (Note 4) |  | 6 | 10 | 10 | N/A (Note 8) |
| Note 1: The element gain in row 1.2 includes the loss given in row 1.8. This means that this parameter in row 1.8 is not needed for the calculation of the BS composite antenna gain and e.i.r.p.Note 2: 16 × 8 means there are 16 vertical and 8 horizontal radiating elements. In the sub-array case, one implementation is 2 vertical radiating elements combined in a 2 × 1 sub-array.Note 3: The vertical coverage range is given in global coordinate system, i.e. 90° being at the horizon.Note 4: The vertical coverage range in row 1.11 includes the mechanical downtilt given in row 1.12.Note 5: The conducted power per element assumes 16 × 8 × 2 elements (i.e. power per H/V polarized element).Note 6: The conducted power per element assumes 8 × 8 × 2 elements (i.e. power per H/V polarized element).Note 7: The conducted power per element assumes 4 × 4 × 2 elements (i.e. power per H/V polarized element).Note 8: The boresight direction is perpendicular to the ceiling. Note 9: In sharing studies, the transmit power calculated using row 1.9 is applied to the typical bandwidth given in Table 7-1 and 8-1 respectively for the corresponding frequency bands.Note 10: In sharing studies, the UEs that are below the coverage range can be considered to be served by the “lower” bound of the electrical beam, i.e. beam steered towards the max. coverage angle. A minimum BS-UE distance along the ground of 35 m should be used for urban/suburban and rural macro environments, 5 m for micro/outdoor small cell, and 2 m for indoor small cell/urban scenarios. |

**3.3 Deployment consideration in a relatively large area**

The IMT deployment density values given in the tables in Section 3.2.1 are for areas where there is high density / contiguous deployment of IMT base stations in a particular frequency band across the whole area. These values are applicable for studies that are considering IMT deployment in a relatively small area, e.g. a small ‘cluster’ of cells/base stations providing contiguous coverage in a particular area. For studies involving IMT deployments over wider areas, however, it is unrealistic to assume that IMT base stations will be deployed at the same high density across the whole area, and the deployment density values in the tables in Section 3.2.1 will need to be adjusted. Similarly, the user terminal density values in the tables in Section 3.2.1 are applicable only for studies that are considering an IMT deployment in a small area and will need to be adjusted in a similar manner for studies that are considering IMT deployments over wider areas.

Therefore, as IMT base stations and user equipment will not be deployed at the same very high density across a large area, the deployment density values will need to be adjusted for large area cases according to the ratio of coverage area to the total large area in study.

Considering the difference of propagation characteristics and available bandwidth etc., relatively large area IMT stations deployment characteristic is frequency and scenario specific, e.g. the higher frequency with larger bandwidth maybe more suitable for capacity enhancement and the deployment characteristic for large area is different from coverage. In addition, IMT station deployment in some frequency bands could be considered as complementary of existing IMT systems, e.g. base stations can be deployed in the areas where existing IMT system cannot satisfy the traffic requirement.

The deployment density values for large area (Dl) to be used in a sharing study is therefore calculated according to the following formula:

 *Dl = Ds \* Ra \* Rb*

where:

 *Ds* = density value for coverage area, i.e. density of simultaneously transmitting UEs or number of BS per km2;

 *Ra* (%) = ratio of coverage areas to areas of cities/built areas/districts;

 *Rb* (%) = ratio of built areas to total area of region in study.

**6-8 GHz frequency range**

The Ra value depends on frequency band and deployment environment. The Ra for 6-8 GHz band would be larger than that for millimetre wave band, noting that 6-8 GHz band is mainly used for capacity enhancement purpose by macro cell and small cell deployments, whereas millimetre wave band is mainly used for capacity enhancement by hotspot deployment. However, IMT base stations in a particular band between 6 and 8 GHz will not be deployed across the entire area of a city, and an Ra value of 100% would greatly over-estimate the number of base stations.

Rb is independent from frequency band and deployment environment. When the size of area under the study is very large assuming very large satellite-footprint or countries the Rb value needs to be decreased to reflect sparse population density of the countries.

For sharing and compatibility studies concerning potential interference into a satellite space station, it is the size of the satellite footprint that is relevant rather than countries. A large satellite footprint will in most cases cover (parts of) a number of countries (unless it is entirely within a very large country), and there may in many cases also be bodies of water within the footprint.

Considering the above, in the case of a study in the frequency band 6-8 GHz, the Ra, and Rb values in Table 11 should be used.

TABLE 11

**Values for Ra and Rb to be used in studies involving IMT deployments for
frequency bands between 6 and 8 GHz**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Options\*** | **Macro** | **Micro** |
| Ra | 1 | 30% Urban, 10% Suburban | 10% Urban |
| 2 | 30% Urban, 18% Suburban | TBD |
| 3 | 40% Urban, 20% Suburban | 10% Urban |
| 4 | 50% Urban, 20% Suburban | 10% Urban |
| 5 | 30% Urban (area < 200 000 km2)10% Urban (area > 200 000 km2)10% Suburban (area < 200 000 km2)15% Suburban (area > 200 000 km2) | 10% Urban (area < 200 000 km2)5% Urban (area > 200 000 km2) |
| Rb (depending on the area under study) | 1 | 5% (area < 200 000 km2)2% (200 000 - 1 000 000 km2)1% (area > 1 000 000 km2) | 5% (area < 200 000 km2)2% (200 000 - 1 000 000 km2)1% (area > 1 000 000 km2) |
| 2 | 5% (area < 3 500 000 km2)3% (area > 3 500 000 km2) | 5% (area < 3 500 000 km2)3% (area > 3 500 000 km2) |
| 3 | 2.5% (area < 200 000 km2)\*\*2% (200 000 - 1 000 000 km2)1% (area > 1 000 000 km2) | 2.5% (area < 200 000 km2)\*\*2% (200 000 - 1 000 000 km2)1% (area > 1 000 000 km2) |
| \* The Ra and Rb values used in the sharing and compatibility studies should be provided together with the results of studies, for the purpose of comparison, as well as information on which specific geographical location the analysis is applicable to.\*\* The value is applicable for Region 1, for bands considered globally the value of 5% should be used. |

[OR]

In the objective to define a satellite operational coverage, the satellite footprint could be defined as the projection on Earth of the antenna beamwidth at -3dB. However, for sharing and compatibility studies, it may be necessary to model sources of interference which are operating within the satellite receiving antenna pattern but which are beyond the satellite operational coverage

**10-11 GHz frequency range**

In the case of a study in the frequency band 10-11 GHz, the Ra and Rb values in Table 12 below should be used.

TABLE 12

**Values for Ra and Rb to be used in studies involving IMT deployments for
frequency bands between 10 and 11 GHz**

|  |  |  |
| --- | --- | --- |
|  | Option\*  | Hotspots (outdoor) |
| Ra | 1 | 7% Urban3% Suburban |
| Rb (depending on the area under study) | 1 | 5% (area < 200 000 km2)2% (200 000 - 1 000 000 km2)1% (area > 1 000 000 km2) |
| 2 | 2.5%\*\* (area < 200 000 km2)2% (200 000 - 1 000 000 km2)1% (area > 1 000 000 km2) |
| 3 | 5% (area < 3 500 000 km2)3% (area > 3 500 000 km2) |
| \* The Ra and Rb values used in the sharing and compatibility studies should be provided together with the results of studies, for the purpose of comparison, as well as information on which specific geographical location the analysis is applicable to.\*\* The value is applicable for Region 2, for bands considered globally the value of 5% should be used. |

[OR]

In the objective to define a satellite operational coverage, the satellite footprint could be defined as the projection on Earth of the antenna beamwidth at -3dB. However, for sharing and compatibility studies, it may be necessary to model sources of interference which are operating within the satellite receiving antenna pattern but which are beyond the satellite operational coverage

**3.4 Network loading factor**

Network loading factors provided in this document reflect average IMT base station activity. In order to provide required and adequate quality of service, IMT networks are designed and dimensioned to avoid undue congestion, such that, overall cells in a network, most of the cells are not heavily loaded simultaneously and only a small percentage of cells are heavily loaded at any specific point in time. The average loading will therefore be significantly lower when averaged over a sufficient number of IMT transmitters.

A network loading value of 20% would normally represent a typical/average value for the loading of base stations across a network (or part thereof), and should be used for sharing and compatibility studies that are considering a relatively wide area (e.g. a large city, province, country or satellite footprint). For studies involving only a small area where there are only a few IMT transmitters, a maximum network loading value of not more than 50% may be used.

In a small area with a few IMT transmitters, if the loading is approaching 50%, then the IMT network performance will not be sufficient (e.g. dropped calls will occur, etc.) and more capacity will need to be installed. This can be solved by off-loading to other frequency bands, addition of additional frequency channels or installation of additional base stations. Mobile operators will try to avoid local situations where loading is greater than 20%. For larger areas a network loading factor of 20% should be used. This area will include a sufficient number of base stations to allow for averaging between highly loaded and lightly loaded base stations.

**3.5 Protection criterion for IMT**

Table 12 contains the IMT protection criterion (irrespective of the number of cells and independent of the number of interferers). This criterion has been developed without considering any percentage of time related to it.

TABLE 12

**Protection criterion for IMT**

|  |  |
| --- | --- |
| Protection criterion (I/N) | -6 dB |

Annex 1

This Annex excerpted the materials contained in [3GPP TS 38.104 v.16.6.0](http://www.3gpp.org/ftp/Specs/archive/38_series/38.104/38104-g60.zip), which are referred to in Tables 1 and 3-1, regarding the IMT-2020 base station specification-related parameters.



Annex 2

This Annex excerpted the materials contained in [3GPP TS 38.101-1 v.16.6.0](http://www.3gpp.org/ftp/Specs/archive/38_series/38.101-1/38101-1-g60.zip), which are referred to in Tables 1 and 3-1, regarding the IMT-2020 mobile station specification-related parameters.



Annex 3

This Annex provides modelling information on extension of IMT array antenna model to support sub-array structures 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 using a common element excitation, which is connected to a single transceiver branch.

The intention with this 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 provided previously do 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 below Table A.

Table A

**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 9, 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 9, row 1.6. |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_