# PARAMETERS AND DEPLOYMENT CONSIDERATIONS

The following tables present the relevant system and deployment related parameters used in this report.

Table 1: WBB system and deployment-related parameters

| Parameter | Value |
| --- | --- |
| **Base Station** | |
| Carrier frequency | 3.85 GHz |
| Channel bandwidth | 100 MHz |
| BS Antenna height | 10 m |
| Cell radius | 400 m |
| Sectorization | 1 sector |
| Frequency reuse | 1 |
| BS TDD activity factor | 75% |
| Network loading factor | 100% and 50% |
| **User Terminal** | |
| UE height | 1.5 m |
| UE density for terminals that are transmitting simultaneously | 3 UEs per sector |
| UE deployment | Uniform and Rayleigh distributions |

Table 2: Antenna and power characteristics for WBB systems

| Parameter | Value |
| --- | --- |
| **Base station (AAS)** | |
| 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!!PDF-E.pdf) |
| Element gain (incl. Ohmic loss) (dBi) | 6.4 |
| Horizontal/vertical 3 dB beamwidth of single element (degree) | 90º for H  65º for V |
| Horizontal/vertical front to back ratio (dB) | 30 for both H/V |
| Antenna polarization | Linear ±45º |
| Antenna array configuration\*  (Row × Column) | 8×8 and 4×4 |
| Horizontal/Vertical radiating element spacing | 0.5 of wavelength for H  0.7 of wavelength for V |
| Array Ohmic loss (dB) | 2 |
| Conducted power (before Ohmic loss) per antenna element for 8×8 AAS\*\* (dBm) | 5.5 (corresponding to a TRP = 24.6 dBm) |
| Conducted power (before Ohmic loss) per antenna element for 4×4 AAS\*\* (dBm) | 17.5 (corresponding to a TRP = 30.6 dBm) |
| Base station maximum coverage angle in the horizontal plane (degrees) | ±60 |
| Base station vertical coverage range\*\*\* (degrees) | 90-120 |
| Mechanical downtilt (degrees) | 10 |
| Maximum base station EIRP for 8×8 AAS (dBm/5MHz) | 38 (51 dBm/100MHz)\*\*\*\* |
| Maximum base station EIRP for 4×4 AAS (dBm/5MHz) |
| \* For the small/micro cell case, for example, 8×8 means there are 8 vertical and 8 horizontal radiating elements.  \*\* For example, for an 8×8 AAS, the conducted power per element assumes 8×8×2 elements (i.e., power per H/V polarized element).  \*\*\* The vertical coverage range includes the mechanical downtilt. 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.  \*\*\*\* A 51 dBm/100MHz EIRP corresponds to WBB MP BS considering the incremental approach. | |

The FS parameters considered in this study are based on the technical, operational characteristics, and protection criteria agreed during the development of this report. In addition, some additional parameters such as the antenna sizes and heights of FS stations within the range provided by some administrations (Case 1 and 2) are also considered. Table 3 contains the FS parameters used in this study and Table 4 contains the FS protection criteria.

Table 3: FS Parameters

| Parameter | Value |
| --- | --- |
| Antenna height (m) | 15[[1]](#footnote-2) (Case 1), 50 (Generic case), 80 (Case 2) |
| Peak antenna gain (dBi) | 42[[2]](#footnote-3) (Generic case and Case 1), 38 (Case 2) |
| Antenna diameter[[3]](#footnote-4) (m) | 4 (Generic case and Case 1), 2.6 (Case 2) |
| Antenna pattern | Refer to Recommendation [ITU-R F.699](https://www.itu.int/dms_pubrec/itu-r/rec/f/R-REC-F.699-8-201801-I!!PDF-E.pdf) |
| Antenna elevation angle (degrees) | 0 |
| Noise Figure and Feeder Loss (dB) | 3 |
| Receiver temperature (K°) | 290 |

Table 4: FS Protection Criteria

| **Frequency Ranges** | **Percentage of time for which the I/N value could be exceeded (%)** | **I/N Criteria (dB)** |
| --- | --- | --- |
| Above 3 GHz | 20%  0.005%[[4]](#footnote-5) | −10  +10 |

It is noted that the chosen short-term criterion of I/N = +10 dB is only assessed as sensitivity analysis.

## DEPLOYMENT

The WBB local network consists of a single base station (BS) which is always facing the FS stations (worst-case). The BS beams direction are still randomised to point towards the UEs within the coverage area. Figure 1 shows an example of a WBB BS and a FS station when they are positioned facing each other with a separation distance of 3 km. In each snapshot of the Monte Carlo simulation, 3 user equipment (UE) are uniformly distributed within each BS sector as shown in Figure 2(a).

For sensitivity analyses, the 3 UE positions are randomly distributed with azimuth angles ranging from -60° to 60° following a uniform distribution, and their ground distances from the BS are randomly generated using a Rayleigh distribution as shown in Figure 2(b). This distribution is deemed suitable for non-public local networks provided that these networks are deployed where users are expected to remain in the local network cell, rather than moving between different cells as in MFCN networks.

The Rayleigh distribution describes the magnitude distribution of a two-dimensional random vector, where the coordinates consist of independent, identically distributed normal variables with a mean of 0. In this study, a standard deviation (σ) of 64 is employed for the normal variables to generate the Rayleigh distribution, with which occasional cell-edge UEs are deployed close to 400 m from the WBB BS. This distribution results in 99.99% of the UEs being deployed at a ground distance from the WBB BS of equal to or less than 300m as indicated in Table 5. Furthermore, this distribution was suggested for hotspots deployments by the ITU-R task group TG 5/1 towards WRC-19[[5]](#footnote-6). Hotspot deployments are assumed here to be similar to those for WBB MP networks.

Table 5: Rayleigh distribution statistics in this study

| **Ground distance range (m)** | **Area of total cell** | **Share of UEs** |
| --- | --- | --- |
| 0-100 | 6.3% | 70.5% |
| 100-200 | 18.8% | 28.7% |
| 200-300 | 31.3% | 0.75% |
| 300-400 | 43.8% | 0.0017% |

It is noted that the WBB BS transmit power is assumed to be split equally among its UEs, meaning that the transmit power for each UE is 10log10(1/3) = ‑4.77 dB lower than the total transmit power of the BS. For simplicity, a common latitude of 50° is used for all cases.

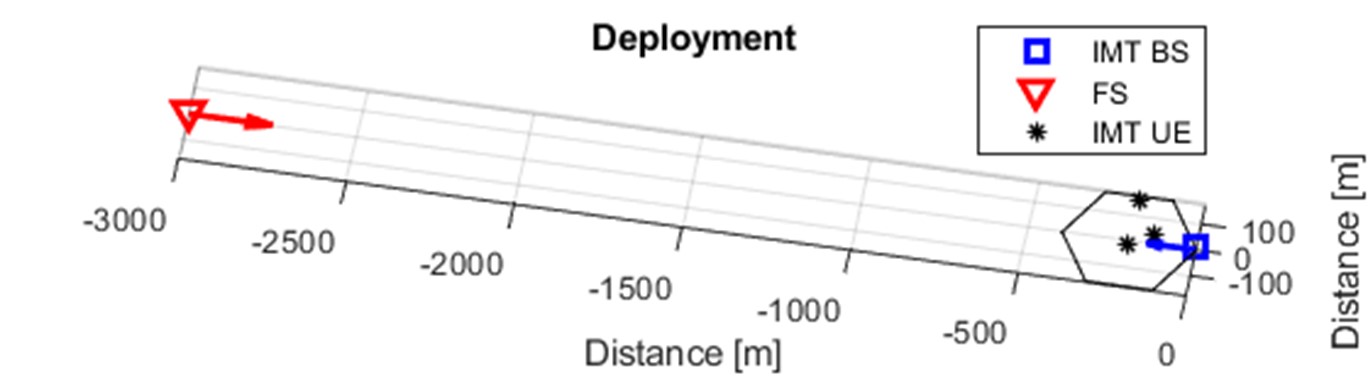


Figure 1. Deployment comprising a single FS station and a single WBB BS

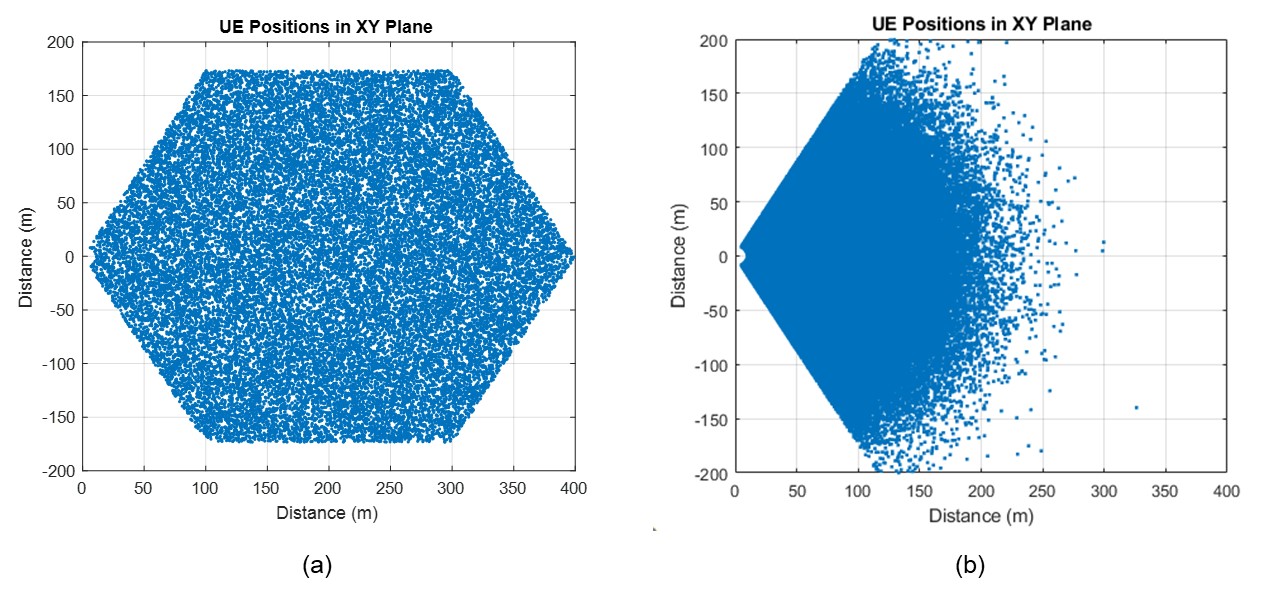


Figure 2. UE deployment: (a) uniform distribution and (b) Rayleigh distribution

## ADDITIONAL CONSIDERATIONS

### Recommendation ITU-R P.452-17 time percentage

The Rec. ITU-R P.452-17 is used in this sharing study between stations on the surface of the Earth as specified by the ITU-R working parties (WPs) 3K and 3M (document [5D/722](https://www.itu.int/md/R19-WP5D-C-0722/en)). A smooth earth surface is assumed. Furthermore, to extend ITU-R P.452 model time percentage (Tpc) range to 0-100%, the ITU-R study group 3 (SG3) guidance (document [6A/198](https://www.itu.int/md/R12-WP6A-C-0198/en)) is that for Tpc > 50% the basic transmission losses are equal to the case Tpc = 50, thus, we use a random variable with a uniform distribution for Tpc between 0-100% with the previous condition.

### Clutter loss

Due to the lack of exact information regarding vegetation and other obstacles along the propagation path, the use of the clutter loss model in Rec. ITU-R P.2108 is a good compromise to account for the additional attenuation due to vegetation and/or other objects. In this study, the clutter losses for terrestrial paths are calculated in accordance with Rec. ITU-R P.2108-1 using a fixed percentage of locations equal to 50% on at least one end of the propagation path (resulting in a clutter loss of ~30.78 dB when the separation distance is larger than ~3km, in line with the characterization of the clutter in urban scenario). Note that this Recommendation indicates that statistical models can be applied for urban and suburban clutter loss modelling, so they cannot be applied for the rural scenario. These models should be used when the characteristics of the radio path, such as the height of buildings and the depth of vegetation, are not well known.

### TDD and Network loading factors

To incorporate these factors into the single-entry simulations, we first conduct Monte Carlo simulations, assuming the WBB BS is always transmitting in every snapshot, i.e., a 100% activity factor. Subsequently, once the interference results of all Monte Carlo snapshots are available in vector form, we extend this vector with empty snapshots (*-Inf* dB), so the following ratio corresponds to the overall activity factor:

Thus, the empty elements in the vector account for the assumed inactivity of the WBB BS. For instance, if the number of empty snapshots is 0, the activity factor is 100%. Conversely, if the number of empty snapshots is significantly greater than that of the active ones, the activity factor will tend to zero.

# Monte carlo Study Results

In this study, for different ground distances between the WBB BS and the FS station, we assume that the WBB BS is always facing the FS station around it (worst-case). Additionally, it is reasonable to assume that the WBB base station is active either 100% or 50% of the time, accounting for varying network loading factors. Moreover, if a TDD activity factor of 75% for downlink (3:1) is considered, the equivalent activity factor becomes 37.5% (50%x0.75). Results are provided for two overall activity factors, 100% and 37.5%.

## Long-term criterion

In this section, we provide the separation distances for the long-term criterion for WBB BS with AAS and clutter losses only on one end of the propagation path. The next table summarizes the separation distances assuming baseline parameters for the instances where the BS is facing the main-lobe (i.e., aligned in azimuth with the FS station) and facing the back-lobe of the FS station:

Table 6: Separation distances using baseline parameters and UE uniform distribution

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **WBB BS** | **Case** | **Maximum EIRP (dBm/100MHz)** | **FS Pattern** | **Activity factor** | **Main-lobe** **(km)** | **Back-lobe** **(km)** |
| 8×8 AAS | Generic | 51 | F.699 | 100% | < 46.5 | < 1 |
| 8×8 AAS | Generic | 51 | F.699 | 37.5% | < 41 | < 0.5 |
| 8×8 AAS | 1 | 51 | F.699 | 100% | < 32.5 | < 1 |
| 8×8 AAS | 1 | 51 | F.699 | 37.5% | < 28 | < 1 |
| 8×8 AAS | 2 | 51 | F.699 | 100% | < 50 | < 0.5 |
| 8×8 AAS | 2 | 51 | F.699 | 37.5% | < 44.5 | < 0.5 |
| 4×4 AAS | Generic | 51 | F.699 | 100% | < 51.5 | < 1.5 |
| 4×4 AAS | Generic | 51 | F.699 | 37.5% | < 47.5 | < 1.5 |
| 4×4 AAS | 1 | 51 | F.699 | 100% | < 37 | < 2 |
| 4×4 AAS | 1 | 51 | F.699 | 37.5% | < 34 | < 1.5 |
| 4×4 AAS | 2 | 51 | F.699 | 100% | < 56 | < 2 |
| 4×4 AAS | 2 | 51 | F.699 | 37.5% | < 51.5 | < 1.5 |

Note that the separation distances change depending on the activity factors assumed, thus it is important to account for this parameter.

Figure 3 shows the I/N values for a probability of 20% around the FS station (Generic case) with an activity factor of 100% for the case of a BS with an 8x8 array size. The darkened area corresponds to locations where the I/N protection criterion is exceeded.



Figure 3. Generic case: (a) I/N around the FS station and (b) I/N CDF at 46.5 km from the FS station (facing main-lobe)

Figure 4 shows the I/N values for a probability of 20% around the FS station (Generic case) with an activity factor of 100% for the case of a BS with an 4x4 array size.



Figure 4. Generic case: (a) I/N around the FS station and (b) I/N CDF at 51.5 km from the FS station (facing main-lobe)

## Long-term criterion (sensitivity analysis)

In this section, as sensitivity analysis, we provide the separation distances for the long-term criterion for WBB BS with AAS and clutter losses only on one end of the propagation path using additional assumptions on the user terminal (UE) deployments. The next table summarizes the separation distances assuming a UE Rayleigh distribution for the instances where the BS is facing the main-lobe (i.e., aligned in azimuth with the FS station) and facing the back-lobe of the FS station.

Table 7: Separation distances using sensitivity analysis parameters and UE Rayleigh distribution

| WBB BS | Case | Maximum EIRP (dBm/100MHz) | FS Pattern | Activity factor | Main-lobe (km) | Back-lobe (km) |
| --- | --- | --- | --- | --- | --- | --- |
| 8×8 AAS | Generic | 51 | F.699 | 100% | < 40 | < 0.5 |
| 8×8 AAS | Generic | 51 | F.699 | 37.5% | < 32 | < 0.5 |
| 8×8 AAS | 1 | 51 | F.699 | 100% | < 27.5 | < 0.5 |
| 8×8 AAS | 1 | 51 | F.699 | 37.5% | < 21 | < 0.5 |
| 8×8 AAS | 2 | 51 | F.699 | 100% | < 43.5 | < 0.5 |
| 8×8 AAS | 2 | 51 | F.699 | 37.5% | < 25.5 | < 0.5 |
| 4×4 AAS | Generic | 51 | F.699 | 100% | < 48.5 | < 1.5 |
| 4×4 AAS | Generic | 51 | F.699 | 37.5% | < 44 | < 1 |
| 4×4 AAS | 1 | 51 | F.699 | 100% | < 34.5 | < 1.5 |
| 4×4 AAS | 1 | 51 | F.699 | 37.5% | < 31 | < 1 |
| 4×4 AAS | 2 | 51 | F.699 | 100% | < 52 | < 1.5 |
| 4×4 AAS | 2 | 51 | F.699 | 37.5% | < 48 | < 1 |

## Short-term criterion (sensitivity analysis)

For the generic case, we provide the separation distances for the short-term criterion for WBB BS with AAS and clutter losses only on one end of the propagation path. Table 8 summarizes the separation distances assuming both baseline and sensitivity analysis parameters, for the instances where the BS is facing the main-lobe (i.e., aligned in azimuth with the FS station) and facing the back-lobe of the FS station.

Table 8: Separation distances using baseline and sensitivity analysis parameters and FS station pattern based on Rec. ITU-R F.699

| WBB BS | Case | Maximum EIRP (dBm/100MHz) | UE Distribution | Activity factor | Main-lobe (km) | Back-lobe (km) |
| --- | --- | --- | --- | --- | --- | --- |
| 8×8 AAS | Generic | 51 | Uniform | 100% | < 44 | < 0.5 |
| 8×8 AAS | Generic | 51 | Rayleigh | 100% | < 40 | < 0.5 |
| 4×4 AAS | Generic | 51 | Uniform | 100% | < 51 | < 0.5 |
| 4×4 AAS | Generic | 51 | Rayleigh | 100% | < 46.5 | < 0.5 |
| 8×8 AAS | 1 | 51 | Uniform | 100% | < 28 | < 0.5 |
| 8×8 AAS | 2 | 51 | Uniform | 100% | < 45 | < 0.5 |

Figure 5 shows the I/N values for a probability of 0.005% around the FS station (Generic case) with an activity factor of 100% for the case of a BS with an 8x8 array size, UE uniform distribution, and FS pattern based on Rec. ITU-R F.699. The darkened area corresponds to locations where the I/N protection criterion is exceeded.



Figure 5. Generic case - Sensitivity analysis with UE uniform distribution, AAS 8x8, and FS F.699 pattern: (a) I/N around the FS station and (b) I/N CDF at 44 km from the FS station (facing main-lobe)

Figure 6 shows the I/N values for a probability of 0.005% around the FS station (Generic case) with an activity factor of 100% for the case of a BS with an 4x4 array size, UE uniform distribution, and FS pattern based on Rec. ITU-R F.699. The darkened area corresponds to locations where the I/N protection criterion is exceeded.



Figure 6. Generic case - Sensitivity analysis with UE uniform distribution, AAS 4x4, and FS F.699 pattern: (a) I/N around the FS station and (b) I/N CDF at 51 km from the FS station (facing main-lobe)

Figure 7 shows the I/N values for a probability of 0.005% around the FS station (Case 1) with an activity factor of 100% for the case of a BS with an 8x8 array size, UE uniform distribution, and FS pattern based on Rec. ITU-R F.699. The darkened area corresponds to locations where the I/N protection criterion is exceeded.



Figure 7. Case 1 - Sensitivity analysis with UE uniform distribution, AAS 8x8, and FS F.699 pattern: (a) I/N around the FS station and (b) I/N CDF at 28 km from the FS station (facing main-lobe)

Figure 8 shows the I/N values for a probability of 0.005% around the FS station (Case 2) with an activity factor of 100% for the case of a BS with an 8x8 array size, UE uniform distribution, and FS pattern based on Rec. ITU-R F.699. The darkened area corresponds to locations where the I/N protection criterion is exceeded.



Figure 8. Case 2 - Sensitivity analysis with UE uniform distribution, AAS 8x8, and FS F.699 pattern: (a) I/N around the FS station and (b) I/N CDF at 45 km from the FS station (facing main-lobe)

# Concluding remarks

Provided the specific Fixed Service (FS) stations and the following specific assumptions considered in this study:

* maximum EIRP of 51 dBm of the WBB MP BS;
* 10 m of antenna height of the WBB MP BS;
* flat terrain;
* urban scenario;
* clutter loss based on Rec. ITU-R P.2108, with fixed percentage of locations equal to 50% (in line with the characterization of the clutter in urban scenario) on one end of the propagation path, based on the assumption that statistical clutter loss models should only be used to characterise clutter for urban and suburban scenarios when the radio path is not precisely known,
* determination of the basic transmission losses based on Rec. ITU-R P.452, with a random time percentage,

simulation results indicate that to prevent harmful interference from an active antenna system (AAS) WBB MP base station (BS), separation distances up to 56 km might be necessary in urban scenario. Additionally, note that for larger AAS antenna arrays, the separation distances decrease due to the enhanced directivity of such larger arrays.

Furthermore, for sensitivity analyses, additional assumptions on the user terminal (UE) deployments and the WBB BS activity factor, are considered to determine their impact on the required separation distances to prevent harmful interference:

* Assuming that Hotspot deployments are similar to those for WBB MP networks, a Rayleigh distribution for the UE ground distance from its BS is deemed suitable for non-public local networks provided that these networks are deployed where users are expected to remain in the local network cell, rather than moving between different cells as in MFCN networks.
* It is assumed that a WBB base station is active either 100% or 50% of the time, accounting for varying network loading factors. Considering a TDD activity factor of 75% for downlink (3:1), the equivalent activity factors become 75% (100%x0.75) and 37.5% (50%x0.75) respectively.

This study shows that considering the mentioned factors (BS activity factor, UE Rayleigh distribution, network loading factors), the distances are reduced by an average of 15% in the case of the main lobe and 25% in the case of the side lobe. The accuracy of our results can be improved if local clutter data is used instead of statistical clutter assumptions.

Finally, our sensitivity analysis assessment for the chosen short-term protection criterion indicates that for some instances the required separation distances are nearly the same or lower compared to those needed for the long-term protection criterion, i.e., FS short-term protection is less stringent than long-term protection.

1. In Italy, most FS links in the field have a height of 15 meters, although some of them can reach up to 100 meters antenna height. [↑](#footnote-ref-2)
2. The maximum antenna gains considered by the study from Italy for FS systems range from 33 dBi to 47 dBi for Medium Power WBB deployment. [↑](#footnote-ref-3)
3. Derived from the peak antenna gains (NOTE 2 in [ITU-R F.1245](https://www.itu.int/dms_pubrec/itu-r/rec/f/R-REC-F.1245-3-201901-I!!PDF-E.pdf)) [↑](#footnote-ref-4)
4. Ofcom - [Technical Frequency Assignment Criteria for Fixed Point-to-Point Radio Services with Digital Modulation](https://www.ofcom.org.uk/__data/assets/pdf_file/0017/92204/ofw446.pdf) [↑](#footnote-ref-5)
5. ITU-R, https://www.itu.int/dms\_ties/itu-r/md/15/tg5.1/c/R15-TG5.1-C-0478!N01!MSW-E.docx, System parameters and propagation models to be used in sharing and compatibility studies, 2018. [↑](#footnote-ref-6)