# Introduction

In this contribution, we present the required separation distances for the coexistence of two unsynchronised WBB LMP BS in the same channel in 3.8-4.2 GHz. In the sections below we provide the results of the study for a range of scenarios.

# Co-channel coexistence studies wbb lmp vs wbb lmp

## Study parameters

### Parameters for WBB LMP

In the Table 1 below, we provide the deployment parameters of WBB LMP BS used in the studies.

Table 1: Deployment parameters of WBB LMP

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Low Power BS | Medium Power BS | Incremental Medium Power BS |
| EIRP | 31dBm/100 MHz | 49dBm/100 MHz | 51dBm/100 MHz |
| Antenna height | Specified to align with the clutter assumptions | | |
| BS Sectorization | 1 | 1 | 1 |
| UEs per sector | 3 | 3 | 3 |
| Use case information  single BS cell range | 0.05 km | 0.4 km | 0.4 km |
| BS TDD activity factor | 50% | 50% | 50% |
| Network loading factor | 100% | 100% | 100% |
| Terminal antenna gain | -4 dBi | -4 dBi | -4 dBi |
| Antenna gain for AAS/non-AAS | 12 dBi | Non-AAS: 16 dBi  AAS: 21.5 dBi  (4x8 elements) | AAS: 21.5 dBi  (4x8 elements) |
| Antenna pattern for AAS/non-AAS | F.1336 Omni | AAS: M.2101 | AAS: M.2101 |
| BS Noise Figure | 13 dB | 10 dB | 10 dB |
| UE Noise Figure | 9 dB | 9 dB | 9 dB |
| UE height | For outdoor BS: 1.5 m | For outdoor BS: 1.5 m | For outdoor BS: 1.5 m |
| Protection criterion | I/N = -6 dB | | |

In Table 2 below, we provide the AAS antenna characteristics of WBB MP BS used in the studies.

Table 2: AAS Antenna characteristics

|  |  |
| --- | --- |
| AAS antenna pattern | Recommendation ITU-R M.2101 (section 5) |
| Element gain (dBi) | 6.4 |
| Horizontal/vertical front‑to‑back ratio (dB) | 30 for both H/V |
| Antenna polarization | Linear ±45º |
| Antenna array configuration (Row × Column) (Note 2) | 4 x 8 elements |
| Horizontal/Vertical radiating element/sub-array spacing, *dh* /*dv* | 0.5 of wavelength for H, 0.7 of wavelength for V |
| Number of element rows in sub-array, *Msub* (Note 1) | 3 |
| Vertical radiating element spacing in sub-array, *dv,sub* (Note 1) | 0.7 of wavelength of V |
| Pre-set sub-array down-tilt, *θsubtilt* (degrees) (Note 1) | 3 |
| Base station horizontal coverage range (degrees) | ±60° |
| Base station vertical coverage range (degrees) (Note 3) | 0 to -30 |
| Mechanical downtilt (degrees) | 10 |
| Note 1: Only needed when subarray antenna model is used  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. 0° being at the horizon. | |

### Propagation parameters

In Table 3 we provide the propagation parameters used in the studies.

Table 3: Propagation parameters used in coexistence studies

|  |  |  |
| --- | --- | --- |
| Case | Urban/Suburban | Rural |
| Both ends above clutter | ITU-R P.452  50% of time, without use of clutter loss | |
| One end above clutter and one end within clutter | ITU-R P.452  50% of time  with ITU-R P.2108 fixed clutter loss corresponding to  50% locations (for urban) or  30% (for sub-urban)  applied to one end. |  |
| Both ends within clutter | ITU-R P.452  50% of time  with- ITU-R P.2108 fixed clutter loss corresponding to  50% locations (for urban) or  30% (for sub-urban) applied to two ends. |  |

## Coexistence simulations

Our simulations capture the potential of interference from an WBB LMP BS into another WBB LMP BS operating co-channel in an unsynchronised manner.

We have selected a range of representative scenarios to simulate, including WBB LMPs with different EIRP values, heights in different environments.

### Simulation Methodology

To assess the coexistence feasibility of WBB LMP BSs in the 3.8-4.2 GHz band with other WBB LMP BS in the same band, co-channel operating in an unsynchronised manner, we performed Monte Carlo simulations in a 3GPP compliant simulator, where the dynamic nature of WBB LMP services was captured. The WBB LMP BSs were assumed to serve three UE within the sector, with UEs uniformly distributed in the sector area. For the configurations based on AAS, at each snapshot the WBB LMP BS steers the beam in the direction of the UE to be served. For a conservative assessment of coexistence, full (100%) BS load was assumed.

Our methodology assumes that the WBB LMP BS acting as the interferer is initially placed 250 m away from the victim WBB LMP BS receiver. Maintaining the separation distance fixed, the interference observed in 10,000 independent simulation runs (snapshots) is captured. The separation distance is then increased in steps of 250 m, with the received interference levels in 10,000 snapshots for each separation distance step being captured. Since there is no % of time associated with the I/N protection criterion of WBB LMP BS, for each separation distance step of 250m, we have considered only the worst-case interfering snapshot. We then plotted the resulting I/N from the worst-case interfering snapshot for each separation distance step and compared it against the I/N protection criterion to determine the minimum separation distance required to protect the WBB LMP BS receiver.

### Simulating the potential interference from outdoor WBB LMP BS into WBB LP BS co-channel

#### Simulation scenarios (interference from outdoor WBB LMPs into WBB LP BS)

Table 4: Simulation scenarios WBB LMP into WBB LP

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scenario No. | Scenario type | Clutter assumption | Interference from | Interference to |
| 1  Urban | Outdoor WBB LP vs  Outdoor WBB LP | Both sides within clutter  50% applied at each side | Outdoor WBB LP BS  EIRP = 31 dBm  Non-AAS  10m height | Outdoor WBB LP BS  12 dBi antenna gain  Non-AAS  10m height |
| 2  Rural | Outdoor WBB LP vs  Outdoor WBB LP | Both sides above clutter  (no clutter considered) | Outdoor WBB LP BS  EIRP = 31dBm  Non-AAS  10m height | Outdoor WBB LP BS  12 dBi antenna gain  Non-AAS  10m height |
| 3  Urban | Outdoor WBB MP  vs  Outdoor WBB LP | Both sides within clutter  50% applied at each side | Outdoor WBB MP BS  EIRP = 49dBm  AAS (4x8)  15m height | Outdoor WBB LP BS  12 dBi antenna gain  Non-AAS  10m height |

#### Results of the studies (interference potential from unsynchronised outdoor WBB LMP BS into WBB LP BS)



Figure 1: WBB LMP BS into WBB LP BS

### Simulating the potential interference from outdoor unsynchronised AAS WBB MP BS into AAS WBB MP BS

#### Simulation scenarios (interference from outdoor unsynchronised AAS WBB MP into AAS WBB MP BS)

In Table 5 below, we demonstrate the details of the scenarios that we have simulated for the interference potential of outdoor WBB MP BS into FSS ES.

Table 5: Simulation scenarios WBB MP into WBB MP

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Scenario No. | Scenario type | Clutter assumption | Interference from | Interference to |
| 4  Rural | Outdoor WBB MP vs  Outdoor WBB MP | Both sides above clutter  (no clutter considered) | Outdoor WBB MP BS  EIRP = 49 dBm/100MHz  AAS (4x8)  15m height | Outdoor WBB MP BS  21.5 dBi antenna gain  AAS (4x8)  15m height |
| 5  Rural | Outdoor WBB MP vs  Outdoor WBB MP | Both sides above clutter  (no clutter considered) | Outdoor WBB MP BS  EIRP = 51 dBm/100MHz  AAS (4x8)  15m height | Outdoor WBB MP BS  21.5 dBi antenna gain  AAS (4x8)  15m height |
| 6  Dense sub-urban | Outdoor WBB MP  vs  Outdoor WBB MP | Both sides within clutter  30% applied at each side | Outdoor WBB MP BS  EIRP = 49dBm  AAS (4x8)  12m height | Outdoor WBB MP BS  21.5 dBi antenna gain  AAS (4x8)  12m height |
| 7  Dense sub-urban | Outdoor WBB MP  vs  Outdoor WBB MP | Both sides within clutter  30% applied at each side | Outdoor WBB MP BS  EIRP = 51dBm  AAS (4x8)  12m height | Outdoor WBB MP BS  21.5 dBi antenna gain  AAS (4x8)  12m height |
| 8  Rural to dense sub-urban | Outdoor WBB MP  vs  Outdoor WBB MP | 30% applied at one side | Outdoor WBB MP BS  EIRP = 51dBm  AAS (4x8)  15m height | Outdoor WBB MP BS  21.5 dBi antenna gain  AAS (4x8)  12m height |

#### Results of the study (interference to WBB MP BS)



Figure 2: WBB MP into WBB MP

# Conclusions

In summary, the results of the separation distances we observed from the simulations are shown in Table 6.

Table 6: Summary of results of the simulation scenarios

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Scenario No. | Scenario type | Clutter assumption | Interference from | Interference to | Separation distance |
| 1  Urban | Outdoor WBB LP vs  Outdoor WBB LP | Both sides within clutter as per P.2108  50% applied at each side | Outdoor WBB LP BS  EIRP = 31 dBm  Non-AAS  10m height | Outdoor WBB LP BS  12 dBi antenna gain  Non-AAS  10m height | No separation distance requirement observed beyond the initial 250m separation configuration |
| 2  Rural | Outdoor WBB LP vs  Outdoor WBB LP | Both sides above clutter  (no clutter considered) | Outdoor WBB LP BS  EIRP = 31dBm  Non-AAS  10m height | Outdoor WBB LP BS  12 dBi antenna gain  Non-AAS  10m height | ~600 m |
| 3  Urban | Outdoor WBB MP  vs  Outdoor WBB LP | Both sides within clutter as per P.2108  50% applied at each side | Outdoor WBB MP BS  EIRP = 49dBm  AAS (4x8)  15m height | Outdoor WBB LP BS  12 dBi antenna gain  Non-AAS  10m height | ~300m |
| 4  Rural | Outdoor WBB MP vs  Outdoor WBB MP | Both sides above clutter  (no clutter considered) | Outdoor WBB MP BS  EIRP = 49 dBm/100MHz  AAS (4x8)  15m height | Outdoor WBB MP BS  21.5 dBi antenna gain  AAS (4x8)  15m height | ~22 km |
| 5  Rural | Outdoor WBB MP vs  Outdoor WBB MP | Both sides above clutter  (no clutter considered) | Outdoor WBB MP BS  EIRP = 51 dBm/100MHz  AAS (4x8)  15m height | Outdoor WBB MP BS  21.5 dBi antenna gain  AAS (4x8)  15m height | ~ 23 km |
| 6  Dense sub-urban | Outdoor WBB MP  vs  Outdoor WBB MP | Both sides within clutter as per P.2108  30% applied at each side | Outdoor WBB MP BS  EIRP = 49dBm  AAS (4x8)  12m height | Outdoor WBB MP BS  21.5 dBi antenna gain  AAS (4x8)  12m height | ~500m |
| 7  Dense sub-urban | Outdoor WBB MP  vs  Outdoor WBB MP | Both sides within clutter as per P.2108  30% applied at each side | Outdoor WBB MP BS  EIRP = 51dBm  AAS (4x8)  12m height | Outdoor WBB MP BS  21.5 dBi antenna gain  AAS (4x8)  12m height | ~500m |
| 8  Rural to dense sub-urban | Outdoor WBB MP  vs  Outdoor WBB MP | 30% applied at one side | Outdoor WBB MP BS  EIRP = 51dBm  AAS (4x8)  15m height | Outdoor WBB MP BS  21.5 dBi antenna gain  AAS (4x8)  12m height | ~ 1km |

As mentioned in the methodology section of this document, the simulations assume that the initial separation distance between the two WBB LMPs was 250m. For the scenarios which assumed clutter at both sides, clutter only at one side was applied for the Monte Carlo steps between 250m-750m and clutter at both sides was applied for the rest of the simulation steps from 1000m onwards.

From the above results, we can see that when clutter (of 50%) was applied at both sides, we did not observe a separation distance requirement, above the 250m of the initial simulation configuration, for outdoor WBB LP BS operating with EIRPs of 31dBm/100MHz. When no clutter was applied at any of the sides, the required separation distance between outdoor WBB LPs that was observed was approximately 600m. In the coexistence simulations between WBB MP BS and WBB LP BS, when clutter (of 50%) was applied at both sides, the observed separation distance was approximately 300m.

Regarding the coexistence between WBB MPs with 49dBm/100MHz and 51dBm/100MHz, when no clutter was considered, at any of the outdoor AAS WBB MP BS side, we observed that the separation distances to satisfy the I/N criterion were approximately 22km and 23km respectively. When clutter (of 30%) was considered both sides we observed that separation distances of approximately 500m were needed to satisfy the I/N criterion for both EIRPs. Finally, when clutter at only one side was considered for a WBB MP with EIRP of 51dBm, we observed that a separation distance of approximately 1km was needed to satisfy the I/N criterion.

In the assessment of the above results, it is worth highlighting the following assumptions that were taken into consideration:

* The results represent separation distances for unsynchronised operation among the WBB LMP services.
* The minimum separation distance to satisfy the I/N criterion was derived based on the worst-case I/N value from each set of 10,000 snapshots simulated for each separation distance step.
* The 15m height assumed for the WBB MP BS, based on the evidence we have from the medium power licences of the UK framework, reflects at least 57% of the existing medium power deployments (with 43% of all licences being less than 15m).
* The assumption of no clutter applied at any of the WBB LMP sides, implies no obstruction of the propagation path between the Tx and the Rx.
* The consideration of 100% network loading factor represents a conservative assumption
* The antenna gain of the non-ASS omni WBB LP BS antenna was assumed to be 12dBi