# Introduction

This document provides technical studies and simulation results on the adjacent-band co-existence between WBB LMP and 5G MFCN in indoor area. Interference from WBB LMP to 5G MFCN is simulated.

# Indoor Area simulation scenarios and Method

## Simulation assumption

### 5G MFCN system parameters

In this document, the MFCN indoor picocell with a non-AAS Local Area BS is considered.

5G MFCN system parameters are given in Table 1.

Table 1: 5G MFCN system and deployment parameters in indoor area

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | BS | UE | Note |
| Centre frequency (MHz) | 3750 | |  |
| Channel bandwidth (MHz) | 100 | |  |
| Antenna height (m) above floor | 3 above floor | 1.5 above floor |  |
| Antenna type | Non-AAS Omni | Non-AAS Omni |  |
| Antenna gain (dBi) | 0 dBi/ antenna  6 dBi per cell with 4T4R | -4 |  |
| Body loss (dB) |  | 4 |  |
| Tx Power (dBm) | 24 dBm | 23 dBm | 3GPP TS38.104 LA BS & TS38.101 |
| Receiver noise figure (dB) | 13 | 9 |  |

### WBB LMP system parameters

WBB LMP system parameters are given in Table 2.

Table 2: WBB LMP system and deployment parameters in indoor area

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | BS | UE | Note |
| Frequency (MHz) | 3850, 3910 | 3850, 3910 |  |
| Channel bandwidth (MHz) | 100 | 100 |  |
| Antenna height (m) above floor | 3 m above floor | 1.5 m above floor |  |
| Antenna type | Non-AAS Omni | Non-AAS Omni |  |
| Antenna gain (dBi) | 0 dBi/ antenna  6 dBi for 4T4R | -4 |  |
| Antenna Pattern | ITU-R F.1336-4 rec 2 |  |  |
| Body loss (dB) |  | 4 |  |
| Tx Power | 24 dBm | 23 dBm | 3GPP TS38.104 & TS38.101 |
| Receiver noise figure (dB) | 13 | 9 |  |

### Local Area BS Tx and Rx Mask

The same local area BS Tx and Rx mask are used for MFCN indoor BS and WBB LMP BS with 24 dBm transmit power and 13 dB receiver noise figure.

Local Area BS emission mask from 3GPP TS38.104 is copied in Table 3.

Table 3: Local Area BS Tx mask in dBm

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency offset of measurement filter ‑3dB point, Δf | Frequency offset of measurement filter centre frequency, f\_offset | Basic limits | Measurement bandwidth |
| 0 MHz ≤ Δf < 5 MHz | 0.05 MHz ≤ f\_offset < 5.05 MHz |  | 100 kHz |
| 5 MHz ≤ Δf < min(10 MHz, Δfmax) | 5.05 MHz ≤ f\_offset < min(10.05 MHz, f\_offsetmax) | -37 dBm | 100 kHz |
| 10 MHz ≤ Δf ≤ Δfmax | 10.05 MHz ≤ f\_offset < f\_offsetmax | -37 dBm | 100 kHz |

The relative Local Area Tx mask in dBc is calculated with Tx power=24 dBm, as given in Table 4.

Table 4: Local Area BS Tx mask in dBc

|  |  |  |  |
| --- | --- | --- | --- |
| Tx Power | 24 | dBm |  |
| WB | 98.28 | MHz |  |
| ΔF (MHz) | dBc | dBm | BW (MHz) |
| 0 | 0 | 24 | 98.28 |
| 49,14 | 0 | 24 | 98.28 |
| 49,15 | -3 |  | 0.86 |
| 50 | -3 |  | 0.86 |
| 50,001 | -54 |  | 0.1 |
| 55 | -54 |  | 0.1 |
| 55,001 | -61 | -37 | 0.1 |
| 90 | -61 | -37 | 0.1 |
| 90,001 | -54 | -30 | 1 |
| 110 | -54 | -30 | 1 |
| 110,001 | -54 | -30 | 1 |
| 250 | -54 | -30 | 1 |

LA BS Rx mask is given in Table 5.

Table 5: LA BS Rx mask in dBc calculated with NF=13 dB

|  |  |
| --- | --- |
| Frequency offset from the centre frequency (MHz) | dBc |
| 0 | 0 |
| 50 | 0 |
| 50.001 | 32.3 |
| 70 | 32.3 |
| 70.001 | 41.3 |
| 110 | 41.3 |
| 110.001 | 61.3 |
| 250 | 61.3 |

### Propagation model

In Recommendation ITU-R P.1238, the site-general model is applicable to situations where both the transmitting and receiving stations are located on the same floor. The median basic transmission loss is given by:

|  |  |  |
| --- | --- | --- |
|  | dB | (1) |

with an additive zero mean Gaussian random variable with a standard deviation (dB), where:

* :3D direct distance between the transmitting and receiving stations (m)
* : operating frequency (GHz)
* : coefficient associated with the increase of the basic transmission loss with distance
* : coefficient associated with the offset value of the basic transmission loss
* : coefficient associated with the increase of the basic transmission loss with frequency.

The recommended coefficient values for indoor propagation environments are provided in Table 6 (Table 2 in ITU-R Rec P.1238).

Table 6: Basic transmission loss coefficients

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Environment | LoS/NLoS | Frequency range (GHz) | Distance range (m) |  |  |  |  |
| Office | LoS | 0.3-83.5 | 2–27 | 1.46 | 34.62 | 2.03 | 3.76 |
| NLoS | 0.3-82.0 | 4–30 | 2.46 | 29.53 | 2.38 | 5.04 |
| Corridor | LoS | 0.3-83.5 | 2–160 | 1.63 | 28.12 | 2.25 | 4.07 |
| NLoS | 0.625-83.5 | 4–94 | 2.77 | 29.27 | 2.48 | 7.63 |
| Industrial | LoS | 0.625-70.28 | 2–101 | 2.31 | 24.52 | 2.06 | 2.69 |
| NLoS | 0.625-70.28 | 5–108 | 3.79 | 21.01 | 1.34 | 9.05 |

This model ITU-R Rec. P.1238 is not yet implemented in SEAMCAT. The IEEE 802.11 (Model C) is a two slope model which was described in ECC Report 252 section A17.11.2:

The mean path loss is characterised by a dual-slope model with a break point dBP, an exponent of 2 for all distances less than dBP, and an exponent of 3.5 otherwise. In short, the mean path loss, L, in dB is

|  |  |  |
| --- | --- | --- |
|  |  | (2) |

Where:

* d is the separation between the transmitter and receiver in kilometres,
* dBP = 0.005 is the break-point in km (i.e. 5 m),
* LFS is free space path loss.

|  |  |  |
| --- | --- | --- |
|  |  | (3) |

Where:

* hTx and hRx are the height of the transmitter (Tx) and receiver (Rx) respectively and are expressed in m
* d is the distance between the Tx and Rx and is expressed in km
* f is the frequency and is expressed in MHz.

This IEEE 802.11 Model C (two slope model) is used in the simulation with the following assumptions:

1. BS antenna height = 3 m above floor
2. UE antenna height = 1.5 m above floor
3. Omni-Cell Range = 30 m
4. UE to UE Break-Point BP=5 m
5. BS to UE Break-Point BP=10 m
6. BS to BS Break-Point BP=15 m

For the Case MFCN and WBB LMP are deployed in different rooms or at different floors, a wall/floor penetration loss of 18 dB taken from Recommendation ITU-R P.1238 Table 4 is used.

## Simulation scenario and method

### Simulation scenario

Two scenarios are considered in the simulations:

1. Scenario\_1: indoor MFCN omni-cell and indoor WBB LMP omni-cell are deployed in the same room
2. Scenario\_2: indoor MFCN omni-cell and indoor WBB LMP omni-cell are deployed in different rooms on the same floor or on different floors

### Simulation method

UEs are randomly generated within each MFCN/LMP indoor cell, interference from WBB LMP BS to MFCN UL is simulated.

# Simulation results of Interference from WBB LMP BS to 5G MFCN BS

The simulation results of interference from WBB LMP DL at 3850 MHz to 5G MFCN at 3750 MHz are given in Table 7 and Table 8 (WBB LMP BS OOBE=-60 dBm/MHz below 3800 MHz).

Table 7: 5G MFCN indoor cell UL throughput loss caused by interference from WBB LMP BS DL at 3850 MHz

|  |  |  |  |
| --- | --- | --- | --- |
| BS to BS separation distance (m) | iRSS\_unwanted (dBm) | iRSS\_blocking (dBm) | UL Throughput Loss (%) |
| 5 | -53.8 | -60.5 | 96.315% |
| 10 | -59.8 | -66.5 | 88.008% |
| 15 | -63.3 | -70.0 | 79.306% |

Table 8: 5G MFCN indoor cell UL throughput loss caused by interference from WBB LMP BS DL at 3850 MHz (WBB LMP BS OOBE=-60 dBm/MHz below 3800 MHz).

|  |  |  |  |
| --- | --- | --- | --- |
| BS to BS separation distance (m) | iRSS\_unwanted (dBm) | iRSS\_blocking (dBm) | UL Throughput Loss (%) |
| 5 | -86.2 | -60.5 | 84.646% |
| 10 | -92.2 | -66.5 | 65.991% |
| 15 | -95.7 | -70.0 | 52.525% |

The simulation results in Table 8 show that even with a reduced OOBE for WBB LMP BS of -60 dBm/MHz below 3800 MHz, the 5G MFCN BS uplink throughput loss is still very high because the 5G MFCN BS receiver blocking remains as a limiting factor.

The simulation results of interference from WBB LMP DL at 3910 MHz to 5G MFCN at 3750 MHz are given in Table 9.

Table 9: 5G MFCN indoor cell UL throughput loss caused by interference from WBB LMP BS DL at 3910 MHz

|  |  |  |  |
| --- | --- | --- | --- |
| BS to BS separation distance (m) | iRSS\_unwanted (dBm) | iRSS\_blocking (dBm) | UL Throughput Loss (%) |
| 5 | -56.3 | -83.6 | 92.607% |
| 10 | -62.3 | -89.6 | 79.784% |
| 15 | -65.9 | -93.1 | 68.358% |

The simulation results in Table 9 show that the unwanted emissions below 3800 MHz from WBB LMP BS is the limiting factor.

5G MFCN indoor cell UL throughput loss caused by interference from WBB LMP BS DL at 3910 MHz in the same room on the same floor with WBB LMP BS OOBE =-60 dBm/MHz below 3800 MHz is given in Table 10.

Table 10: 5G MFCN indoor cell UL throughput loss caused by interference from WBB LMP BS DL at 3910 MHz with WBB LMP BS OOBE =-60 dBm/MHz below 3800 MHz

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| BS to BS separation distance (m) | iRSS\_unwanted (dBm) | iRSS\_blocking (dBm) | UL Throughput Loss (%) |  |
| 5 | -86.3 | -83.6 | 13.262% |  |
| 10 | -92.3 | -89.6 | 4.317% |  |
| 15 | -95.9 | -93.1 | 2.049% |  |

The simulation results in Table 10 show with an OOBE=-60 dBm/MHz below 3800 MHz for WBB LMP BS, when the indoor WBB LMP BS (Local Area BS) and 5G MFCN indoor BS (Local Area BS) is separated more than 10 meters, the 5G MFCN indoor BS uplink throughput loss is below 5%.

For the case WBB LMP BS and MFCN BS are not in the same room on the same floor or not on the same floor, with 18 dB wall/floor Loss, the simulation results are given in Table 11 and Table 12.

Table 11: 5G MFCN indoor cell UL throughput loss caused by interference from WBB LMP BS DL at 3910 MHz at different room/floor with 18 dB wall/floor loss

|  |  |  |  |
| --- | --- | --- | --- |
| BS to BS separation distance (m) | iRSS\_unwanted (dBm) | iRSS\_blocking (dBm) | UL Throughput Loss (%) |
| 5 | -74.3 | -101.6 | 35.826% |

Table 12: 5G MFCN indoor cell UL throughput loss caused by interference from WBB LMP BS DL at 3910 MHz at different room/floor with 18 dB wall/floor loss and WBB LMP BS OOBE =-60 dBm/MHz below 3800 MHz

|  |  |  |  |
| --- | --- | --- | --- |
| BS to BS separation distance (m) | iRSS\_unwanted (dBm) | iRSS\_blocking (dBm) | UL Throughput Loss (%) |
| 5 | -104.3 | -101.6 | 0.308% |

The simulation results in Table 12 show with an OOBE=-60 dBm/MHz below 3800 MHz, when the indoor WBB LMP BS (Local Area BS) and 5G MFCN indoor BS (Local Area BS) are deployed in different rooms on the same floor or on different floors with the assumption of 18 dB wall/floor loss, the 5G MFCN indoor BS uplink throughput loss is below 1%.

# Conclusions

In this document, Local Area BS parameters (transmit power of 24 dBm, Noise figure of 13 dB) are used as assumption for both WBB LMP and 5G MFCN indoor deployment. The simulation results lead to the following conclusions:

1. The co-existence between 5G MFCN indoor BS and WBB LMP BS in unsynchronised operation in 3800-3860 MHz is difficult, even with a reduced OOBE level (-60 dBm/MHz) of WBB LMP BS below 3800 MHz, the MFCN BS receiver blocking still remains as a limiting factor.
2. With an OOBE=-60 dBm/MHz below 3800 MHz for WBB LMP BS operating above 3860 MHz, when the indoor WBB LMP BS (Local Area BS) and 5G MFCN indoor BS (Local Area BS) is separated of more than 10 meters when they are deployed in the same room on the same floor, the 5G MFCN indoor BS uplink throughput loss caused by the interference from WBB LMP BS is below 5%.
3. With an OOBE=-60 dBm/MHz below 3800 MHz for WBB LMP BS operating above 3860 MHz, when the indoor WBB LMP BS (Local Area BS) and 5G MFCN indoor BS (Local Area BS) are deployed in different rooms on the same floor or on different floors, the 5G MFCN indoor BS uplink throughput loss caused by the interference from WBB LMP BS is below 1%.