# Introduction

This document provides technical studies on the in-band co-existence between two WBB LMP local area networks using the agreed WBB LMP system parameters.

# WBB LMP system Parameters and simulation scenarios

## WBB LMP system parameters and deployment assumptions

WBB LMP system parameters and deployment assumptions are given in Table 1.

Table 1. WBB LMP system and deployment parameters

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | WBB LMP BS | WBB LMP UE | Note |
| Centre frequency (MHz) | 3900  (3900, 4000) | | For co-channel case  (For adjacent channel case) |
| Channel bandwidth (MHz) | 100  (98.280 MHz Nrb=273 Rb=12\*30kHz) | |  |
| SCS (kHz) | 30 | |  |
| BS Tx Power (EIRP dBm/100 MHz) for non-AAS and AAS  (baseline study) | <= 49  TRP=31 dBm/100 MHz with 4x4 AAS antenna |  |  |
| BS Tx Power (EIRP dBm/100 MHz) for non-AAS and AAS  (incremental study) | <=51  TRP=33 dBm/100 MHz with 4x4 AAS antenna |  |  |
| Non-AAS antenna gain (dBi) | 12dBi for LP in urban/suburban area  16 dBi for MP in Rural area |  | For LP BS  For MP BS |
| Non-AAS antenna pattern | ITU-R F.1336 for 12 dBi antenna for LP BS  Directive ITU-R F.1336 for 16 dBi antenna for MP BS |  | For LP BS  For MP BS |
| AAS antenna configuration | 4x4 |  | For MP BS |
| Element gain (dBi) | 6.4 |  | For MP BS |
| H\_Spacing  V\_Spacing | 0.5 for H  0.7 for V |  | For MP BS |
| BS antenna height (m) | 10, 20 |  | Outdoor MP BS |
| BS antenna downtilt(°) | 0° for Hbs=10m  -6° for Hbs=20m in urban/suburban area  -3° for Hbs=30m in Rural area |  |  |
| Noise figure (dB) | 10 for MP BS with 13 for LP BS with | 9 |  |
| BS Tx mask (ACLR in dB) | ACLR= 31 dB for LP non-AAS BS with 31 dBm/100 MHz EIRP  ACLR=38 dB for MP non-AAS BS with 49 dBm/100 MHz EIRP  ACLR=40 dB for MP non-AAS BS with 51 dBm/100 MHz EIRP  ACLR=33.7 dB for AAS (4x4) MP BS with 49 dBm/100 MHz EIRP  ACLR=35.7 dB for AAS (4x4) MP BS with 51 dBm/100 MHz EIRP |  | 3GPP TS.38.104 |
| BS Rx mask (ACS in dB) | 32.3  For both MP BS for LP BS |  | ACS is calculated with -47 dBm with NF=10 dB for MR BS  -44 dBm for LP BS with NF=13 dB |
| UE Tx Power (dBm) |  | TRP=23 dBm for Mobile/Nomadic  Maximum TRP=28 dBm for Mobile/Nomadic UE  EIRP=28 dBm for FWA terminal |  |
| Outdoor UE H\_ue (m) |  | 1.5 above ground |  |
| Mobile/Nomadic UE antenna gain (dBi) |  | -4 | WBB LMP parameters |
| FWA terminal gain (dBi) |  | 0 |  |
| Body loss (dB) |  | 0 | WBB LMP parameters |
| UE Tx mask (ACLR in dB) |  | 30 for class 3 UE (Tx P=23 dBm)  31- for class 2 UE (Tx P=26 dBm) | 3GPP TS.38.101 |
| UE Rx mask (ACS in dB) |  | 33 | 3GPP TS.38.101 |
| Network loading (%) | 100% for single BS case  50% for network case | |  |
| Indoor/outdoor UE percentage | 70% / 30% in urban/suburban  50% / 50% in Rural | | For outdoor BS |
| Wall loss (dB) | 12 | |  |
| Cell Range (m) | Urban & Suburban:  400 m for Hbs=20m  250 m for Hbs=10m  Rural:  1000 m for Hbs=30m  350 m for Hbs=10m | |  |

The ACLR absolute *basic limit* for non-AAS BS is specified in table 6.6.3.2‑2 of 3GPP TS38.104.

|  |  |
| --- | --- |
| Category B Wide Area BS | -15 dBm/MHz |
| Medium Range BS | -25 dBm/MHz |
| Local Area BS | -32 dBm/MHz |

The non-AAS BS Tx mask for 31 dBm EIRP with 12 dBi antenna is 31 - 12 – 45 = - 26 dBm/98.28 MHz = -45.9 dBm/MHz, which is much below the ACLR absolute basic limit for both MR BS and LA BS.

The non-AAS BS Tx mask for 49 dBm EIRP with 16 dBi antenna is 49 - 16 – 45 = - 12 dBm/98.28 MHz = -31.9 dBm/MHz, which is also below the ACLR absolute basic limit for MR BS.

The ACLR to be used in the simulation for LA BS with 12 dBi antenna gain with 31 dBm/100 MHz EIRP is

ACLR = 31 – 12 – (-32+10\*log10(98,28)) = 31 dB

The ACLR to be used in the simulation for MR BS with 16 dBi antenna gain with 31 dBm/100 MHz EIRP is

ACLR = 31 – 16 – (-25+10\*log10(98,28)) = 20 dB

The ACLR to be used in the simulation for MR BS with 16 dBi antenna gain with 49 dBm/100 MHz EIRP is

ACLR = 49 – 16 – (-25+10\*log10(98,28)) = 38 dB

The ACLR to be used in the simulation for MR BS with 16 dBi antenna gain with 51 dBm/100 MHz EIRP is

ACLR = 51 – 16 – (-25+10\*log10(98,28)) = 40 dB

The ACLR for AAS BS is defined as TRP, in 3GPP TS38.104 section 9.7.3.2, it is said

The ACLR (CACLR) absolute *basic limits* in table 6.6.3.2-2 + X, 6.6.3.2-2a + X (where X = 9 dB) or the ACLR (CACLR) *basic limit* in table 6.6.3.2-1, 6.6.3.2-2a or 6.6.3.2-3, whichever is less stringent, shall apply.

The TRP ACLR absolute *basic limit* for AS BS is specified in table 6.6.3.2‑2+ 9 dB in 3GPP TS38.104.

|  |  |
| --- | --- |
| Category B Wide Area BS | -6 dBm/MHz |
| Medium Range BS | -16 dBm/MHz |
| Local Area BS | -23 dBm/MHz |

The BS *rated carrier TRP output power* for *BS type 1-O* shall be within limits as specified in table 9.3.1-1.

Table 9.3.1-1: BS *rated carrier TRP output power* limits for *BS type 1-O*

|  |  |
| --- | --- |
| BS class | Prated,c,TRP |
| Wide Area BS | (note) |
| Medium Range BS | ≤ + 47 dBm |
| Local Area BS | ≤ + 33 dBm |
| NOTE: There is no upper limit for the Prated,c,TRP of the Wide Area Base Station. | |

It should be pointed out that the MP AAS BS with EIRP=49 dBm/100 MHz or 51 dBm/100 MHz, the corresponding AAS BS class is the Local Area BS with a TRP<=33 dBm.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| BS Tx Power EIRP (dBm/98.28 MHz) | 49 | | 51 | |
| AAS antenna | 4x4 |  | 4x4 |  |
| Antenna Gain (dBi) | 18.4 |  | 18.4 |  |
| BS Tx Power TRP (dBm/98.28 MHz | 30.6 |  | 32.6 |  |
| Absolute TRP ACLR (dBm/MHz) | -23 |  | -23 |  |
| Relative ACLR (dB/98,28 MHz) | 33.7 |  | 35.7 |  |

Propagation models used in the simulations are summarized in Table 2 and Table 3.

Table 2. Propagation model for the BS to UE link

|  |  |  |
| --- | --- | --- |
| **Radio Links** | **Urban/Sub-urban area** | **Rural area** |
| BS to UE for BS antenna above clutter | 3GPP TR38.901 UMa LOS Probability  (12 dB Wallloss for indoor UE) | 3GPP TR38.901 RMa LOS Probability |
| BS to UE for BS antenna below clutter | 3GPP TR38.901 Umi LOS Probability  (12 dB Wallloss for indoor UE) |  |

Table 3: Propagation model for the BS to BS link

|  |  |  |
| --- | --- | --- |
| Case | Urban/Suburban | Rural |
| Both ends above clutters | ITU-R P.452 / P.2001 50% of time, without clutter loss  Note: ITU-R P.1546 may be used for studies beyond radio horizon | |
| One end above clutters and one end within clutters | ITU-R P.452/P.2001 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.  For D<250m,   * 3GPP TR38.901 UMa LOS Probability between Macrocell BS and microcell BS in Urban/suburban areas | ITU-R P.1546 Land Rural 50% of time |
| Both ends within clutters | ITU-R P.452 / P.2001 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 for D>= 1km  Clutter loss applied to one end for 1000m>D>=250m  For D<250m,  3GPP TR38.901 Umi LOS Probability between Microcell BSs in Urban/suburban areas. |  |
| Both BSs below rooftops and in the same street adjacent to each other | 3GPP TR38.901 Umi LOS |  |
| Both BSs are in indoor area in the same building | ITU-R P.1238 for BSs in the same building, other valid model can be used with explanation |  |
| One or two BSs are in indoor area in different building | Outdoor model + Wall Loss 12 dB at each indoor BS or P.2109 for incremental study |  |

## Simulation scenarios

1. Scenario\_1: In urban/sub-urban area, LA BS (non-AAS) with maximum Tx Power EIRP <=31 dBm/100 MHz and antenna height <= 10m
2. Scenario\_2: In rural area, MR BS (non-AAS and AAS) with maximum Tx Power <= 49 dBm/100 MHz

The simulation scenario is illustrated in figure 1, each local area network is modelled as singe BS to single BS.

**WBB LMP\_A**

WBB LMP\_B

D

Figure 1: Simulation scenario: Network A (single BS) to Network B (single BS)

For each simulation scenario, co-channel and adjacent channel between the network A and the network B are simulated, as illustrated in figure 2.

|  |  |
| --- | --- |
| 100 MHz  Hz  100 MHz  0 MHz | 100 MHz  Hz  100 MHz  0 MHz |

Figure 2: Co-channel and adjacent channels between network A and network B

## Field Strength levels

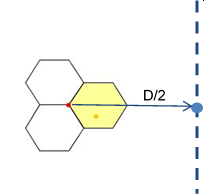
The power level Pr1 at cell edge and Pr2 at the middle point (D/2) between the two networks are simulated and calculated. Then the field strength levels E1 and E2 are calculated using the following equation.

The relation between field strength E (dBµV/m) and power level Pr (dBm) can be expressed as

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

Where:

* F is the frequency in MHz.



Cell Edge

Figure 3. Field strength simulation/calculation at cell edge and at D/2

# Simulation results

## Simulation results of co-channel interference from WBB LMP DL to WBB LMP UL

### Urban/sub-urban area (31 dBm/100 MHz EIRP non-AAS BS)

The simulation scenario in urban/sub-urban area has been done with BS EIRP of 31 dBm/100 MHz with BS antenna height of 10m. LA BS with non-AAS antenna (omni-directional) with 12 dBi antenna gain is considered.

Both Local area BS are not in line of sight, clutter loss with 50% clutter loss locations is applied to both ends of the transmitting BSs and the receiving BSs for D>=1 km, and applied to one end for 250 m<=D<1km.

The simulation scenario for urban/sub-urban co-existence is plotted in figure 4, for each case, 1000000 simulation runs are performed with balancing factor = 0.9 and CL percentile =114 dB. Simulation results of the uplink through put loss are given in Table 4.

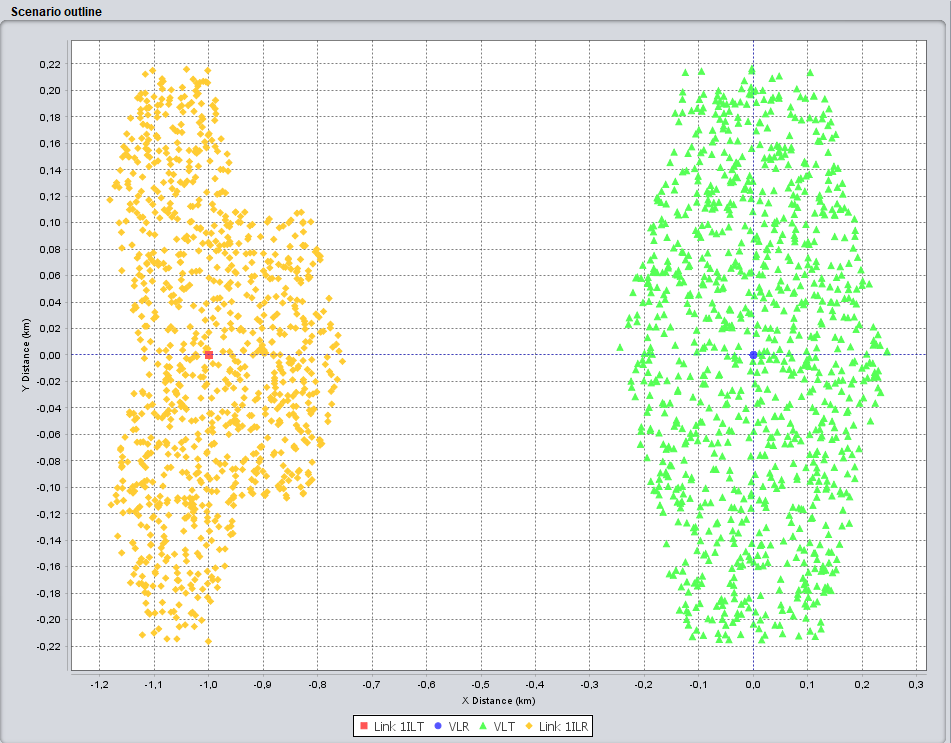


Figure 4. Urban/Sub-urban co-existence simulation scenario

Table 4. Simulation results in urban/Sub-urban area (co-channel) (P452+P 2108 CL at 50%)

|  |  |  |  |
| --- | --- | --- | --- |
| D (km) | iRSS (dBm) at the Victim BS | UL TP Loss(%) | Note |
| 0.5 | -82.1 | 82.847% | CL applied at one end |
| 0.9 | -89.4 | 17.934 % | CL applied at one end |
| 1 | -90.4 | 14.132% | CL applied at one end |
| 1 | -119.4 | 0.02800% | CL applied at two end |

Table 4a. Simulation results in urban/Sub-urban area (co-channel) (P1546 Urban)

|  |  |  |  |
| --- | --- | --- | --- |
| D (km) | iRSS (dBm) at the Victim BS | UL TP Loss(%) | Note |
| 0.5 | -80.8 | 100% | CL applied at one end |
| 0.9 | -91.8 | 93.242% | CL applied at one end |
| 1 | -93.8 | 6.57% | CL applied at one end |
| 1 | -120.4 | 0.024% | CL applied at two end |

The simulation results in Table 4 and Table 4a show that simulation results using the two different models of P.452+P.2108 and P1546 for the BS-to-BS interfering link are comparable., when the BSs of the network A and the network B are below clutters, applying the clutter loss at 50% locations to both ends, at a separation distance of 1 km, the victim uplink throughput loss is below 0.1%. If the clutter loss is applied to one end, the victim BS UL throughput loss is 14.132% with P452+P2108 50% Clutter loss, and 6.57% when using ITU-R P.1546 with one end urban clutter loss.

The simulated field strength value at 3 meters height at the cell edge, as well as the separation distance middle point (D=500m) is given in Table 5, as illustrated in Figure 5.

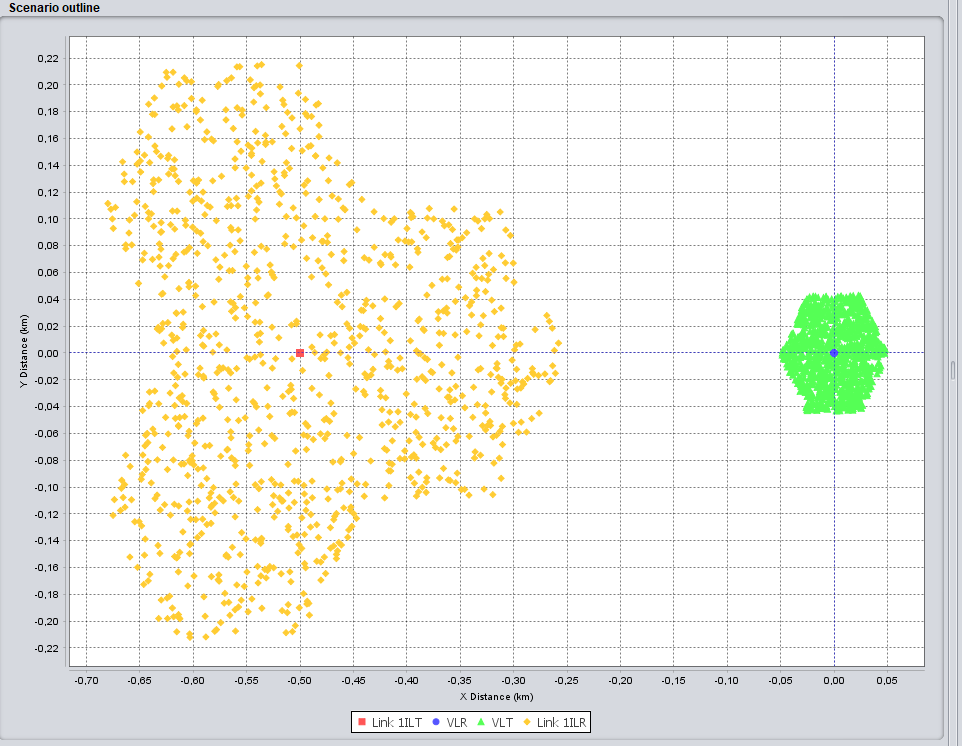
****

Figure 5. FS simulation in Urban/Sub-urban area

Table 5. FS value at 3m at the cell edge (Cell Range=250m, non-AAS BS EIRP=31 dBm/100 MHz)

|  |  |  |
| --- | --- | --- |
| Antenna | Cell edge | D/2 |
| Distance | 250 m | 500 m |
| Pr (dBm) at 3m | -88.18 | -98.67 |
| f (MHz) | 3900 | 3900 |
| E (dBV/m/100 MHz) at 3m | 60.8 | 50.4 |
| **E (dBV/m/5 MHz) at 3m** | **47.8** | **37.3** |

It should be pointed out that the simulation results given above are for the case there is no visibility between the base stations, clutter losses are applied to both ends of the interfering BS and the victim BS. These results are not valid for the case when the interfering BS and the victim BS are installed in the same street, the propagation mechanism in this case is a street Canyon partial Line of Sight. The coordination may be required for this special case.

### Urban/sub-urban area (49 EIRP non-AAS BS)

When WBB LMP non-AAS BS is synchronised or semi-synchronized with 5G MFCN below 3800 MHz, it possible to transmit at 49 dBm/MHz

The simulation scenario in urban/sub-urban area for WBB MP non-AAS BS EIRP of 49 dBm/100 MHz with BS antenna height of 20 m with downtilt of -6°. WBB MP BS with non-AAS antenna (directional) with 16 dBi antenna gain is considered. By considering that WBB MP BS antenna height at 20m is above clutters, no clutter loss is used.

In the simulations, 1000000 simulation runs are performed with balancing factor = 0.9 and Coupling Loss Percentile=117 dB. Simulation results of the uplink throughput loss are given in Table 6.

Table 6. Simulation results in urban/Sub-urban area (co-channel) (P452) (WBB MP non-AAS BS EIRP=49 dBm)

|  |  |  |
| --- | --- | --- |
| D (km) | iRSS (dBm) at the Victim BS | UL TP Loss(%)  (EIRP=49 dBm/100 MHz) |
| 1 | -45.4 | 100% |
| 5 | -59.4 | 100% |
| 10 | -65.5 | 100% |
| 15 | -69.0 | 100% |
| 20 | -71.6 | 100% |
| 25 | -75.1 | 100% |
| 30 | -82.5 | 96.444% |
| 35 | -89.9 | 37.792% |
| 36 | -91.4 | 26.308% |
| 37 | -92.8 | 18.398% |
| 38 | -94.4 | 12.771% |
| 40 | -97.57 | 6.363% |
| 50 | -113.1 | 0.263% |

The simulation results in Table 6 show that when the BSs of the network A and the network B are at 20m above the ground, without applying the clutter loss,

1. at a separation distance of 35.678 km, the victim network BS will loss 30% UL data rate,
2. at a separation distance of 36.797 km, the victim network BS will loss 20% UL data rate,
3. at a separation distance of 38.432 km, the victim network BS will loss 10% UL data rate,

By considering the validity of the propagation model UMa is limited to 22 km, the field strength calculation is simulated with the ITU-R P.1546 propagation model. The simulated field strength values at 3 meters height at the cell edge, as well as the separation distance middle point are simulated with the ITU-R P.1546 propagation model are given in Table 7.

Table 7. FS value at 3m at the cell edge and D/2 (non-AAS BS EIRP=49 dBm/100 MHz)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Cell edge | 10% TP Loss | 20% TP Loss | 30% TP Loss |
| Distance D/2 | 400 m | 19.216 | 18.399 | 17.844 |
| Pr (dBm) at 3m | -74.9 | -155.7 | -154.5 | -153.8 |
| E (dBV/m/100 MHz) at 3m | 74.1 | -6.7 | -5.5 | -4.8 |
| E (dBV/m/5 MHz) at 3m | 61.1 | -19.7 | -18.5 | -17.8 |

The FS values in Table 5 show that for Medium Power WBB LMP BS at 49 dBm/100 MHz EIRP, the field strength level at D/2 is very low, because the very large separation distance.

### Urban/sub-urban area (49 EIRP AAS BS)

The simulation scenario in urban/sub-urban area for WBB MP AAS BS EIRP of 49 dBm/100 MHz with BS antenna height of 20 m with downtilt of -6°. WBB MP BS with AAS antenna configuration 4x4 is considered. By considering that WBB MP BS antenna height at 20m is above clutters, no clutter loss is used.

In the simulations, 1000000 simulation runs are performed with balancing factor = 0.9 and Coupling Loss Percentile=114 dB. Simulation results of the uplink throughput loss are given in Table 8.

Table 8. Simulation results in urban/Sub-urban area (co-channel) (P452) (WBB MP AAS BS EIRP=49 dBm)

|  |  |  |
| --- | --- | --- |
| D (km) | iRSS (dBm) at the Victim BS | UL TP Loss(%)  (EIRP=49 dBm/100 MHz) |
| 1 | -70.4 | 77.164% |
| 5 | -84.4 | 49.319% |
| 10 | -90.5 | 34.836% |
| 12.5 | -92.5 | 29.532% |
| 15 | -94.0 | 25.156% |
| 20 | -96.7 | 20.259% |
| 25 | -100.0 | 13.536% |
| 26 | -101.6 | 11.221% |
| 27 | -103 | 9.119% |
| 30 | -114.8 | 0.987% |

The simulation results in Table 8 show that when the BSs of the network A and the network B are at 20m above the ground, without applying the clutter loss,

1. at a separation distance of 12.4 km, the victim network BS will loss 30% UL data rate,
2. at a separation distance of 20 km, the victim network BS will loss 20% UL data rate,
3. at a separation distance of 26.6 km, the victim network BS will loss 10% UL data rate,

The field strength calculation is simulated with the ITU-R P.1546 propagation model. The simulated field strength values at 3 meters height at the cell edge, as well as the separation distance middle point are simulated with the ITU-R P.1546 propagation model are given in Table 9.

Table 9. FS value at 3m at the cell edge and D/2 (AAS BS EIRP=49 dBm/100 MHz)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Cell edge | 10% TP Loss | 20% TP Loss | 30% TP Loss |
| Distance D/2 | 400 m | 13.3 | 10 | 6.2 |
| Pr (dBm) at 3m | -84.8 | -155.5 | -148.4 | -137.1 |
| E (dBV/m/100 MHz) at 3m | 64..2 | -6.5 | 0.6 | 11.9 |
| E (dBV/m/5 MHz) at 3m | 51.2 | -19.5 | -12.4 | -1.1 |

The FS values in Table 9 show that for Medium Power WBB LMP AAS BS at 49 dBm/100 MHz EIRP, the field strength levels at D/2 (for 10%, 20%, and 30% UL throughput losses) are relatively low, but much better compared to the WBB MP non-AAS BS.

### Rural area

Four cases are considered in the simulations in Rural Area:

1. Case\_1: MR BS with non-AAS antenna with BS EIRP of 31 dBm/100 MHz with BS antenna height of 10 m.
2. Case\_2: MR BS with non-AAS antenna with BS EIRP of 49 dBm/100 MHz with BS antenna height of 30 m.
3. Case\_3: MR BS with 4x4 AAS antenna with BS EIRP of 49 dBm/100 MHz with BS antenna height of 30 m.

In Rural area, with BS antenna height of 10m and 30m, they are above clutters, no clutter loss is applied to the BS end. The propagation model for the BS to BS link is ITU-R P.1546 Rural. In the simulations, 1000000 simulation runs are performed with balancing factor = 0.9 and Coupling Loss Percentile=98.2 dB. The simulation results for these 3 cases are given in Table 10, 11, and 12.

Table 10: Simulation results in Rural area (co-channel): Hbs=10m, non-AAS BS EIRP=31 dBm/100 MHz, cell range=350 m, downtilt=0°

|  |  |  |  |
| --- | --- | --- | --- |
| D (km) | iRSS (dBm) | UL TP Loss (%) | Note |
| 0.5 | -69.39.1 | 73.739% |  |
| 0.92 | -77.9 | 29.129% |  |
| 1 | -79.1 | 24.025% |  |
| 1.1 | -80.8 | 18.043% |  |
| 1.2 | -82.2 | 13.655% |  |
| 1.3 | -83.6 | 10.424% |  |
| 1.4 | -84.9 | 8.045% |  |
| 1.5 | -86.1 | 6.27% |  |
| 2 | -91.1 | 2.13% |  |

The simulation results in Table 10 show that, at 5% network uplink throughput loss, the required separation distance between two base stations is D=1.65 km. D=1.3 km for 10% UL throughput loss, and 1.06 km for 20% throughput loss, 0.91 km for 30% throughput loss.

Table 11: Simulation results in Rural area (co-channel): Hbs=30m, non-AAS BS EIRP=49 dBm/100 MHz, cell range=1000 m with downtilt of -3°

|  |  |  |  |
| --- | --- | --- | --- |
| D (km) | iRSS (dBm) | UL TP Loss (%) | Note |
| 1 | -40.8 | 100% |  |
| 10 | -77.5 | 100% |  |
| 15 | -87.4 | 48.22% |  |
| 16 | -89 | 32.981 |  |
| **16.2** | **89.3** | **30.557** |  |
| 17 | -90.5 | 22.498% |  |
| **17.3** | **90.9** | **20.182** |  |
| 18 | -91.9 | 15.827% |  |
| 19 | -93.3 | 11.464% |  |
| **19.5** | **-94** | **9.872%** |  |
| 20 | -94.6 | 8.55% |  |
| **22** | **-97** | **4.984%** |  |
| 25 | -100.3 | 2.461% |  |

The simulation results in Table 11 for non-AAS BS at 49 dBm/100 MHz EIRP with Hbs=30m show that, at 5% network uplink throughput loss, the required separation distance between the two AAS base stations is D=22 km, D=19.5 km for 10% UL throughput loss, D=17.3 km for 20% UL throughput loss, D=16.2 km for 30% UL throughput loss,

Table 12: Simulation results in Rural area (co-channel): Hbs=30m, AAS BS EIRP=49 dBm/100 MHz, cell range=1000 m with downtilt of -3°

|  |  |  |  |
| --- | --- | --- | --- |
| D (km) | iRSS (dBm) | UL TP Loss (%) |  |
| 1 | -61.7 | 91.736% |  |
| 5 | -83.3 | 61.091% |  |
| 8 | -93.2 | 34.134% |  |
| **8.5** | **-94.6** | **29.908%** |  |
| **10** | **-98.3** | **19.965%** |  |
| 12 | -102.8 | 11.589% |  |
| **12.6** | **-104** | **9.631%** |  |
| **14.5** | **-107.4** | **5.072%** |  |
| **15** |  | **4.259%** |  |

The simulation results for -AAS BS with 49 dBm/100 MHz EIRP in Rural Area in Table 12 show that, at 5% uplink throughput loss, the required separation distance between the two AAS base stations is D=14.5 km. D=12.6 km for 10% UL throughput loss; D=10 km for 20% UL throughput loss, D=8.5 km for 30% UL throughput loss.

The simulation Field strength values at 3 meters height at the cell edge and at the middle point D/2 for 5%, 10%, 20%, and 30% UL throughput loss for the Case1, Case 2, and Case 3 are given respectively in Table 13, 14, and 15.

Table 13. Median FS value at 3m for MR non-AAS BS with 31 dBm/100 MHz EIRP and Hbs=10 m (Rural)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Cell Edge (R=350m) | 5% UL TP Loss  D/2=1.65 km | 10% UL TP Loss  D/2=1.3 km | 20% UL TP Loss  D/2=1.06 km | 30% UL TP Loss  D/2=0.91 km |
| Pr(dBm) at 3m | -85.5 | -113.1 | -109 | -105.5 | -102.8 |
| F(MHz) | 3900 | 3900 | 3900 | 3900 | 3900 |
| E (dBV/m/100 MHz) at 3m | 63.5 | 35.9 | 40 | 43.5 | 46.2 |
| **E (dBV/m/5 MHz) at 3m** | 50.5 | 22.9 | 27 | 30.5 | 33.2 |

Table 14. Median FS value at 3m for MR non-AAS BS with 49 dBm/100 MHz EIRP and Hbs=30 m (Rural)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Cell Edge (R=1 km) | 5% UL TP Loss  D/2=11km | 10% UL TP Loss  D/2=9.75 km | 20% UL TP Loss  D/2=8.65 km | 30% UL TP Loss  D/2=8.1 km |
| Pr(dBm) at 3m | -76.9 | -120.4 | -117.5 | -114.7 | -113.2 |
| f(MHz) | 3900 | 3900 | 3900 | 3900 | 3900 |
| E (dBV/m/100 MHz) at 3m | 72.1 | 28.6 | 31.5 | 34.3 | 35.8 |
| **E (dBV/m/5 MHz) at 3m** | 59.1 | 15.6 | 18.5 | 21.3 | 22.8 |

Table 15. Median FS value at 3m for MR AAS BS with 49 dBm/100 MHz EIRP and Hbs=30 m (Rural)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Cell Edge (R=1 km) | 5% UL TP Loss  D/2=7.25 km | 10% UL TP Loss  D/2=6.3 km | 20% UL TP Loss  D/2= 5 km | 30% UL TP Loss  D/2=4.25 km |
| Pr(dBm) at 3m | -88.2 | -121.8 | -118.9.0 | -114.0 | -110.8 |
| f(MHz) | 3900 | 3900 | 3900 | 3900 | 3900 |
| E (dBV/m/100 MHz) at 3m | 60.8 | 27.2 | 30.1 | 35 | 38.2 |
| **E (dBV/m/5 MHz) at 3m** | 47.8 | 14.2 | 17.1 | 22 | 25.2 |

## Simulation results of adjacent-channel interference from WBB LMP DL to WBB LMP UL

### Urban/sub-urban area (31 dBm/100 MHz EIRP non-AAS BS)

The simulation scenario in urban/sub-urban area has been done with BS EIRP of 31 dBm/100 MHz with BS antenna height of 10m. LA BS with non-AAS antenna (omni-directional) with 12 dBi antenna gain is considered.

Both Local area BS are not in line of sight, clutter loss with 50% clutter loss locations is applied to both ends of the transmitting BSs and the receiving BSs for D>=1 km, and applied to one end for 250 m<=D<1km. Simulation results of the uplink through put loss are given in Table 16.

Table 16. Simulation results in urban/Sub-urban area (adjacent-channel) (P452+P2108 CL 50%)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D (km) | iRSS\_unwanted(dBm) | iRSS\_blocking(dBm) | UL TP Loss(%) | Note |
| 0.5 | -113.1 | -114.3 | 0.189% | CL applied at one end |
| 0.9 | -120.4 | -121.6 | 0.042% | CL applied at one end |
| 1 | -121.4 | -122.6 | 0.033% | CL applied at one end |
| 1 | -150.4 | -151.6 | 0% | CL applied at two end |

The simulation results in Table 19 show that when the BSs of the network A and the network B are below clutters, applying the clutter loss at 50% locations to one end, at a separation distance of 0.5 km, the victim uplink throughput loss is below 0.2%.

The simulated field strength value at 3 meters height at the cell edge, as well as the separation distance middle point (D/2=250m) is given in Table 16.

Table 16. FS value at 3m at the cell edge (Cell Range=250m, non-AAS BS EIRP=31 dBm/100 MHz)

|  |  |  |
| --- | --- | --- |
|  | Cell edge | D/2 |
| Distance | 250 m | 250 m |
| Pr (dBm) at 3m | -88.18 | -88.18 |
| f (MHz) | 3900 | 3900 |
| E (dBV/m/100 MHz) at 3m | 60.8 | 60.8 |
| **E (dBV/m/5 MHz) at 3m** | **47.8** | **47.8** |

### Urban/sub-urban area (49 EIRP non-AAS BS)

The simulation scenario in urban/sub-urban area has been done with non-BS EIRP of 49 dBm/100 MHz with BS antenna height of 20m. MP BS with non-AAS antenna with 16 dBi antenna gain is considered.

Both MP BS are in line of sight above clutters, no clutter loss is applied. Simulation results of the uplink through put loss are given in Table 17.

Table 17. Simulation results in urban/Sub-urban area (adjacent-channel, MP non-AAS BS EIRP=49 dBm/100 MHz)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D (km) | iRSS\_unwanted(dBm) | iRSS\_blocking(dBm) | UL TP Loss(%) | Note |
| 1 | -83.4 | -77.6 | 100% |  |
| 5 | -97.4 | -91.6 | 31.656% |  |
| 5.1 | -97.6 | -91.8 | 30.41% |  |
| 6 | -103.5 | -97.7 | 21.391% |  |
| 6.2 | -99.3 | -93.5 | 20.011% |  |
| 8 | -103.5 | -97.7 | 11.865% |  |
| 8.7 | -102.3 | -96.5 | 10.056% |  |
| 9 | -102.6 | -96.8 | 9.409% |  |
| 10 | -103.5 | -97.7 | 7.735% |  |
| 12 | -105.1 | -99.3 | 5.474% |  |
| 12.6 | -105.5 | -99.7 | 5.008% |  |

The simulation results in Table 17 show that when the BSs of the network A and the network B are at 20m above the ground, without applying the clutter loss,

1. at a separation distance of 5.1 km, the victim network BS will loss 30% UL data rate,
2. at a separation distance of 6.2 km, the victim network BS will loss 20% UL data rate,
3. at a separation distance of 8.7 km, the victim network BS will loss 10% UL data rate,
4. at a separation distance of 12.6 km, the victim network BS will loss 5% UL data rate,

The field strength calculation is simulated with the ITU-R P.1546 propagation model. The simulated field strength values at 3 meters height at the cell edge, as well as the separation distance middle point are simulated with the ITU-R P.1546 propagation model.

Table 18. FS value at 3m at the cell edge and D/2 (non-AAS BS EIRP=49 dBm/100 MHz)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Cell edge | 5% TP Loss | 10% TP Loss | 20% TP Loss | 30% TP Loss |
| Distance D/2 | 400 m | 6.3 | 4.35 | 3.1 | 2.55 |
| Pr (dBm) at 3m | -74.9 | -128.3 | -120.2 | -113.5 | -110.1 |
| E (dBV/m/100 MHz) at 3m | 74.1 | 20.7 | 28.8 | 35.5 | 38.9 |
| E (dBV/m/5 MHz) at 3m | 61.1 | 7.7 | 15.8 | 22.5 | 25.9 |

### Urban/sub-urban area (49 EIRP AAS BS)

simulation scenario in urban/sub-urban area has been done with AAS BS EIRP of 49 dBm/100 MHz with BS antenna height of 20m. Simulation results of the uplink through put loss are given in Table 19.

Table 19. Simulation results in urban/Sub-urban area (adjacent-channel, MP AAS BS EIRP=49 dBm/100 MHz)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D (km) | iRSS\_unwanted(dBm) | iRSS\_blocking(dBm) | UL TP Loss(%) | Note |
| 0.4 | -96.1 | -94.6 | 29.992% |  |
| 0.6 | -99.7 | -98.2 | 21.75% |  |
| 0.67 | -100.7 | -99.2 | 19.733% |  |
| 0.8 | -102.1 | -100.7 | 16.7% |  |
| 1 | -104.1 | -102.6 | 13.217% |  |
| 1.28 | -106.2 | -104.7 | 9.865% |  |
| 2 | -110.1 | -108.6 | 5.259% |  |
| 3 | -113.6 | -112.2 | 2.593% |  |

The simulation results in Table 19 show that when the AAS BSs of the network A and the network B are at 20m above the ground, without applying the clutter loss,

1. at a separation distance of 0.4 km, the victim network BS will loss 30% UL data rate,
2. at a separation distance of 0.67 km, the victim network BS will loss 20% UL data rate,
3. at a separation distance of 1.28 km, the victim network BS will loss 10% UL data rate,
4. at a separation distance of 2 km, the victim network BS will loss 5% UL data rate,

The field strength calculation is simulated with the ITU-R P.1546 propagation model. The simulated field strength values at 3 meters height at the cell edge, as well as the separation distance middle point are simulated with the ITU-R P.1546 propagation model.

Table 20. FS value at 3m at the cell edge and D/2 (AAS BS EIRP=49 dBm/100 MHz)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Cell edge | 5% TP Loss | 10% TP Loss | 20% TP Loss | 30% TP Loss |
| Distance D/2 | 400 m | 1 | 0.64 | 0.4 | 0.4 |
| Pr (dBm) at 3m | -84.8 | -104.3 | -94.9 | -84.8 | -84.8 |
| E (dBV/m/100 MHz) at 3m | 64.2 | 44,7 | 54.1 | 64.2 | 64.2 |
| E (dBV/m/5 MHz) at 3m | 51.2 | 31,7 | 41.1 | 51.2 | 51.2 |

### Rural area

Four cases are considered in the simulations in Rural Area:

1. Case\_1: MR BS with non-AAS antenna with BS EIRP of 31 dBm/100 MHz with BS antenna height of 10 m.
2. Case\_2: MR BS with non-AAS antenna with BS EIRP of 49 dBm/100 MHz with BS antenna height of 30 m.
3. Case\_3: MR BS with 4x4 AAS antenna with BS EIRP of 49 dBm/100 MHz with BS antenna height of 30 m.

In Rural area, with BS antenna height of 10m and 30m, they are above clutters, no clutter loss is applied to the BS end. The propagation model for the BS to BS link is ITU-R P.1546 Rural.

The simulation results are these 3 cases are given in Table 21, 22, and 23.

Table 21: Simulation results in Rural area (adjacent-channel): Hbs=10m, non-AAS BS EIRP=31 dBm/100 MHz, cell range=350 m, downtilt=0°

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D (km) | iRSS\_unwanted(dBm) | iRSS\_blocking(dBm) | UL TP Loss(%) | Note |
| 0.7 | -105.1 | -106.3 | 0.161% |  |

The simulation results in Table 21 show that the separation distance of 0.7 km, the victim uplink throughput loss is below 1%.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 22: Simulation results in Rural area (adjacent-channel): Hbs=30m, non-AAS BS EIRP=49 dBm/100 MHz, cell range=1 km with downtilt of -3°D (km) | iRSS\_unwnated (dBm) | iRSS\_blocking (dBm) | UL TP Loss (%) | Note |
| 2 | -84.9 | -79.1 | 100% |  |
| **4** | **-96.2** | **-90.4** | **29.832%** |  |
| **4.34** | **-97.7** | **-92** | **20.248** |  |
| **5** | **-100.4** | **-94.6** | **10.767%** |  |
| **5.85** | **-103.8** | **-98** | **5.036%** |  |
| 6 | -104.1 | -98.3 | 4.749 |  |
| 7.5 | -108.8 | -103.1 | 1.683% |  |
|  |  |  |  |  |
| **5.9** |  |  |  |  |
| **6** | **-104.1** | **-98.3** | **4.749** |  |

The simulation results in Table 22 show that :

1. at a separation distance of 4 km, the victim network BS will loss 30% UL data rate,
2. at a separation distance of 4.3 km, the victim network BS will loss 20% UL data rate,
3. at a separation distance of 5 km, the victim network BS will loss 10% UL data rate,
4. at a separation distance of 5.85 km, the victim network BS will loss 5% UL data rate,

Table 23: Simulation results in Rural area (adjacent-channel): Hbs=30m, AAS BS EIRP=49 dBm/100 MHz, cell range=1 km with downtilt of -3°

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| D (km) | iRSS\_unwanted (dBm) | iRSS\_blocking (dBm) | UL TP Loss (%) |  |
| 2 | -101.5 | -100.1 | 21.643% |  |
| **2.08** | **-102.1** | **-100.7** | **20.117%** |  |
| **2.94** | **-107.6** | **-106.1** | **10.025%** |  |
| 3 | -107.8 | -106.4 | 9.486% |  |
| **3.66** | **-111.3** | **-109.8** | **4.996%** |  |
| 4 | -112.9 | -111.4 | 3.62% |  |

The simulation results for AAS BS in Rural Area in Table 23 show that, at a separation distance of 2.08 km, the uplink throughput loss is 20%, at D=2.94 km, uplink throughput loss is 10%, and at D=3.66 km, UL throughput loss is 5%

The simulation Field strength values at 3 meters height at the cell edge and at the middle point D/2 for 5%, 10%, 20%, and 30% UL throughput loss for the Case1, Case 2, and Case 3 are given respectively in Table 24, 25, and 26.

Table 24. Median FS value at 3m for MR non-AAS BS with 31 dBm/100 MHz EIRP and Hbs=10 m (Rural)

|  |  |  |
| --- | --- | --- |
|  | Cell edge | D/2 |
| Distance | 350 m | 350 m |
| Pr (dBm) at 3m | -85.5 | -85.5 |
| f (MHz) | 3900 | 3900 |
| E (dBV/m/100 MHz) at 3m | 63.5 | 63.5 |
| **E (dBV/m/5 MHz) at 3m** | 50.5 | 50.5 |

Table 25. Median FS value at 3m for MR non-AAS BS with 49 dBm/100 MHz EIRP and Hbs=30 m (Rural)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Cell Edge (R=1 km) | 5% UL TP Loss  D/2=2.925 km | 10% UL TP Loss  D/2=2.5 km | 20% UL TP Loss  D/2=2.15 km | 30% UL TP Loss  D/2=2 km |
| Pr(dBm) at 3m | -76.9 | -93.3 | -90.8 | -88.4 | -87.2 |
| f(MHz) | 3900 | 3900 | 3900 | 3900 | 3900 |
| E (dBV/m/100 MHz) at 3m | 72.1 | 55.7 | 58.2 | 60.6 | 61,8 |
| **E (dBV/m/5 MHz) at 3m** | 59.1 | 42.7 | 45.2 | 47.6 | 48,8 |

Table 26. Median FS value at 3m for MR AAS BS with 49 dBm/100 MHz EIRP and Hbs=30 m (Rural)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Cell Edge (R=1 km) | 5% UL TP Loss  D/2=1.83 km | 10% UL TP Loss  D/2=1.47 km | 20% UL TP Loss  D/2=1.04 km |
| Pr(dBm) at 3m | -88.2 | -97 | -93.9 | -88.4 |
| f(MHz) | 3900 | 3900 | 3900 | 3900 |
| E (dBV/m/100 MHz) at 3m | 60.8 | 52.0 | 55.1 | 60.6 |
| **E (dBV/m/5 MHz) at 3m** | 47.8 | 39.0 | 42.1 | 47.6 |

# Summary of In-bnd co-existene study between neighbouring local area networks

It should be pointed out that for the in-band co-existence, it is not possible to have a bandpass filter within the frequency band to define an additional requirement on the out of block emission requirement, the possible solution is by coordination at national level.

There are several possible case by case coordination solutions between two local area networks: 1) Synchronisation between two neighbouring local area networks; 2) Field strength levels at the local area network coverage edge between two local area networks.

The field strength level can be defined as function of the acceptable throughput loss. In this document, the FS values at different throughput losses of 5%, 10%, 20%, 30% are proposed for consideration, the choice of the FS values at different throughput losses can be made at national level based on the principle of equal access to the spectrum use.

The simulation results of the co-channel and adjacent-channel co-existence between two local area networks can be summarized as:

1. Co-channel co-existence between two neighbouring local area networks is very difficult to manage without a careful coordination, in particular for Medium Power non-AAS BS with antenna above clutters.
2. MP AAS BS corresponding a Local Area AAS BS provides much better in-band co-existence condition.
3. It is proposed to use the following Field Strength values at the local area network coverage border at national level:

Table 27. FS values (dBµV/m/5 MHz) at 3m at each local area network coverage border for unsynchronized operation with neighbouring local area networks

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Environment | Urban/Sub-urban | | | Rural | | |
| Power class | LP EIRP<=31 dBm/100 MHz  Hbs<=10 m | MP 31 dBm/100MHz < EIRP<= 51 dBm/100 MHz | | LP EIRP<=31 dBm/100 MHz | MP 31 dBm/100MHz < EIRP<= 51 dBm/100 MHz | |
| BS type | Non-AAS | Non-AAS | AAS | Non-AAS | Non-AAS | AAS |
| Non-Preferential frequency | 37 | -17 | 0 | 33 | 22 | 35 |
| Preferential frequency | 48 | 26 | 48 | 48 | | |

Note:

**Non-Preferential frequency** is defined as the case where the local area network has full or partial frequency overlap with at least one of the neighbouring local area networks

**Preferential frequency** is defined as the case where the local area network has no-frequency overlap (full or partial) with any neighbouring local area networks

Table 28. FS values (dBµV/m/5 MHz) at 3m at each local area network coverage border for unsynchronized operation with neighbouring local area networks without MP WBB in Urban/sub-urban areas

|  |  |
| --- | --- |
| Environment | Urban/Sub-urban/Rural |
| Non-Preferential frequency | 32 |
| Preferential frequency | 48 |

In case of synchronised operation with neighbouring local area networks, the FS values in Table 29 can be considered for both non-AAS and AAS.

Table 29. FS values (dBµV/m/5 MHz) at 3m at each local area network coverage border for synchronized operation with neighbouring local area networks (for both non-AAS and AAS BS)

|  |  |
| --- | --- |
| Environment | FS Value (dBµV/m/5 MHz) |
| Urban/Sub-urban/Rural | 61 |

