# background

1. Conclusions from existing input contributions and resulting BEMs

Compatibility studies between *Wireless Broad Band Low and Medium Power (WBB LMP)* networks and 5G MFCN in adjacent bands are already included in the draft ECC Report

* Nokia ([CG4G(23)031](https://www.cept.org/Documents/ecc-pt1/78162/ecc-pt1_cg4g-23-031_coexistence-studies-between-unsynchronised-wbb-lmp-and-5g-mfcn-services-operating-in-the-adjacent-band)) assumed respectively 600m, 1500m and 3000m for urban, suburban and rural cell range (diameter) and derived, based on set of parameters/use case (clutter loss in both sides of the path/one side of the path, I/N protection criterion…) separation distance from WBB LMP and MFCN considering both interference scenario (MFCN 5G BS as interferer/victim and WBB LMP as a victim/interferer).
* Orange ([PT1\_CG4G(23)042](https://www.cept.org/Documents/ecc-pt1/78654/ecc-pt1_cg4g-23-042_orange_adjacent-band-co-existence-study-between-local-area-nerwork-and-5g-mfcn) and [PT1\_CG4G(23)058](https://www.cept.org/Documents/ecc-pt1/80404/ecc-pt1_cg4g-23-058_orange_evaluation-of-the-initial-draft-lrtc)) assumed respectively 600, 1000 and 2000 for urban, suburban and rural cell diameter but defined a fixed 50m (from MFCN micro BS)/100m (from MFCN Macro BS) separation distance between WBB LMP and Macro BS for any environment and derived, based on set of parameters, the needed unwanted emissions levels from WBB LMP (as interferer) to protect MFCN Macro BS receiver (-43dBm/MHz EIRP below 3800 MHz for non-AAS WBB base stations ). This figure is similar[[1]](#footnote-1) to the restricted BEM baseline set for the non-AAS unsynchronized networks in ECC Dec(11)06 (-34dBm/5MHz EIRP =-41dBm/MHz EIRP)

From regulatory perspective, results from

* Nokia were not conclusive as they were expressed as separation distance which could suggest that administrations could use them as a coordination procedure every time a stakeholder is wishing to register a station from the vertical local area network.
* Orange were expressed as an unwanted emission levels that could be used by administrations as a BEM. Since these results were achieved assuming a low separation distance between WBB LMP and MFCN 5G stations (100m for both urban, suburban and rural scenarios), such conditions will significantly limit the coordination requests but also make stringent the BEM requirements similarly to the restricted BEM baseline set for the non-AAS unsynchronized networks in ECC Dec(11)06 (-34dBm/5MHz EIRP =-41dBm/MHz EIRP[[2]](#footnote-2)).

1. Analysis of these preliminary results with the current regulation

It’s not sure that these (low) restricted baseline power limits for unsynchronized networks in 3400-3800 MHz (-41dBm/MHz EIRP for non-AAS, -50dBm/MHz TRP for AAS) are actually used in any CEPT countries. Such “stringent” technical conditions could be seen as an “invitation to synchronize among networks” to meet relaxed BEM defined in Table 3 from ECC Decision(11)06 (and corresponding more or less to the *Spectrum Emission Mask* from ETSI standard) with the exception of the cross-border coordination between neighbouring countries.

This situation with AAS/non-AAS stringent BEM for unsynchronized networks is not specific to the C-Band when considering the 2.6GHz channelling arrangement. Any TDD BEM defined in the duplex gap (See Annex 2 from [ECC Decision(05)05](https://docdb.cept.org/download/4009)) where -45dBm/MHz EIRP baseline level for non-AAS (See Table 3 ) and -52dBm/MHz TRP (See Table 5) for AAS is set below 2570 MHz (FDD UL), only 5MHz away from the in-block component of the TDD operator block (starting above 2575 MHz) and similar even more stringent than the restricted baseline for the non-AAS case in 3400-3800 MHz (respectively 4dB and 2dB more stringent for non-AAS and AAS case[[3]](#footnote-3)).

Several countries have already opened the band 3800-4200 MHz for a shared access between new local area networks and the incumbent services (FSS, FS) and provide further insight on the licence conditions.

The [UK spectrum regulator Ofcom](https://www.ofcom.org.uk/__data/assets/pdf_file/0035/157886/shared-access-licence-guidance.pdf) provides insight on the targeted applications (agriculture, mining, oil & gas, indstrial IoT, logistics & distribution...) for band 3800-4200 MHz and not for MFCN[[4]](#footnote-4). Technical licencing conditions are described in the above document in Tables 1 (licensing conditions), 5 and 6 (Out-of-Block/band limits). Tables 5 and 6 applied to networks in 3800-4200 MHz show that the selected BEM refers to the baseline power limits corresponding to the synchronized networks (Table 3 from ECC Decision(11)06) for non-AAS although notes 3.14 and 3.15 from Ofcom document states that *Synchronisation is not required in* c) *the 3.8-4.2 GHz unless There may be some circumstances where it is required in the 3.8-4.2 GHz band* to synchronize. It is further clarified in note 3.20 that there is no *planning on imposing a synchronisation requirement in the 3.8-4.2 GHz band. However, we reserve the rights to mandate synchronisation at a later date if this turns out to be necessary to ensure spectrum is being used efficiently*. Another note (3.21) indicates that *there’s a small chance that if licensees in this band operating in very close proximity to each other happen to be using adjacent channels within the band, they may interfere with each other. In these situations, we’d encourage both parties to work together and reach a mutual agreement on how to avoid this. Measures to avoid interference might include users synchronising their transmissions.*

The Norwegian regulator NKMO also [published](https://nkom.no/aktuelt/nkom-has-opened-3-8-4-2-ghz-for-local-area-5g-networks/_/attachment/download/cedba85d-febe-41ab-bfba-348a118f7150:2288b83dfe5e9deea2bf5c153a397354a795b0cf/Regulation%20of%203,8-4,2%20GHz%20December%202022.pdf) a document describing the spectrum regulation in 3.8-4.2 GHz to enable *industry and verticals to get access to 5G* through standalone private networks. As highlighted in the introduction, licences for local networks will be applied within a *geographically delimited areas*. The geographical area where sites of the local non-public networks operate (labelled as *licence area* for Low Power station) does not necessarily correspond to a coverage area i.e. *the location of connected devices is not limited to the licence area*. Even though the regulator *will not require synchronisation in local networks[[5]](#footnote-5)* (see chapter 6), it considers measure applied to those new networks to *avoid interference with public mobile networks operating in the frequency band below 3800 MHz* such as

* *a 40-MHz (3800-3840 MHz) protection band*.
* Exclusion zone around (more than 10 000 inhabitants) urban settlements for medium power station where public mobile networks densely serve end-to-end users where it is also recognized that for specific situations, the regulator *may grant exemptions from this restriction (such as ports, large industrial areas, etc.), if the advantages are assessed to exceed the disadvantages.*

As can been seen, selected baseline power limits for the unsynchronized networks were not the stringent ones coming from ECC Decision(11)06 but likely the one related to the synchronized networks although synchronization is not imposed for the new local area networks, provided that the spectrum is being used efficiently and that mutual agreement is found among stakeholders as it is expected in any coordination procedure (e.g. cross-border coordination).

1. National situation in TDD duplex gap for the MFCN channelling arrangement at 2.6GHz

MFCN deployment in 2500-2570 MHz for FDD UL and 2570-2620 MHz for FDD DL in 2010’s in France was accompanied by frequency assignment to *Professional Mobile Radio (PMR)* networks in TDD duplex gap 2575-2615 MHz from May 2019. This demand resulted from spectrum needs expressed by PMR stakeholders for this duplex gap and related to mobile broadband with same technology as the one used by MFCN (LTE). It should be noted those PMR networks occupying the spectrum in the 2.6 GHz TDD duplex gap are not synchronized with MFCN deployed in the FDD UL/DL band plan as they use the same spectrum for both UL/DL with time division splitting. Consequently, such configuration raises a coexistence issue between MFCN and PMR network in adjacent band but also among PMR networks both in adjacent blocks (within the TDD duplex gap) or within the same block (co-channel) where a geographical separation is unavoidable. In any case, every PMR operator is allocated “an licensed area” with a radiation threshold not to be exceeded at its border. This technical measure is set by the regulator in order to protect stations from other networks operating in adjacent band (e.g. MFCN) as well as ensuring the coexistence among the local area networks in a proportionate manner. In practice, “an licensed area” can be understood as a geographical zone bounded by a *power flux density (pfd)* limit or field strength level not to be exceeded at the receiving antenna of the BS to be protected.

The recommended value by the regulator[[6]](#footnote-6) (ARCEP) is sufficient to ensure the protection of the networks in adjacent band (both MFCN in 2500-2570 MHz and other TDD block in 2575-2615 MHz) and provide a good balance for the co-channel PMR coexistence i.e. a tolerable network throughput loss and acceptable coverage range, similarly to what was addressed in CEPT for the cross-border coordination[[7]](#footnote-7) in 3600-3800 MHz. Indeed, when considering C/N=-10 dB[[8]](#footnote-8) as minimum target for a high data rate at the cell edge of a network would lead to a minimum coverage field strength in the operating block of the operator. Such figure would result in 40dB lower field strength level in adjacent block of another network with an *Adjacent Channel Interference Ratio (ACIR)* filtering (i.e. ) from transmitting and receiving BSs. As highlighted in ECC Report 331, similar value to (actually 0 dBµV/m/(5 MHz) at 3 m) can *lead in practice to very large exclusion zones in cross-border areas. In order to facilitate the deployment of TDD MFCN in border areas, there is a need to study the field strength values with different more realistic deployment options and to analyse operational solutions for efficient usage of spectrum.*

That’s why was set, which would reduce the coverage range (by around 10dB) in comparison to at the cell edge but at the same time would relax the protection of Macro BSs from the other networks sharing the same block in adjacent geographical area by 11.5dB when considering I/N=0dB (instead of -6dB), GBS peak=13.5dBi (instead of 17dBi for a sectoral antenna), NoiseFigureBS Rx=5dB (instead of 3dB).

Licensed area typically comprise a set of BSs covering this area. Due to the heterogeneity of the urbanization level of this zone (cluttering height and building material), BSs are not geographically deployed in a regular grid noting that their amount depend on their input power, the user experienced data rate. Since these characteristics have an impact on the coordination between two local networks, it’s important to get a rough estimate of the geographical overlapping between two licensed areas. For example, if two PMR networks with High Radiated Power BSs (>51dBm) are 200m away, the co-channel coexistence will be challenging while an adjacent band case scenario with sufficient filtering of the unwanted emissions would facilitate the operation of both networks without mutually suffering from harmful interference. Co-channel coexistence between two networks could be feasible when operating with low power (<31dBm) and facilitating propagation with additional isolation loss such as indoor deployment.

# methodology for least restrictive technical conditions above 3800 MHz

* 1. Proposed way forward

As observed in the background through different existing regulations in place, an alternative to the stringent BEM set for the vertical networks (transmitting stations) non-synchronized with MFCN to coexist with them would be to set technical conditions at the victim receiver location through a *pfd* or a *field strength* threshold. Such approach is currently used in cross-border coordination for TDD networks in different frequency ranges (e.g. 2.6, 3.6 GHz) including the coexistence in adjacent blocks (by considering the coordination threshold with/without preferential frequency blocks between two neighbouring countries) would provide more flexibility to the new local area networks wishing to be deployed above 3800 MHz while ensuring the protection of MFCN Base Stations operating below 3800MHz.

National coordination procedure could rely on setting an licensed area for every mobile operator of a local area network around which a threshold not to be exceeded would be set. This threshold would be established by considering the protection criteria of the other networks e.g. MFCN. To do so, a sufficient condition to protect a station receiver would be that the licensed area does not contain this site as this zone would be delimited by a *pfd* or a field strength protection level. It is proposed in the following sections to describe in details the method to coordinate those *Wireless BroadBand stations with* *Low and* *Medium Power* (*WBB LMP*) for the protection of Macro BSs from MFCN and apply it through examples of WBB LMP networks with suitable technical characteristics as agreed by ECC/PT1 to derive least restrictive technical conditions for those networks in 3800-4200 MHz.

* 1. Protection MFCN in adjacent band from interference generated by WBB LMP

Interference from WBB LMP stations affecting Macro AAS BSs from MFCN below 3800 MHz has multiple origins:

* (MFCN Macro BS) Receiver Overloading threshold is the maximum interfering signal level at which the receiver loses its ability to discriminate against interfering signals at frequencies other than that of the wanted signal.
* Receiver selectivity in filtering emissions outside its operational bandwidth
* Unwanted emissions from WBB LMP transmitter

The two first origins relate to the physical design of the receiver but with different behaviour as the first one considers the frequential location of the interferer i.e. WBB LMP in-band interference while the second one features the capability of the receiver to filter outside its receiver bandwidth the emissions from the interferer (in-band, out-of-band and spurious noting that the higher emission level likely comes from the in-band component).

The last component relates to the capability of the transmitter to filter its emission outside its channel bandwidth within out-of-band, spurious domains.

Coexistence studies deals with adjacent use case by combining the two last phenomena through *Adjacent Channel Interference Ratio (ACIR)* with *Adjacent Channel Leakage Ratio (ACLR)* and *Adjacent Channel Selectivity (ACS)* It is then proposed to consider them separately i.e. *Itotal=IRx filtering+Iunwanted*.

Coexistence studies deal with co-channel use case when considering the receiver overload threshold . However, since there is no requirement in 3GPP/ETSI standards on it, such scenario is generally not addressed for the protection of MFCN (unlike other services/application such as Mobile Satellite Service, Radiolocation...).

**Step 1:** Based on (MFCN Macro AAS) BS receiver characteristics (protection criterion *I/N,* antenna gain *G*, noise figure to compute the noise power *N, rejection filtering*), compute the protection threshold not to be exceeded in the operational receiver bandwidth.. The calculation of the maximum pfd/electrical field strength level Sprotection to protect MFCN Macro BS receiver is then expressed as follows:

Or for the field strength metric at the receiver antenna height ( being the impedance of free space, expressed in Ohms):

* 1. Coverage range of the WBB LMP networks

Analytical expressions protection thresholds expressed in the previous section deserve some comments:

* Whatever metric is selected (pfd or field strength), the threshold for the unwanted emissions case set in the receiver bandwidth (i.e. *Iunwanted*) can be translated in the interferer bandwidth by applying the relevant filtering (ACIR).
* Although one could claim that these thresholds would be sufficient to provide the expected protection for MFCN Macro AAS BS receiver, it’s important to compare the size of the licensed area delimited by these thresholds to evaluate the feasibility of the coordination procedure: ***how often*** is the coordination procedure between an allotment and existing notified MFCN Macro AAS (e.g. 100%, 10%, 1% of AAS Macro BSs deployed to be coordinated) needed and also ***how challenging*** is the coordination procedure between the area and registered BS sectors (practical separation distance in light of cluttering environment)?

To tackle properly these two issues (occurrence and difficulty of the coordination procedure), an investigation of the coverage range of these vertical networks is carried out (i.e. coverage level at the cell-edge, average distance ***d*** of the WBB LMP station from its cell-edge).

**Step 2**: Calculate the minimum pfd/electrical field strength level Scoverage needed to meet the user’s demand in WBB network within the band of the WBB.

**Step 3**: Converts Scoverage to the receiver operating band by performing the appropriate filtering Scoverage adjacent= Scoverage+ACIR

**Step 4**: Calculate the gap Sprotection -Scoverage adjacent:

* + if , there is a coexistence margin and Scoverage can be relaxed (i.e. increased).
  + if , an additional isolation loss is needed, resulting in reducing Scoverage.

In any case, Scoverage S’coverage= Scoverage+

**Step 5**: Calculate median coverage distance d from S’coverage in order to draw one’s opinion on the feasibility for an allotment region to be deployed in any MFCN environment (rural, suburban, urban, indoor/outdoor).

# Applications on LRTC for the protection of MFCN in adjacent band

1. WBB LMP system parameters and deployment assumptions

The following table summarizes the general parameters for WBB LMP used for the coexistence studies. One could notice that WBB Medium Power station can operate with AAS or non-AAS while Low Power station assumes only non-AAS design (probably because the peak gain for AAS would result in very low single element conducted power.

Table 1: General characteristics of Wireless Broad Band Low and Medium Power stations

|  |  |  |
| --- | --- | --- |
| Parameter | Low Power BS | Medium Power BS |
| Bandwidth | 100 MHz | 100 MHz |
| Antenna height | Outdoor/Indoor: 10 m above ground | 20 m above the ground |
| Deployment scenario | Outdoor/indoor 6dB | Outdoor |
| MIMO gain (Non-AAS) | 6 dB for 4T/4R | 6 dB for 4T/4R |
| Non-AAS BS Tx and Rx antenna gain per RF chain (including system loss) | 6 dBi for Local Area (LA) BS (Note 1)  0 dBi (omni) for indoor BS (Note 1) | 10 dBi for Medium Range (MR) BS (Note 1) |
| AAS single element peak gain | N/A | 6.4 dBi |
| AAS antenna array configuration | N/A | 4 vertical x 4 horizontal radiating sub-arrays |
| BS Tx EIRP limit  (for AAS & non-AAS) | 31 dBm | 51 dBm |
| Note 1: The composite gain for non-AAS is achieved with summation of MIMO gain and the Tx/Rx antenna gain per RF chain | | |

Characteristics on unwanted emissions level achieved by WBB Low and Medium Power stations are extracted from the 3GPP standard referring to 5G NR MFCN (Serie 38) for the Base Station (Number 104). Classes of BSs whose characteristics are expected to close to WBB LMP refer to Medium and Local Area network.

The section dealing with the filtering capability of those Base Stations relates 3GPP TS 38.104

* For AAS equipment on section 9.7.3.2, it is stated that
* *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

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 only WBB Medium Power station uses AAS. For example, if using 51 dBm/100 MHz EIRP, the corresponding AAS BS class is the Local Area BS with a TRP<=33 dBm. This means that TRP absolute basic limit to be considered for WBB MP AAS station is **-23dBm/MHz**.

* For Non-AAS equipment on Section 6.6.3 on *Adjacent Channel Leakage Power Ratio* as specified in section 6.6.3.1 General: *For a BS operating in non-contiguous spectrum, the ACLR requirement in clause 6.6.3.2 shall apply in sub-block gaps,*

According to Table 5.2-1, frequency range 3300 MHz – 4200MHz relates to band #77.

Clause 6.6.3.2 on Limits and Basic Limits gives the requirements:

* For limits *in table 6.6.3.2‑1*

Table 2: Base station ACLR limit (Table from TS 38.104)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *BS channel bandwidth* of *lowest/highest carrier* transmitted BWChannel (MHz) | BS adjacent channel centre frequency offset below the lowest or above the highest carrier centre frequency transmitted | Assumed adjacent channel carrier (informative) | Filter on the adjacent channel frequency and corresponding filter bandwidth | ACLR limit |
| 3, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90,100 | BWChannel | NR of same BW (Note 2) | Square (BWConfig) | 45 dB,  38 dB (Note 4) |
|  | 2 x BWChannel | NR of same BW (Note 2) | Square (BWConfig) | 45 dB,  38 dB  (Note 4) |
|  | BWChannel /2 + 2.5 MHz | 5 MHz E-UTRA | Square (4.5 MHz) | 45 dB (Note 3) |
|  | BWChannel /2 + 7.5 MHz | 5 MHz E-UTRA | Square (4.5 MHz) | 45 dB (Note 3) |
| NOTE 1: BWChannel and BWConfig are the *BS channel bandwidth* and *transmission bandwidth configuration* of the *lowest/highest carrier* transmitted on the assigned channel frequency.  NOTE 2: With SCS that provides largest transmission bandwidth configuration (BWConfig).  NOTE 3: The requirements are applicable when the band is also defined for E-UTRA or UTRA.  NOTE 4: For BS operating in band n104, ACLR requirement 38 dB applies. For BS operating in other bands, ACLR requirement 45 dB applies. | | | | |

* For basic limits *in table 6.6.3.2‑2*

Table 3: Base station ACLR absolute basic limit (Table 6.6.3.2-2 from TS 38.104)

|  |  |
| --- | --- |
| BS category / BS class | ACLR absolute *basic limit* |
| Category A Wide Area BS | -13 dBm/MHz |
| Category B Wide Area BS | -15 dBm/MHz |
| Medium Range BS | -25 dBm/MHz |
| Local Area BS | -32 dBm/MHz |

The least stringent limit refers:

* For 31dBm EIRP (with 12dBi peak gain outdoor and 6dBi peak gain indoor) WBB Low Power to Local Areas BS which is **-32dBm/MHz** compared to 38dB which would have led to 31dBm/100MHz EIRP=25dBm/100MHz output power=5dBm/MHz=-33dBm/MHz for indoor case and -39dBm/MHz for outdoor
* For 51dBm EIRP (with 16dBi peak gain non-AAS) WBB Medium Power to Medium Area BS[[9]](#footnote-9) basic limit is the least stringent i.e. leading to **-25dBm/MHz** than relative 45dB ACLR 15dBm/MHz-45=-30dBm/MHz. for 16dBi peak gain, 12.5dBm/MHz-45dB=-32.5dBm/MHz.

For any case (non-AAS and AAS equipment), according to Tables 6.6.1-1 (non-AAS case) and 9.7.1-1 (AAS case) from TS 38.104 and considering the bandwidth under study for WBB LMP in 3800-4200 MHz (>200 MHz), the maximum offset of the operating band for out-of-band levels is 40 MHz. This means that the above mentioned out-of-band levels stands in 3800-3840 MHz band.

The Adjacent or nearby Leakage Ratio of the unwanted emissions from WBB LMP can be calculated by subtracting WBB LMP In-band TRP/output power to its unwanted emissions level below 3800 MHz. For example, when considering WBB Low Power Station indoor (Non-AAS), from Table 1:

* peak gain of the antenna is 0dBi+MIMO gain=6dBi,
* 31dBm/100MHz in-band EIRP

leading to 31dBm/100 MHz – 6dBi = 25dBm/100MHz=5dBm/MHz In-band output power.

This would mean that ACLR=output powerIn-band – unwanted level=5dBm/MHz-(-32dBm/MHz)=37dB denoted as Case #1 for WBB Low Power stations.

ACLR parameters for WBB LMP in different scenarios (class of stations: Low/Medium Power AAS/non-AAS, different frequency separations) are summarized in the below table and will be used for the sharing studies. Assuming that Lower Power WBB stations unwanted emission levels are compliant to both ACLR limits from the (3GPP 38.104) standard perspective (relative and absolute) , one could consider -39dBm/MHz for outdoor (corresponding to 38dB ACLR in below table), also applied to indoor case (corresponding to 44dB ACLR in below table), denoted as Case #2 for WBB Low Power stations.

Table 4: Leakage Ratio of WBB LMP from In-band emission

|  |  |  |
| --- | --- | --- |
|  | ACLR Low Power | ACLR Medium Power |
| 3800-3840 MHz | Indoor: 37dB (Case #1), 44 dB (Case #2)  Outdoor: 31dB (Case #1), 38dB (Case #2) | AAS: 35.5 dB  Non-AAS: 40 dB |
| >3840 MHz | Not studied | oob level: -45 dBm/MHz  AAS: 57.5 dB  Non-AAs: 60 dB |

One could make the following observations:

* ACLR is lower for class of equipment operating outdoor than for indoor because the higher peak gain of the antenna (for outdoor compared to indoor) reduces more the in-band TRP and will consequently decrease the dynamic of the emissions levels from the unwanted emissions (absolute) limit,
* The gap in ACLR between WBB Medium non-AAS and AAS is different for different frequency separations because the absolute ACLR level is less stringent for AAS (-23dBm/MHz) than for non-AAS (-25dBm/MHz).
* The consideration of lower oob (e.g. -45dBm/MHz ) comes from the observation that
  + for several classes of stations, out-of-band levels are already lower than -30dBm/MHz (WBB Low Power Station considered as local area network with -32dBm/MHz or -39dBm/MHz with ACLR=38dB for outdoor,
  + during the current deployment for 5G NR in 3600-3800 MHz MFCN in France, emissions from BSs above 3800 MHz were found to be very low. It is then expected that if a large frequency separation (e.g. 90, 100 MHz) is assumed (which might be the case when handling the interference due to the MFCN Macro BS receiver blocking with a high tolerance level), a high level e.g. -45dBm/MHz is assumed for this study.

1. MFCN 5G system receiving parameters and deployment assumptions
   1. General deployment

The following table summarizes parameters used for the studies undertaken in this contribution.

Table 5: 5G NR MFCN Deployment parameters

|  |  |  |
| --- | --- | --- |
| Parameter | 5G NR BS | 5G NR UE |
| Channel bandwidth (MHz) | 100 (98.280 MHz Nrb=273 Rb=12\*30kHz) | |
| BS antenna height (m) | 20 for outdoor urban macrocell BS  25 for outdoor suburban and rural macrocell BS |  |
| BS noise figure (dB) | 3 | 9 |
| Cell range (m)  Note: typical values from deployed networks | Urban: 400  Suburban: 1000  Rural: 2000 | |
| Indoor/outdoor UE |  | Urban/suburban: 70%/30%  Rural: 50%/50% |
| Building wall loss (dB) | 12 | |
| UE heights (above ground or building floors) (m) | N/A | 1.5 |
| Protection criterion | I/N=-6dB |  |
| TDD activity factor | 75% DL | 25% UL |

The modelling of Macro AAS BS antenna array pattern based on local sub-array is performed using characteristics from the below table. Noting that the receiving part of the AAS Macro BS matters,

Table 6: MFCN AAS characteristics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Rural macro | Suburban macro | Urban macro |
| 1.2 | Element gain (dBi) (Note 1) | 6.4 | 6.4 | 6.4 |
| 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 H 65º 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 |
| 1.6 | Antenna array configuration (Row × Column) (Note 2) | 4 × 8 elements | 4 × 8 elements | 4 × 8 elements |
| 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 |
| 1.7a | Number of element rows in sub-array, *Msub* | 3 | 3 | 3 |
| 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 |
| 1.7c | Pre-set sub-array down-tilt, *θsubtilt* (degrees) | 3 | 3 | 3 |
| 1.10 | Base station horizontal coverage range (degrees) | ±60 | ±60 | ±60 |
| 1.11 | Base station vertical coverage range (degrees) (Notes 3, 4, 7) | 90-100 | 90-100 | 90-100 |
| 1.12 | Mechanical downtilt (degrees) (Note 4) | 3 | 6 | 6 |
| 1.13 | Composite peak gain (dBi) | 26.2 | 26.2 | 26.2 |

Parameters related to the transmitting part of the BS (conducted power, ohmic loss) are not considered in this table as the impact from WBB LMP station to MFCN Macro BS receiver is only carried out in this document (not the interference from MFCN towards WBB LMP receivers).

* 1. Macro BS Rejection filtering capability

Depending on the frequency domain where emissions are considered, this characteristic is featured either through Adjacent Channel Selectivity (ACS) or Blocking Level. For this case, the resulting blocking response should involve the level of the interfering signal in co-channel IIB and adjacent channel of the victim receiver IOOB at the same (receiver) desensitization level *D* as follows:

Blocking Response= IOOB,D -IIB,D= IOOB,D 3GPP -Noise power-10log10[10D/10-1]

Macro BS AAS receiver characteristics refer to Over The Air (OTA) requirements (in Section 10) because there is no separation between transceiver and antenna components and corresponds to BS type *1-0* (while *2-0* relates to the millimeter wave frequencies).

Table 10.5.2.2-1 indicates that the interfering signal mean power is -43 dBm-ΔOTAREFSENS for 6dB desensitization level. Similarly to what was observed for non-AAS equipment: (see Table 7.5.2.5.2-0 for ΔfOOB offset for NR operating bands in FR1) Δf00B= 60 MHz, leading to conclude that this requirement -43 dBm-ΔOTAREFSENSapplies for 3800-3860 MHz. However, although a definition of ΔOTAREFSENS is provided in the same document involving two other parameters (BeWθ,REFSENS, BeWφ,REFSENS), the fact that no value for them is proposed in TS 38.104 does not allow to calculate properly ΔOTAREFSENS. It is then proposed to use -43 dBm for 6dB desensitization level.

According to table 10.6.2.1-1, the out-of-band blocking is expressed in terms of interfering field-strength 0.36 V/m. The conversion of this electrical field strength to power level assumes that the resulting value is after the receiving antenna gain. The formula from ECC Report 331[[10]](#footnote-10) *Eoverload() = Ioverload (dBm)+ 20 ∗ log10 f(MHz) + 77.2* is only valid for an isotropic receiving antenna gain. For a directive antenna, an adjustment of the receiving antenna peak gain in the formula is needed. Noting that the considered frequencies domain where the blocking is defined[[11]](#footnote-11) refers to the unwanted emissions, Macro AAS antenna pattern might not involve full correlation of the radiating elements of the antenna phased array that’s why a single element model is considered within this unwanted domain i.e. *Ioverload (dBm)+*-37dBm+6.4dBi=-30.6dBm for a 6dB desensitization level (after AAS receiving antenna).

Those results are summarized in the below table with the inclusion of the overload threshold adjusted for 1dB desensitization level used for the sharing studies.

Table 7: Blocking requirement for AAS Macro BS Receiver

|  |  |  |  |
| --- | --- | --- | --- |
| AAS | In-band blocking 3800-3860 MHz (1-O, 1-H) | Out-of-blocking >3860 MHz (1-O) | Out-of-blocking >3860 MHz (1-H) |
| Interferer signal level  6dB desensitization | -43 dBm (**Table 10.5.2.2-1**) | -30.6 dBm | -15 dBm |
| ACS | 43.3 dB | 55.7 dB | 71.3 dB |
| Interferer signal level  1dB desensitization | -53.6 dBm | -41.2 dBm | -25.6 dBm |

* 1. MFCN-WBB LMP Propagation assumptions

The following table aims at capturing the propagation model between WBB LMP and AAS Macro MFCN stations in urban/suburban and rural environments based on 3GPP TR38.901 in order to capture a long range of distances e.g. from several tens meters to around 1km where varying clutter is reflected considering *Line of Sight (LoS)* probability of the transmitter site with respect to the receiver side.

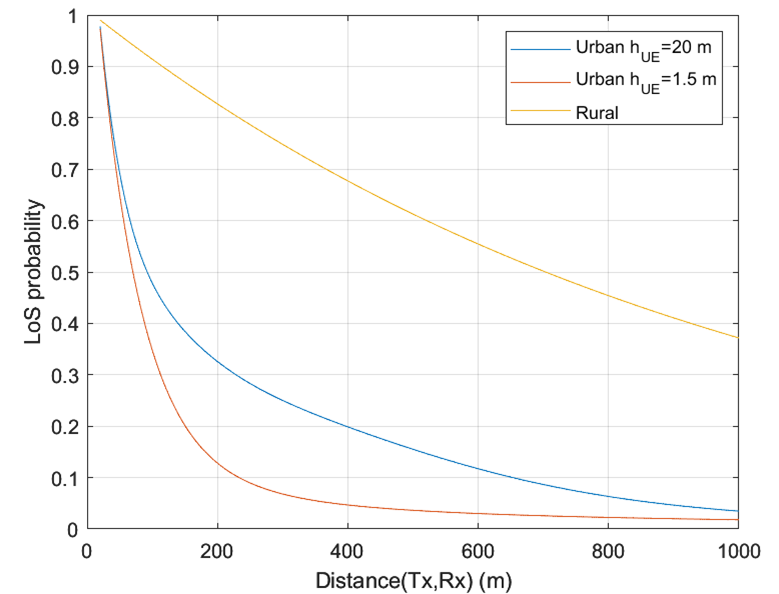
Table 8: Propagation model for the Macro AAS MFCN BS to WBB LMP BS link

|  |  |  |
| --- | --- | --- |
| Case | Urban/Suburban | Rural |
| Both BSs are outdoor | 3GPP TR38.901 UMa + LoS Probability between Macrocell BS and WBB Low Power Station (10m height)  3GPP TR38.901 UMa + custom[[12]](#footnote-12) LoS Probability formula between Macrocell BS and WBB Low Power Stations (20m height) | 3GPP TR38.901 RMa + LoS Probability between Macrocell BS and WBB Lower Power Station (10m height)  3GPP TR38.901 RMa LoS formula between Macrocell BS and WBB Medium Power Station (20m height) |
| One of the BS is indoor area | Outdoor model + Wall Loss 12 dB |  |

Pathloss computed based on the formula from this 3GPP report (See Table 7.4.1-1) is a random variable with a given standard deviation and a mean (corresponding to the analytical formula). The value computed to derive the average distance are the mean ones.

Since WBB Low Power Station is assumed to operate at low height (10m) in any environment, this transmitter is considered below the clutter unlike MFCN Macro BSs. When computing the pathloss between MFCN and WBB LP stations, this will result in considering LoS probability formula (UMa for urban/suburban areas, RMA for rural areas[[13]](#footnote-13)) between those two stations.

WBB Medium Power Station, due to a higher height (20m) is considered above the clutter like MFCN Macro BS. This means that the probability of visibility between those two BSs is higher than when BS operates with ground UEs. This probability decays with the distance(WBB LMP, MFCN Macro BS). LoS probability12 formula from TR 38.901 involves the height of UE (up-to 22.5m ave the ground) for urban case but not for rural areas. Plotting the curves for rural scenario, urban regular case (ground UEs at 1.5m) and at same height as WBB Medium Station (20m) for the other case would lead to the following figure.



The curve plot for the rural case exhibits high percentages of LoS for short distances e.g. more than 80% when BS and UE are 200m away. This percentage remains above 50% up-to 700m separation distance and for distance up-to 1km, the LoS probability remains non negligible (less than 40%). From these observations, it could be reasonable to extend this LoS probability formula for the rural case with two BSs (one at 25m and another BS at 20m) in conjunction with PL formulation from TR 38.901.

On the one hand, the probability of LoS for urban case strongly falls down leading to very low values even for short distances (<200m) and when UEs stand 20m above the ground (less than 35%) which might not reflect the visibility between two stations set “above the clutter”. On the other hand, it would be irrelevant to apply LoS formulation of the PL given in 3GPP TR 38.901 because this would ignore the possibility for two BSs to be obstructed depending on their separation.

That’s why it is proposed to carry out the evaluation of LoS probability from a Macro BS deployed in urban area by considering the existing MFCN deployment in France for C-Band as well as the knowledge of the clutter within area of interest. Such investigation requires several data:

* French database of notified Macro BS in urban area: part of this data is publicly available through data.anfr.fr [website](https://data.anfr.fr/anfr/visualisation?id=dd11fac6-4531-4a27-9c8c-a3a9e4ec2107) except the BS EIRP and the antenna height only available internally. In order to distinguish Macro from micro BSs (declared in the French database) 58dBm was chosen to filter BSs data from the French database of BSs.
* Elevation surface model in urban area (corresponding to the clutter database composed [French clutter database hosted by IGN](https://geoservices.ign.fr/bdtopo). There are different categories of cluttering objects available in the database: cemetery, linear building (limited to low wall), surface building (sport terrain, park…) delimited by barrier, single object (pylon, reservoir), vegetation (e.g. set of trees in park or big avenue). The main one is the volume object corresponding to built-up objects: home, buildings and covers almost 99% of the aforementioned objects. This category will be the only one to be used for the assessment of the built-up area surface. An illustration of the matching of the clutter objects within Google-Earth visual is depicted in the below picture for one single built-up area, located in Paris (left/right side with/without the object).



The urban environment to be retained for such assessment needs to be compliant with the typical 20m BS antenna height assumptions for Macro BS deployment for this area. This will imply that the median or the average building height should be close to 20m and not too higher (otherwise it will underestimate the LoS probability) or too lower (otherwise it will overestimate the LoS probability for such deployment). One input contribution (3K/50) from Huawei provides the distribution of building height for several big cities around the world. In particular the empirical cumulative density function (cdf) for the city of Paris whose an extract is provided below:

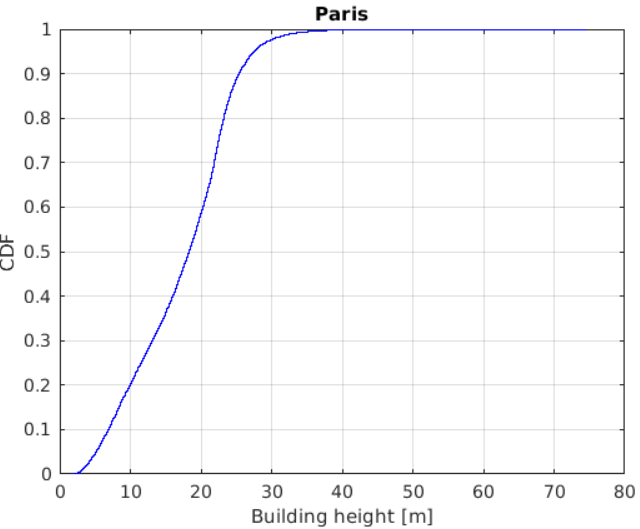


Figure 1: Building height distribution in Paris (from Doc ITU-R 3K/050)

It should be noted that the median value is lower than 20m while the 20m building height would correspond to 59th percentile. This city would represent a good candidate for such assessment while smaller cities in France would have a lower average/median building height (e.g. [French input to ITU-R Correspondence Group G 3K-3M-12](https://extranet.itu.int/rsg-meetings/sg3/wp3k/cg3k3m12/_layouts/15/WopiFrame2.aspx?sourcedoc=%7BB3D61D2D-85DE-4684-841C-B9E09697A76B%7D&file=CG-3K-3M-12_2020_23_ClutterModel_France.docx&action=default&IsList=1&ListId=%7BC4E69168-82F1-47E4-AB29-5E975E53D554%7D&ListItemId=116) indicates for Rennes city that the median building height is only 10m). Consequently, the evaluation of probability of Line-of-Sight is performed over notified Macro BSs and using French clutter database in Paris. An illustration of notified Macro BSs within Paris area is displayed in the below picture, noting Macro BSs from all 4 operators were considered in the assessment (the graph only depicts deployed sectors from one operator for the sake of the readability of the document).

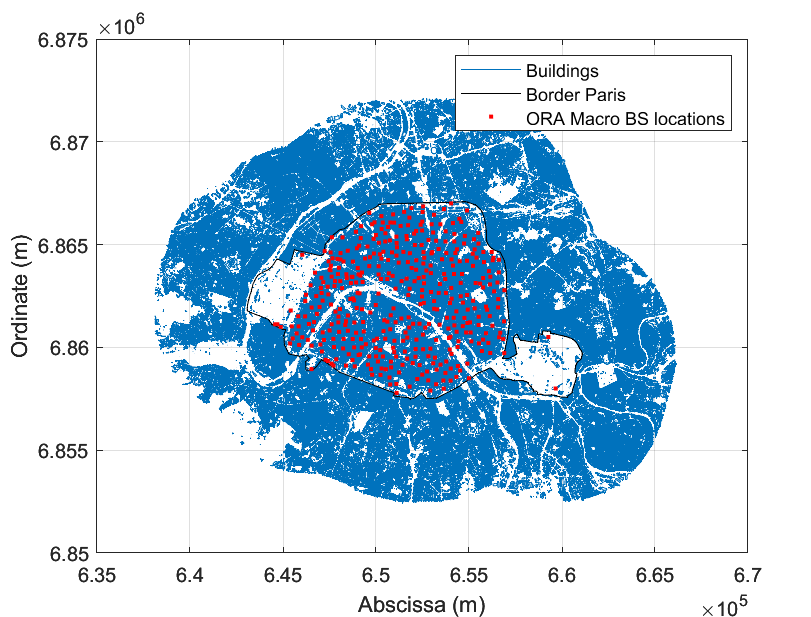


Figure 2: Buildings and 5G NR Macro BS deployment in Paris in 3400-3800 MHz for one mobile operator (Lambert 93 projection format coordinates)

Computing the distance between Macro BS locations and the closest position where a building obstructs the visibility of the BS will lead to derive the resulting probability of LoS as follows:

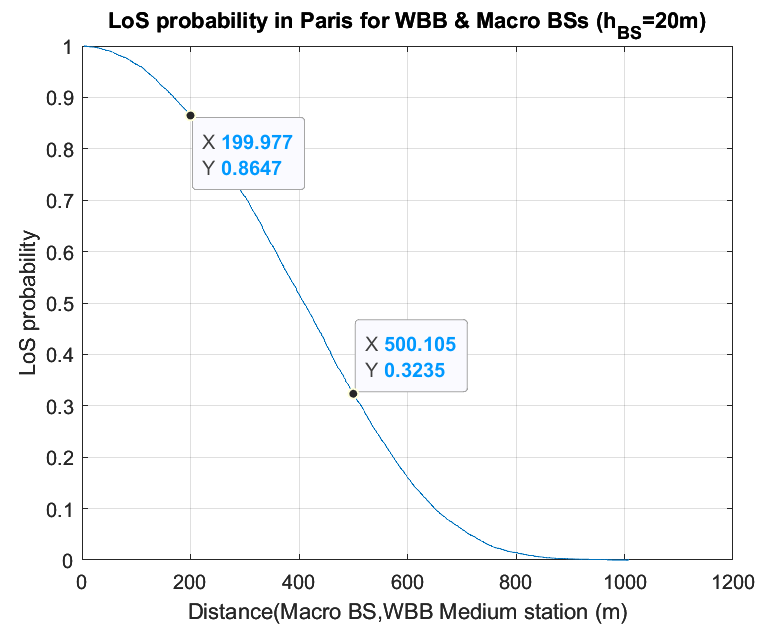


Figure 3: LoS probability between 2 stations at 20m height in Paris

Unlike the UMa LoS Probability from 3GG TR 38.901, for short distances (<200m), this probability remains very high (more than 86%) and progressively decays but remains non-negligible even for 500m separation distance (around 32%). On the hand, using this distribution would avoid overestimating the pathloss by using a more realistic LoS probability than the UMa formula between two BSs at 20m above the ground. On the other hand, for the urban case, this distribution would also avoid underestimating the pathloss between those two stations “above the clutter” as 100% LoS probability is never achieved in practice as it’s distance dependent. Hence, it is proposed to use this distribution as a LoS probability function instead of the one UMa from TR 38.901 Table 7.4.2-1 but still use the LoS/NLoS Pathloss formula from Section 7.4.1 of 3GPP TR 38.901.

1. Choice of the scenarios for the protection of MFCN

The results are expressed in terms of protection threshold at the MFCN AAS Macro BS receiver (pfd or field strength) for different frequency separations of the WBB LMP station from MFCN band edge (3800 MHz). Both mechanisms causing interference are carried in the study: MFCN AAS Receiver filtering selectivity (In-band blocking and out-of-band-blocking) and WBB LMP unwanted emissions (ACLR). It is noted that the frequencies range over which a given ACLR or blocking requirement applies differ as highlighted in the below table. 3860 MHz reflects the frequency edge between in-band and out-of-band blockings (from MFCN Macro BS AAS) while 3840 MHz could potentially separate out-of-band from spurious domains for the WBB LMP unwanted emissions with similarity to MFCN BS oob below 3840MHz and spurious level above 3840 MHz where (3GPP TS 38.104) MFCN band-pass filter is standardized for band no.78.

Table 9: Filtering capabilities of MFCN Macro BS Rx (ACS) and WBB LMP Tx (ACLR)

|  |  |  |  |
| --- | --- | --- | --- |
|  | ACS | ACLR Low Power | ACLR Medium Power |
| 3800-3840 MHz | 43.3 dB | Indoor: 37dB (Case #1), 44 dB (Case #2)  Outdoor: 31dB (Case #1), 38 dB(Case #2) | AAS: 35.5 dB  Non-AAS: 40 dB |
| 3840-3860 MHz | 43.3 dB | Not studied | oob level: -45 dBm/MHz  AAS: 57.5 dB  Non-AAs: 60 dB |
| >3860 MHz | 55.7 dB  71.3 dB | Not studied | oob level: -45 dBm/MHz  AAS: 57.5 dB  Non-AAs: 60 dB |

It is then proposed to study the extreme cases i.e. when WBB LMP directly operates adjacent to MFCN band (above 3800 MHz) and with 60 MHz frequency separation (above 3860 MHz[[14]](#footnote-14)). As expected, the higher frequency separation, the more relaxed is the protection threshold, which results in achieving smaller average distance from WBB LMP station in its cell. The following table presents the resulting *Adjacent Channel Interference Ratio (ACIR)* for these retained scenarios.

Table 10: ACIR for WBB LMP stations with different frequency separations from MFCN upper-edge band (3800 MHz)

|  |  |  |
| --- | --- | --- |
|  | ACIR Low Power | ACIR Medium Power |
| 3800-3840 MHz | Indoor: 36.1 dB, 40.6 dB  Outdoor: 30.8 dB, 36.9 dB | AAS: 34.8 dB  Non-AAS: 38.3 dB |
| >3860 MHz | Not studied | oob level: -45 dBm/MHz  AAS: 53.5dB (1-0)  57.3dB (1-H)  Non-AAs: 54.3dB (1-O)  59.7dB (1-H) |

1. MFCN Protection threshold

From Equations (1) and (3) (See Section 2.2 Step 1), the MFCN protection threshold can be computed using the MFCN protection criterion (see Table 5) I/N=-6dB and the AAS Macro BS antenna gain. The computation of MFCN AAS Macro BS antenna gain (using parameters values from Table 6) shows its variability in time due to mobility of the served users within the cell the sector is covering. The variation of the beam steering towards the UE (or within its vicinity) leads to evaluate this gain with respect to WBB LMP station at a given fixed position. A WBB MP station was positioned (at 20m above the ground for the left side picture below, at 10m above the ground for the right-side picture below) at fixed distance from the Macro BS AAS, corresponding to the cell radius (200m for urban, 500m for suburban, 1000m for rural). The Macro BS antenna gain towards this WBB MP was calculated over 105 samples and led to the following plot.

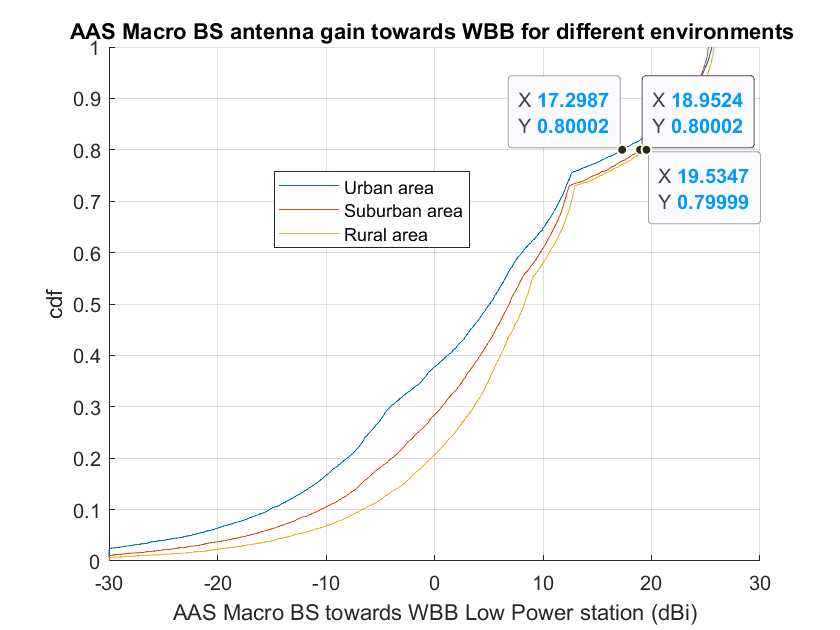
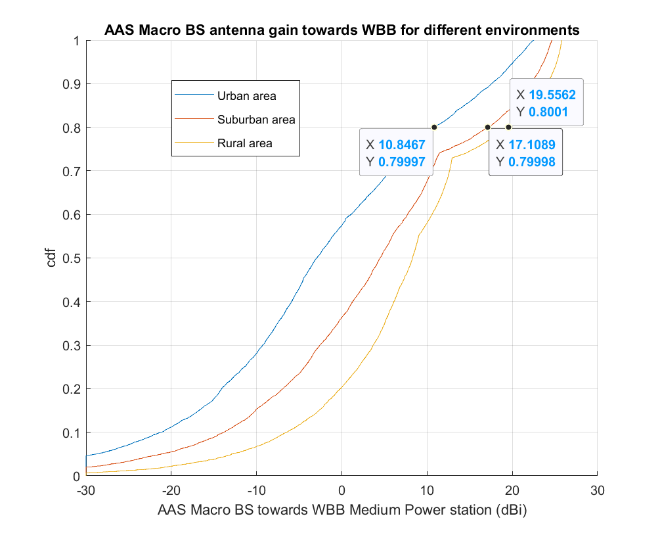


Figure 4: Distribution of MFCN AAS gain towards WBB MP stations

Selecting a high percentile for the antenna gain would reasonably provide the expected protection to MFCN BS receivers in the computation of the protection threshold. 80th percentile was selected for this study and shows that the achieved gain can be close to the peak gain (rural case with around 6dB discrimination antenna gain for the WBB Low Power station) but also much smaller than the peak gain (for WBB Medium Power station in urban areas because the cell size is so small that the peak gain is never achieved when serving ground UEs at the cell edge).

From these assumptions, the protection threshold (field strength, pfd) can be calculated for different environments and different classes of station and the results are summarized in the below table **at the antenna height of the AAS Macro BS below 3800 MHz for MFCN Protection threshold**.

Table 11: Comparison between WBB Coverage and MFCN Protection Thresholds

|  |  |  |
| --- | --- | --- |
| Protection threshold assessed with I/N=-6dB and GMacro MFCN AAS BS 80% | WBB Low Power station | WBB Medium Power station |
| MFCN protection pfd threshold | Urban: -111.3  Suburban: -113.0  Rural: -113.5 | Urban: -104.8  Suburban: -111.1  Rural: -113.6 |
| MFCN protection field strength | Urban: 34.5  Suburban: 32.8  Rural: 32.3 | Urban: 41.0  Suburban: 34.7  Rural: 32.2 |
| WBB field strength at cell-edge | 52.8 | |

The fact that WBB stations do have different heights (10m for Low Power station and 20m for Medium Power Station) explain why the gain of the MFCN Macro BSS AAS towards this WBB differ and would lead to higher gain when the WBB station stands “below the clutter” similarly to served ground UEs.

For a fair comparison of the coverage field strength at WBB LMP cell-edge with the MFCN field strength, it’s necessary to convert the coverage value 52.8 within the MFCN band (below 3800 MHz) by performing an ACIR filtering. According to Table 10, the smallest ACIR value stands for 29 dB (corresponding to WBB Low Power Station with -30dBm/MHz output power in the spurious domain) and would lead to 52.8-29=23.8 which is far below the most stringent MFCN Protection field strength (32.2) calculated in the above Table.

This observation suggests that the protection criterion related to the Macro AAS BS receiver is not a constraint for the WBB LMP network. As indicated in Section 2 (on the methodology), this trend should be further confirmed with a thorough assessment of the median distance from the WBB Low Power station this threshold can be achieved to evaluate how tough the coordination procedure could be (i.e. whether the WBB LMP network licensed area contains or not MFCN Macro BSs).

1. Results of the studies

Results of the studies are expressed in terms of median distance from WBB LMP station can achieve for the protection of MFCN Macro BSs AAS. As described in Steps 4 and 5 from Methodology (See Section 2), this median distance is computed by considering the margin offered when the MFCN protection threshold is higher (i.e. more relaxed) than the WBB LMP cell-edge level needs.

* 1. WBB Low Power

As described in Section on WBB LMP parameters, Low Power (LP) stations are non-AAS.

Table 12: Median distance from WBB LP station can achieve the protection of MFCN BSs (directly adjacent to 3800 MHz)

|  |  |  |  |
| --- | --- | --- | --- |
| Above 3800 MHz | ACIR Low Power  urban | ACIR Low Power  suburban | ACIR Low Power  rural |
| Case #2  ACIR Indoor: 40.6 dB  ACIR Outdoor: 36.9 dB | Indoor: 95m  Outdoor: 195m | Indoor: 101m  Outdoor: 213m | Indoor: 275m  Outdoor: 769m |
| Case #1  ACIR Indoor: 36.1 dB  ACIR Outdoor: 30.8 dB | Indoor: 114m  Outdoor: 272m | Indoor: 122m  Outdoor: 299m | Indoor: 407m  Outdoor: 929m |

From case #1, median distance is almost[[15]](#footnote-15) always smaller than the cell size of MFCN for any environment (urban, suburban, rural), suggesting that the coexistence between WBB LP and MFCN Macro BS AAS is feasible without triggering a systematic coordination procedure. For case #2 (corresponding to WBB LP -39dBm/MHz oob level), the median distance is even smaller than urban MFCN cell size (outdoor 195m and indoor 95m <200m). This does not exclude the fact that a WBB licensed area could include Macro BSs sites. For the cases with Macro BSs within such zone, a coordination procedure can be performed to protect Macro BS by collecting information regarding the case: cluttering environment, characteristics of Macro BS and WBB station antennas (pattern, orientation) in order to assess whether (and which if any) WBB sites could interfere with MFCN BS receivers or not.

One could conclude from these results that from the protection of MFCN Macro BS receiver perspective, WBB Low Power station could operate in any environment (urban, suburban, rural) directly above 3800 MHz without affecting AAS MFCN Macro BS either because the WBB licensed area does not contain any AAS Macro BS site or if this zone covers one or few Macro sectors, the coordination procedure will be manageable in light of the small protection distance this local area network needs to achieve (this distance being reduced from the average value by using mitigation techniques regarding the propagation loss towards the MFCN AAS Macro BS).

* 1. WBB Medium Power

The below table summarises scenarios involving WBB MP station with/without frequency separations: operating directly above 3800 MHz, operating above 3860 MHz. When WBB MP stations directly operate above 3800 MHz, adjacent channel interference rejection level (ACIR) is based on the standard (3GPP TS 38.104). When WBB MP stations operate at least above 3860 MHz (to consider the blocking receiver requirement from AAS MFCN Macro BS for different categories of MFCN AAS stations: 1-O or 1-H), **-45dBm/MHz oob level below 3800MHz** is assumed.

Table 13: Median distance from WBB MP station can achieve the protection of MFCN BSs

|  |  |  |
| --- | --- | --- |
| Directly Above 3800 MHz | WBB Medium Power AAS | WBB Medium Power non-AAS |
| ACIR | 34.8 dB | 38.3 dB |
| 51dBm EIRP WBB (urban) | 678m | 585m |
| 51dBm EIRP WBB (suburban) | 943m | 777m |
| 51dBm EIRP WBB (rural) | 2116m | 1792m |

|  |  |  |
| --- | --- | --- |
| -45dBm/MHz (MFCN type 1-O) | WBB Medium Power AAS | WBB Medium Power non-AAS |
| ACIR | 53.5 dB | 54.3 dB |
| 51dBm EIRP WBB (urban) | 415m | 409m |
| 51dBm EIRP WBB (suburban) | 455m | 447m |
| 51dBm EIRP WBB (rural) | 965m | 931m |

|  |  |  |
| --- | --- | --- |
| -45dBm/MHz (MFCN type 1-H) | WBB Medium Power AAS | WBB Medium Power non-AAS |
| ACIR | 57.3dB | 59.7dB |
| 51dBm EIRP WBB (urban) | 380m | 350m |
| 51dBm EIRP WBB (suburban) | 428m | 414m |
| 51dBm EIRP WBB (rural) | 827m | 739m |

When WBB operates directly adjacent (above 3800 MHz) to the MFCN band, the median distance from WBB MP station can achieve the protection of MFCN Macro BSs is always much bigger than the MFCN cell size e.g. reaching 678m for urban case AAS WBB station to be compared with 200m cell radius (even higher than 400m cell range). This situation would result in achieving 100% probability that the licensed area contains several MFCN sectors.

With 60 MHz minimum frequency separation, the median distance WBB MP station can achieve the protection of MFCN Macro BSs is smaller (e.g. for suburban environment 428m when WBB MP AAS is interfering with MFCN Macro BS AAS type 1-H) in comparison to cell size of every environment (e.g. 500m for suburban environment) except for the urban case (AAS with 380m>200m and non-AAS with 350m>200m with MFCN AAS BS 1-H category). This result suggests that the coordination procedure wouldn’t be systematic even though the requests might occur more frequently for urban areas than those other areas (suburban, rural). To reduce the number of coordination procedure requests in several environments, a mitigation technique would consist in reducing the height of WBB medium power station e.g. when setting an upper-limit to 10m (instead of 20m) the median distance that can be achieved from this station to achieve the MFCN protection threshold will be lower (188m instead of 428m for suburban, 139m instead of 380m for urban regarding WBB MP AAS) than the suburban and urban cell size (respectively 500m, 200m) for non-AAS.

* 1. MFCN Protection threshold

The resulting MFCN protection field strength thresholds not to be exceeded below 3800 MHz at the MFCN antenna height were given in Table 11. Noting that these values depend on the MFCN protection criterion (I/N=-6dB) but also the MFCN Macro BS antenna gain receiver 80th percentile (varying with the height of the WBB station), this threshold would belong to a range of values.

Table 14: Field strength threshold at the border of WBB licensed area

|  |  |  |  |
| --- | --- | --- | --- |
| Field strength threshold | Urban | Suburban | Rural |
| In MFCN Band (below 3800 MHz) depending on the antenna height of WBB station | 34.5-41 | 32.8-34.7 | 32.2-32.3 |
| In MFCN Band (below 3800 MHz) for any antenna height of WBB station | 34.5 | 32.8 | 32.2 |

Except for the urban case, the variation of this threshold is low (0.1-1.9dB), making the selection of a single threshold easy for the regulator and applicable to both WBB Low and Medium Power stations. Actually, the urban scenario is not an issue in the sense that the lowest threshold was derived for WBB station at low antenna height. This means that the lowest value 34.5 can be applied to both WBB LMP at different heights (10m and 20m for this study).

To compute the Field Strength threshold at the WBB in-block, the extra filtering level should be considered and will depend on the frequency separation between MFCN upper-edge band and WBB band. For example, 59.7dB for non-AAS, 57.3dB for AAS WBB station should be used if -45dBm/MHz oob level is assumed to be achieved at 3800MHz to protect MFCB Macro BS type 1-H i.e. with a frequency separation larger or equal than 60 MHz. As an illustration, for rural environment, any licensed area involving non-AAS WBB Medium Power station X MHz above 3800 MHz should be respecting 32.2+ 59.7=91. upper-bound.

# impact OF emissions from mfcn into WBB LMP receivers

Studies performed in the previous section only analysis the interference caused by WBB LMP stations towards MFCN networks. However, if vertical networks are to be deployed within 3800-4200 MHz in the future, it is also important to assess the interference environment over which they would operate. Although interference from AAS Macro BS towards WBB LMP station receivers are not studied here, it is important to anticipate several elements:

* Regarding the WBB LMP blocking response: as highlighted in section 2 on the methodology to derive LRTC, if the rejection filter capability of the WBB LMP has similar performance as the AAS Macro BS ACLR, the interference level is shared among the MFCN BS interference and WBB LMP victims. Reminding that 3GPP band n.78 (3300- 3800 MHz) band-pass filter achieves -30dBm/MHz spurious level 40MHz above the band edge i.e. above 3840 MHz, MFCN Macro BS AAS ACLR would stand around 61dBc , similar requirement for WBB LMP blocking receiver (with associated noise figure in 10dB range) e.g. 64.3dBc would be equivalent to a -15dBm. This value is close to -15dBm AAS MFCN BS out-of-band blocking requirement with 60MHz frequency separation. Noting that MFCN AAS systems directly operate below 3800 MHz, such requirement would mean that WBB LMP would operate at least 60MHz away from the band edge i.e. above 3860 MHz in order to tolerate interference from MFCN below 3800 MHz.
* Regarding the unwanted emissions levels from AAS Macro BS, it is also noted that within 3800-3840 MHz, WBB LMP would be subject to receive higher oob level (from MFCN AAS Macro BSs) than -30dBm/MHz spurious which would make the coexistence probably more difficult to handle than the interference from the reverse link (WBB LMP interferer-AAS MFCN Macro BSs).

These two issues vanish themselves if WBB LMP and MFCN networks are synchronized, especially when they are operating closely e.g. for urban or suburban areas.

# Conclusions on Studies

Based on the results of the studies addressed in the previous sections (impact from overload threshold and unwanted emissions) but also the possible impact from MFCN towards vertical networks in terms of interference, the following approach to enable coexistence between unsynchronized MFCN and WBB LMP, while limiting coordination, would be as follows:

* The WBB LMP licensed area for non-synchronized operation could be defined with an unwanted emission field strength threshold at the border of the allotment, below 3800 MHz, in order to limit coordination at the edge of the allotment and to protect MFCN BSs receivers[[16]](#footnote-16). The values calculated above for any value of WBB LMP antenna height are 34.5 field strength for urban environment, 32. for suburban environment, 32. for rural area **at the antenna height of the AAS Macro BS** at its border. It is noted that this could be converted into in-band field strength threshold at the border of the allotment (see end of section 3).
* Non-synchronized WBB *Low Power* stations could operate either
  + directly adjacent to MFCN i.e. above 3800 MHz with an amount of coordination procedures triggered for any MFCN BS site within the licensed area of a WBB LP network, providing that the above threshold at the border of the allotment is met,
  + by defining a BEM for OoB emissions below 3800 MHz (e.g. -45dBm/MHz conducted power) to protect MFCN AAS BS and a blocking requirement (e.g. -15dBm) to tolerate interference from MFCN with significant reduction of the coordination cases.
* WBB *Medium Power* stations could operate either:
  + By defining a BEM for OoB emission below 3800 MHz (eg. -45 dBm/MHz conducted power), ensuring that non-synchronized WBB Medium Power stations could comply with the above threshold at the border of the allotment and a blocking requirement (e.g. -15dBm), thus limiting coordination of MFCN BS site within the licensed area of a WBB MP network.
  + Without defining a mandatory BEM, which would make necessary non-synchronized WBB Medium Power stations to operate with sufficient frequency separation) away from MFCN upper-edge band in order to allow filter roll-off out of band conducted/TRP level to be much lower than -30dBm/MHz (e.g. -45dBm/MHz).

1. With 2dB difference. [↑](#footnote-ref-1)
2. See Table 4 from [ECC Dec(11)06](https://docdb.cept.org/download/1531) for non-AAS Case [↑](#footnote-ref-2)
3. the restricted baseline for non-AAS in 3400-3800 MHz is -34dBm/5MHz EIRP=-41dBm/MHz EIRP 4dB more relaxed than -45dBm/MHz EIRP non-AAS for 2.6GHz TDD Duplex gap while it is -43dBm/5MHz=-50dBm/MHz TRP for 3400-3800MHz and -52dBm/MHz for 2.6GHz TDD Duplex gap. [↑](#footnote-ref-3)
4. As stated in page 5: *It is not permitted to use the 3.8-4.2 GHz band to provide national mobile broadband services;* [↑](#footnote-ref-4)
5. See Chapter 3 [↑](#footnote-ref-5)
6. See Section 3.4.1 from (French) document available here <https://www.arcep.fr/fileadmin/cru-1677573101/reprise/PMR26/Document_attribution_bande_26_TDD.pdf> [↑](#footnote-ref-6)
7. See Section 1.2 from ECC Report 331 for an overview of the coordination threshold used between unsynchronized TDD neighbouring networks [↑](#footnote-ref-7)
8. See 3GPP TR 36.942 Annex A Table A.2 where SNR=-10dB enables non-null spectral efficiency i.e. 0.08 bps/Hz i.e. 14.4 kbps sufficient for voice application at the cell-edge. [↑](#footnote-ref-8)
9. Because In-band TRP is equal to 51dBm-16dBi=35dBm belonging to Medium Range of BS (33dBm<<47dBm). [↑](#footnote-ref-9)
10. See formula (1) from Annex 3 [↑](#footnote-ref-10)
11. From the MFCN receiving band i.e. below 3800 MHz. [↑](#footnote-ref-11)
12. See further explanation in the text below the Table. [↑](#footnote-ref-12)
13. See Table 7.4.2-1 from Section 7.4.2 (3GPP TR 38.901). [↑](#footnote-ref-13)
14. to cover the out-of-band blocking requirement from MFCN AAS Macro BS [↑](#footnote-ref-14)
15. Except for the urban area with an outdoor deployment with an average distance higher (272m) than the urban cell radius (200m). [↑](#footnote-ref-15)
16. Provided that coupling loss between WBB LMP and MFCN BSs is calculated at the border of the licensed area and at the MFCN BS location at the same height to ensure that the value of the protection threshold behaves in a monotonic way (i.e. if this threshold is met at the border of the licensed area, it remains met at the MFCN BS location). [↑](#footnote-ref-16)