Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

ECC RECOMMENDATION (04)05

GUIDELINES FOR ACCOMMODATION AND ASSIGNMENT OF MULTIPOINT FIXED WIRELESS SYSTEMS IN FREQUENCY BANDS 3.4-3.6 GHz AND 3.6-3.8 GHz

Recommendation adopted by the Working Group "Spectrum Engineering" (SE)

INTRODUCTION

Multipoint Fixed Wireless Systems (FWS) are deployed in several bands; the lowest frequency band, among preferential bands for Fixed Wireless Access (FWA), identified CEPT/ERC REC13-04, is the band 3.4-3.6 GHz.

In that band, CEPT/ERC REC14-03 recommends channel arrangements that, for Point-to-Multipoint (PMP) systems, are primarily based on multiple slots of 0.25 MHz with possible duplex spacing of 50 and 100 MHz, but also other rasters (multiple of 1.75 MHz) are provided in the recommendation.

In addition, CEPT/ERC REC12-08 recommends the optional use of the band 3.6-3.8 GHz, providing, for PMP systems, the same channel arrangement, frequency assignment criteria and duplex spacing as in REC 14-03; this band is therefore used by some administrations as an extension of, or an alternative to, the 3.4–3.6 GHz band. It is also recognised that both bands are also used by Point-to-Point (PP) systems in the Fixed Service, FSS systems and ENG/OB users, along with a secondary allocation to the Radio Location Service.

However, none of the above mentioned recommendations gives any further guidance on the assignment rules among different operators, or different service types, in either co-ordinated or uncoordinated deployment, leaving to administrations to decide on any further limitations (e.g. in term of EIRP limitation, guard-bands, co-ordination distance for frequency re-use, etc.). Also no guidance is given within the referenced documents on how sharing should be managed between PMP FWS that use spectrum adjacent to non-MP services.

Those bands, even if being of limited size, are valuable because they provide for quite wide cell coverage when Line-of-Sight (LOS) rural conventional deployment is considered, as well as connections with partially obstructed (Non-LOS, NLOS) paths and even with simple self-deployable indoor terminals, which is important feature for deployments where simple and cost-effective radio-access connections are desirable. Therefore the bands around 3.5 GHz are potentially interesting for a quick growth of domestic/small business access connectivity of moderate capacity, typically for ensuring the policy goals of proliferation of broadband Internet (IP) connections (e.g. in accordance with EU e-Europe action plan).

For such purpose a wide variety of Multipoint FWS technologies are already available on the market; they span from different system capacities, modulation formats (e.g. 4 or 16 states using Single Carrier or OFDM) access methods (e.g. TDMA, FDMA, CDMA and OFDM/OFDMA), system architectures (PMP and MP-MP), duplex arrangements (TDD and FDD) and asymmetry (different up-stream/down-stream traffic as typically needed for IP-based access). Each technology offers to operators specific benefits for specific market segments/characteristics; in addition, the continuous extensive evolution of the market and of the related technologies could imply that operators might be willing to change the system deployed with others, which better fit the changing needs; and this switch-over should not impact other operators, irrespective of the newly selected system. Some of these technologies would enlarge the field of possible applications, for instance to nomadic applications for indoor terminals.

PMP FWS technologies, whenever the local conditions and the administrative (license) policies permit, may be used also for provisioning of mobile network infrastructure, in particular for traffic collection from mobile base stations serving rural low density and urban pico-cells. In addition, as envisaged in CEPT/ERC Recommendation 14-03, FWA operators have interests in deploying point to point links within their own blocks (e.g., for their infrastructure or to connect remote stations).

Consequence of the above considerations is the need for a technology-neutral assignment methodology, possibly harmonised among CEPT administrations for reducing the market fragmentation. This recommendation is addressing elements for a harmonised assignment methodology, based on studies reported in ECC Report 33.

Given the latest trends for the development of FWA in this band, it is currently expected that most of new deployments will utilise the broadband systems, which means that broader frequency blocks would be needed. Thus, this assumption was taken into consideration in this recommendation.

It has to be finally noted that Multipoint-to-Multipoint (MP-MP), also known as "Mesh", network architectures were not specifically addressed by ECC Report 33, and consequently by this Recommendation, due to lack of sufficient supportive contributions.

BACKGROUND TO RECOMMENDED ARRANGEMENTS

In order to cater for the mix of technologies and services to be delivered it is most appropriate that a block (or blocks) of spectrum should be made available to a potential operator in a manner consistent with the technology and market that the operator may wish to address.

Medium-to-large size blocks (most likely of similar size between different operators) are anticipated and their size will depend, up to certain extent, on the applications foreseen. Administrations should be aware of the spectrum engineering measures proposed in the annexes of this recommendation and their relationship to the assigned block size. A key principle of the assignment guidelines is that even though a technology specific channelisation scheme is expected to operate within an assigned block, this channelisation is not the basis for the assignment process.

It is a requirement of the block assignment process, detailed in this recommendation, that systems supporting both symmetric and asymmetric traffic are accommodated as well as systems that employ FDD and TDD techniques. However, it should be taken into account that the guidance in this Recommendation would not completely eliminate any possible interference; in particular, if very different technologies were deployed in frequency adjacent blocks in the same geographic area without coordination, the probability of interference may increase. Therefore, while maintaining the neutrality of assignments, any "common-practice" measure and available information on systems to be deployed should be used in conjunction with the provisions of this Recommendation; furthermore, also inter-operator coordination should be encouraged and favoured for reducing the interference potential among operators directly or via the administrative licensing regime.

On the opposite, such inter-operator coordination, in conjunction with these "common-practice" measures, would in some situations allow the possibility to exceed the limits provided in this Recommendation while maintaining inter-systems interference at acceptable level.

Actually, different methodologies for the assignment of those blocks might be envisaged; namely, either block-edge regulations or guard bands between assigned blocks might be enforced depending on the required protection between adjacent assignments. However the amount of protection depends on equipment technology and characteristics that, in these bands, are consistently varying from system to system due to the large number of different market needs addressed. On this basis, this recommendation proposes as a preferred option to assign blocks contiguously with associated "block-edge mask" requirement, which is considered the most simple and "spectral efficient" among "technology neutral" methods.

Measures are recommended for dealing with the issue of inter-operator coexistence both between frequency blocks and between neighbouring geographic areas. The basis for these measures is to allow deployment with the minimum co-ordination, although more detailed co-ordination is encouraged as an inter-operator issue.

It is also noted that ETSI ENs for PMP FWS in these bands (see references below) have not been historically designed for a technology neutral deployment (this is done only in the 40 GHz MWS EN 301 997); therefore, they do not contain system controlling parameters, in terms of EIRP or absolute power densities, useful for the desired "technology neutral" and "uncoordinated" deployment. Not having any previous ECC harmonised guidance for such deployment, ETSI ENs are still bound to a cell-by-cell "co-ordinated deployment" concept actually not used in most of the licensing regimes. It is therefore assumed, that this recommendation would eventually generate feedback actions in revising also ETSI ENs accordingly.

Aspects that relate to sharing issues with P-P FS links, FSS, radiolocation (in adjacent band) and ENG/OB are not considered in this Recommendation, but are being dealt with in other ECC deliverables.

The applicability of this Recommendation is based on the following aspects:

- The presented guidelines should be independent from the access methods described in the ETSI EN 302 326-2 and EN 301 753.

- MP-MP (Mesh) architectures have not been considered. In order to include Mesh architectures, within the same assignment framework, a number of assumptions on "typical" application in these bands (e.g. on the use of omni-directional/directional antennas) still need to be defined in order to devise a typical set of intra-operator, mixed MP-MP/PMP interference scenarios and any necessary simulations should be carried out in order of define, if needed, specific requirements for that.

- This recommendation considered both outdoor and indoor deployment of user terminals, assuming respectively directional and omni-directional antennas;

- Performance and availability requirements for indoor terminals applications, for their nature, are assumed to be less stringent than conventional outdoor applications with directional antennas;

- Also channel sizes and modulation schemes were not specifically considered unless for defining "typical" system parameters;

- Use of either FDD/TDD, symmetric/asymmetric deployments was considered.

- Additionally, system independent, absolute power density limits at the edge of deployed region (pfd boundary conditions), as well as at the edge of assigned spectrum (block edge boundary conditions) are considered as licensing conditions for "generic" co-existence between neighbouring operators (similarly to the principles in ECC/REC 01-04 for the 40 GHz band); however, it should be taken into account that there might be few "worst cases" on the territory where site-by-site co-ordination may be needed. Being provided as guidelines for licensing conditions only, these limits shall not be used for the purpose of presuming conformity of equipment for access to the market.

Presently, the spectrum blocks assigned per operator vary widely from country to country; examples of assigned blocks ranging from ~10 MHz up to ~28MHz (single or duplex) have been reported. However current assumptions of broadband services, required by the market drive, suggest the need for wider system channel bandwidths (e.g. up to ~14/28 MHz) and therefore correspondingly wider spectrum blocks assignment in the future.

"The European conference of Postal and Telecommunications Administrations,

considering

a) that within CEPT the band 3.4-3.6 GHz has been identified as a preferred frequency band for Fixed Wireless Access (FWA), ERC/REC13-04, ERC/REC14-03 refer;

b) that the band 3.6-3.8 GHz is also used or might be used in the future in several CEPT countries for Point-to-Multipoint Fixed Wireless Systems (PMP FWS) in accordance with provisions of ERC/REC 12-08;

c) that the Fixed Satellite Service is also allocated with primary status in these bands and in some locations appropriate measures will be needed in the planning and deployment of FWS around earth stations installations to ensure sharing with the Fixed Satellite Service;

d) that other radiocommunications services also operate in the bands 3.41 – 3.6 GHz and 3.6 – 3.8 GHz;

e) that the EU "e-Europe" program states that "affordable, high speed Internet access, available over a variety of technology platforms, is crucial to ensuring that everybody has access to the benefits of the Information Society";

f) that harmonisation of the frequency assignment regulation will greatly enhance the penetration of such access through appropriate FWS technologies;

g) that FWS in the bands 3.41–3.6 GHz and 3.6–3.8 GHz are expected to provide broadband services with enhanced availability for fast Internet connections, including telephony, video, media streaming and data services to both residential and business customers (see examples of standardised technologies in annex 5);

h) that national licensing policies may also allow deployment of various other FWS applications in these bands, such as PMP FWS used for mobile networks infrastructure (e.g. linking low-traffic base stations) and point-to-point links (e.g. for FWS infrastructure or connections to single remote stations) within the allocated FWS spectrum blocks;

i) that it is desirable to achieve a flexible frequency assignment plan that can accommodate both symmetrical and asymmetrical MP FWS traffic requirements, whilst remaining consistent with good spectrum management principles, including provision for co-existence of PMP FWS systems and overall spectrum efficiency;

j) that both time division duplex (TDD) systems and frequency division duplex (FDD) systems should be allowed inside assigned frequency blocks, provided that appropriate co-existence criteria can be met;

k) that sufficient capacity and flexibility for deployment of multiple systems within a desired service area can be achieved by the aggregation of a variable number of contiguous frequency slots from a homogeneous pattern to form a block assignment;

l) that in order to enhance the efficient use of the assigned block(s) according present and future available technology, operators should be able to freely define and modify suitable channel arrangement(s) within the block(s);

m) that the frequency assignment methodology for FWS should consider the need for necessary traffic capacity as well as provisions for inter-operator coexistence within contiguously assigned blocks;

n) that in PMP applications, particularly when also NLOS propagation situations are considered, intra and inter system coexistence studies may be carried out only on statistical basis; therefore interference forecast could only be given in terms of a certain occurrence probability of worse cases;

o) that it is desirable to provide suitable harmonised CEPT guidelines for implementation of PMP systems using both conventional fixed terminals with outdoor directional antennas, as well as terminals with omni-directional or low directivity antennas, flexibly deployed by the users, typically in indoor scenarios;

p) that self-deployed terminal stations with omni-directional or low directivity antennas, by their nature more sensitive to interference, may also have less demanding objectives in term of error performance and availability; therefore over-regulating limitations of all base stations emissions, in the attempt of providing these indoor terminals with the protection objectives similar to those of conventional terminals with outdoor directional antennas, might adversely and unnecessarily affect the market;

q) that administrations should encourage and facilitate the co-operation among operators to maximise the efficient use of assigned blocks and for resolving worst cases of interference that might occur beyond the assumptions and objectives of this recommendation;

r) that guidance material, on which this recommendation is based, is available in ECC Report 33 to assist administrations with co-existence considerations for deployment of FWS systems in multiple operators scenario;

s) that in some countries interference to FWS operations was noted from radars operating below 3.4 GHz, therefore administrations should take this potential problem into account when assigning frequencies to FWS in lower parts of 3.4 GHz band;

t) that the national implementation of measures recommended in this recommendation should take due account of any prior bi- or multi-lateral international coordination agreements in the subject band;

u) that the provisions of block edge mask given in this recommendation are based on limitation of transmitter emissions only. Although it was recognised that receiver selectivity also may have impact on co-existence, it was not taken into account in these studies because of the technology neutrality assumption;

v) that the ECC Report 33 could not consider multipoint-to-multipoint (MP-MP or Mesh) architectures. Therefore further studies might be necessary in order to verify the applicability of this recommendation for Mesh systems;

recommends

1) that administrations wishing to apply block assignment of frequencies to PMP FWS in bands subject of this recommendation, should assign frequency blocks contiguously, following the guidance in Annex 1 for defining the preferred block arrangement and size, including some spectrum allowance for internal guard bands;

2) that administrations should consider the guidance given in Annex 2 when deciding on maximum EIRP levels to be established in FWS licences, to provide reference to assess the interference level between adjacent blocks and adjacent service areas and the interference to other services or systems;

3) that the Block Edge Mask measures given in Annex 3 may be used to limit interference between frequency-adjacent blocks within the same geographic area. Operators of the adjacent blocks might be allowed to deviate from the Block Edge Mask requirements, subject to their mutual agreement (e.g. involving co-ordinated deployment, mitigation techniques, etc);

4) those administrations who do not wish to follow the approach of contiguous block assignment as given in Recommends 1, should still find appropriate guidance for inter-block coexistence in annexes 1 and 3 when defining the size of external guard bands;

5) that administrations should consider the measures given in Annex 4 to limit interference between the same blocks assigned in geographically adjacent service areas;

6) that blocks should be assigned without further regulatory requirements on the actual channel arrangements and centre frequencies inside the blocks;

7) that administrations encourage inter-operator co-operation on co-existence issues to maximise utilisation of the assigned blocks, e.g. by requesting advance notification of technical and geographical deployment characteristics of base stations and making such data base available to all operators;

8) that due consideration should be given to ensure sharing/compatibility of PMP FWS with other radiocommunications systems/services, which may require alternative protection criteria, not addressed in this recommendation;

9) that care should be taken when licensing systems using MP-MP (mesh) architectures, due to the not yet proven applicability of this recommendation to them.

Note:

Please check the Office web site (http://www.ero.dk) for the up to date position on the implementation of this and other ECC and ERC recommendations.

ANNEX 1

FREQUENCY ASSIGNMENT IN BLOCKS

Point-to-Multipoint Fixed Wireless Systems (PMP FWS) may be provided by a number of different access technologies. The following recommended approach includes steps addressing the situation whereby no decision is taken beforehand by an administration regarding the technology anticipated. It provides the most flexibility and freedom for operators to choose how to make best use of the spectrum:

1. Consider the amount of spectrum available for PMP FWS applications and its distribution over the bands 3.4-3.6 GHz and/or 3.6-3.8 GHz (e.g. how many suitably sized blocks could be possibly accommodated adjacent each other);

2. Consider the geographic extent of licences: local/regional vs. nation-wide service areas;

3. Consider any constraints brought about by the need to share with other services;

4. The blocks should be made from aggregation of a number of basic 0.25 MHz slots. It is then also possible to form blocks according to existing channel plans (e.g. 3.5 MHz raster). Reference is made to relevant provisions in CEPT ERC/RECs 14-03 and 12-08;

5. Co-existence between frequency-adjacent blocks and most efficient use of spectrum should be preferably addressed by assigning blocks contiguously, by advocating inter-operator co-ordination and/or applying the block edge mask as given in Annex 3. For the block edge mask to be effective, the blocks must include spectrum required to facilitate internal guard bands at the block edges. Alternatively, it should be also possible to use external guard bands for additional protection and as a reserve for possible future expansion of blocks; the size of external guard bands should be approximately equal to 25% of block size (of the largest block, if assigning of equal blocks is not possible);

6. Consider that assigned blocks within the same geographical areas should be as far as possible of equal or very similar size, subject to market demand, so that the necessary co-existence measures can be balanced between the operators of adjacent blocks.

7. Consider the requirement for duplex spacing in the band. Unless there is a clear *a priori* preference from operators for TDD deployment, the assigned blocks should be paired, as shown in Fig. A1.1, as this would, in principle, allow operators choosing either FDD or TDD deployment[1]. In case of having explicit *a priori* knowledge of required proportion of planned FDD and TDD deployments, the available band could be more efficiently divided for paired vs un-paired blocks, e.g. as shown in Fig. A1.2.

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[1] Whilst contiguous frequency blocks for TDD would have been most advantageous in terms of equipment cost and spectrum efficiency, TDD systems do not necessarily require contiguous frequency blocks; therefore, in view of balancing flexibility and complexity within the assignment criteria, their use may be fitted in the general policy of paired symmetric block assignment. However, in this case the necessary guard-bands may reduce the overall spectrum utilization factor.

8. Consider the appropriate block size (B, MHz) for assignment. Although it is difficult to determine an absolute value for the optimum block size, typical values for contiguously assigned blocks are suggested in the Table below:

Recommended block sizes, MHz Paired deployment	Recommended block sizes, MHz Un-paired deployment
17.5 x 2	35
21 x 2	42
35 x 2	70
42 x 2	84

Note 1: If administration decides to have external guard bands, then the necessary minimum size of the blocks may be reduced by some 20%, which is then dedicated to external guard bands.

Note 2: The block sizes given in the above table are suitable for typical channel sizes of up to 7 MHz, if the requirement for broader channels would be envisaged, this may require block sizes of up to 50/60 MHz x2 paired or 100/120 MHz unpaired).

9. Taking due account of the technology choices and the constraints on spectrum access brought about by the need to share the band, consider the following guidelines in order to develop an appropriate frequency block assignment plan:

- Paired equal blocks should be normally offset by 100 MHz[2], unless the amount of available band dictates differently[3]. Only if the available frequency band is limited, the offset of 50 MHz[2] may be used as alternative.

- In cases when two operators would both wish to operate TDD systems, while having been initially assigned adjacent paired blocks, such operators should be allowed to swap the blocks so that they could themselves achieve formation of contiguous blocks optimised for TDD operation, as shown in Fig. A1.2, with due respect of national regulations and international cross-border agreements. This may bring increased efficiencies to these assignments.

- For a generic co-existence enhancement and for harmonisation of the CEPT market, in absence of any different legacy or other constraints (e.g. existing bi- or multi-lateral co-ordination agreements at country-borders), the following should be considered:

  A. Symmetric FDD PMP systems should use the lower sub-band for the transmission from the terminals to the central station and the upper sub-band for the transmission from the central station to the terminals;

  B. Use of geographic and frequency separation might provide a useful tool for improving co-existence of different systems (e.g. TDD vs. FDD).

- Without prejudice to any requirements stemming from bi- or multi-national cross-border coordination agreements, an operator should have the flexibility to choose its own system channel arrangement within its block. Consequently, an assigned block may contain a number of actual channels, as defined by the operator independently from the original raster used for creating the block, as well as variable in-block guard bands to meet the inter-block co-existence requirements for the case of contiguously allocated blocks.

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[2] Depending on the band allocation in each country, these are the offset options provided by CEPT ERC/REC 14-03 and 12-08.

[3] In the band 3.41 to 3.5 GHz or 3.41 to 3.6 GHz, the missing band 3.4 to 3.41 GHz will create unpaired corresponding band, 3.45 to 3.46 GHz or 3.5 to 3.51 GHz, respectively. This un-paired sub-band should either constitute a guard band, a single unpaired assignment or be attached to one or both adjacent blocks forming an asymmetric paired assignment, see Figure A1.1.

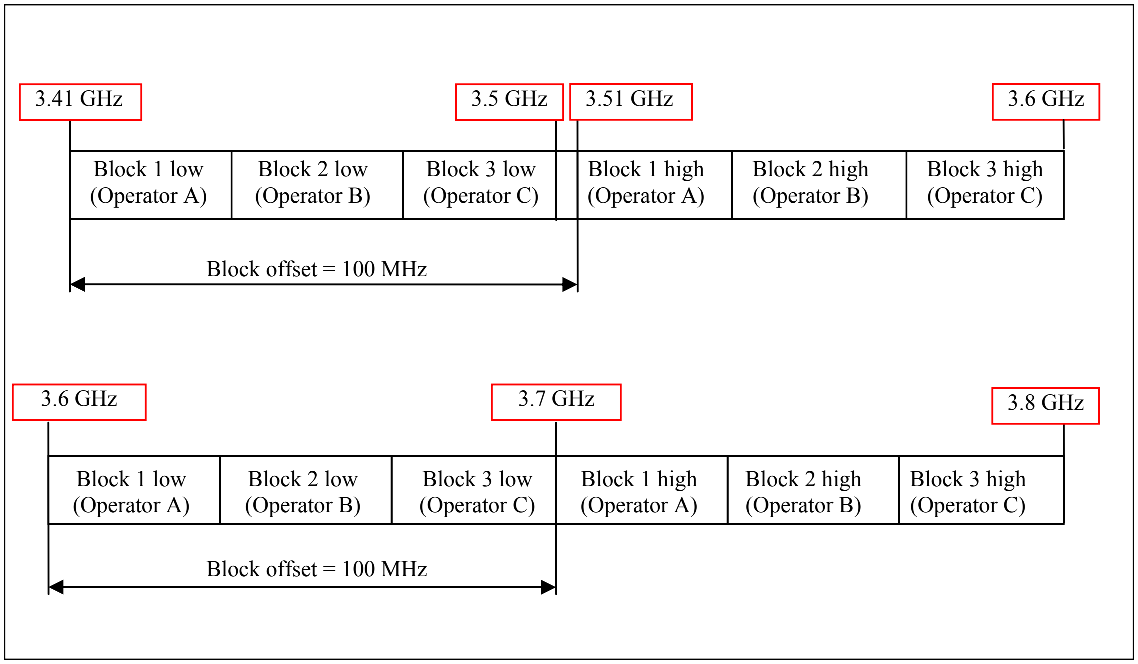


Figure A1.1: Example scheme for the concept of paired equal blocks only in 3.4-3.6 GHz and 3.6-3.8 GHz bands

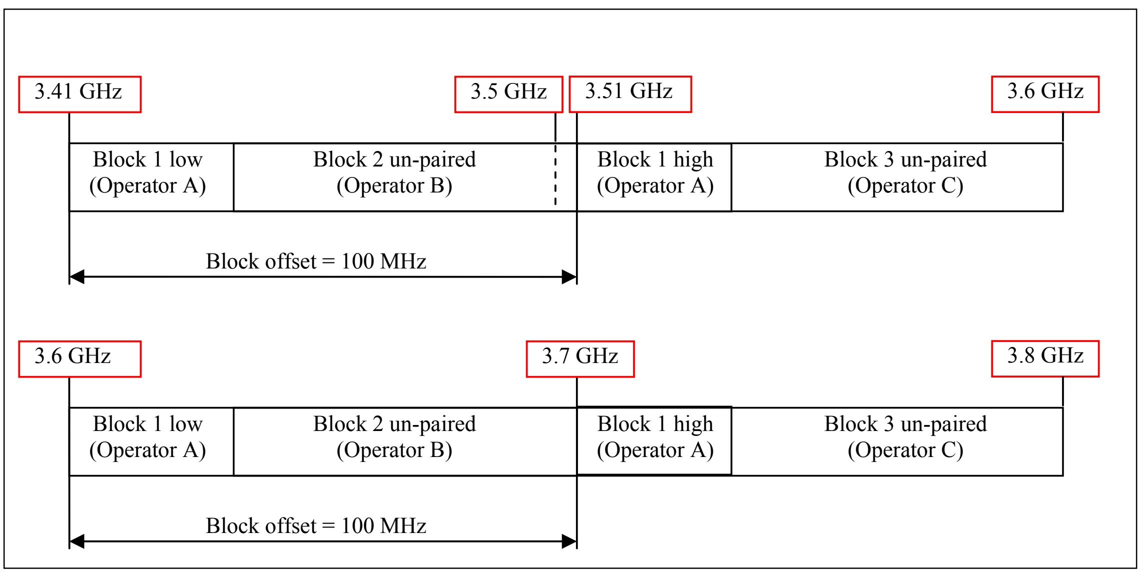


Figure A1.2: Example scheme for combining paired and un-paired blocks in 3.4-3.6 GHz and 3.6-3.8 GHz bands

Background for choosing the block size for considered PMP FWS applications

For the examples of PMP FWS applications referred in Annex 5, it appears that most of them are designed for a cell coverage methodology of "reuse four", using four frequency channels with separation (ChS) of typically 3.5/7 MHz.

In other ERC/ECC recommendations for higher bands, where the channel size of system on the market is in practice constant at 28 MHz, the recommended assignment methodology provides for blocks composed by 2/4 x 28 MHz channels, keeping, for mixed TDD and FDD licensing, one or two further 28 MHz channels as guard band.

Therefore:

a) for contiguously adjacent, technology neutral blocks that may need to contain also suitable guard bands inside those blocks, this would require block sizes that would exceed the 4 x ChS by an amount of one to two additional channels. Therefore in such cases of contiguously assigned blocks, typically required block sizes might be in the order of:

- System channel raster 3.5 MHz: Block size B=~17.5÷21 MHz
- System channel raster 7 MHz: Block size B=~35÷42 MHz

b) if external guard bands are employed between the assigned blocks, then the suitable size of assigned blocks should be equivalent just to the sum of 4 reference channel bandwidths.

Studies carried out by industry, based on assessing the balance between the coverage data density requirements and the economics of system deployment conclude that total paired block sizes ranging from about 2x17.5 MHz up to 2x35 MHz (including allowance for internal guard bands) can accommodate a reasonable capacity to meet the demands of a currently anticipated service set. However these block sizes might be considered only a starting point if higher data rate demands are expected, therefore total paired block size of about 2x42 MHz to 2x50 MHz, when available, would be more desirable, easily satisfying current needs whilst providing capacity for future expansion and growth as well as spectrum for dealing with interference issues.

In addition, whenever operators in contiguously assigned adjacent blocks would use the same standardised systems, the potential for closer coordination and cooperation is maximised, increasing efficiency of spectrum use.

ANNEX 2

MAXIMUM EIRP

1. Introduction

Maximum EIRP density limits are set by administrations in their national licensing conditions in order to define pfd levels for co-ordination distances between different geographical areas or for cross-border agreements or sharing with other services. Transmit output power and EIRP levels for Multipoint FWS systems are more driven by trade-offs between the required service coverage and other operational considerations. EIRP density depends also on the system bandwidth that in modern PMP FWS might be flexibly changed.

2. Maximum EIRP within a block

The following table A2 gives guidance for Administrations on setting possible maximum EIRP limits or to arbitrate interference cases between operators.

Station Type	**Max EIRP spectral density (dBW/MHz)** (Including tolerances and ATPC range, Note 1)
Central Station (CS) (and Repeater Station(RS) down-links)	+23 Note 2
Terminal Station (TS) outdoor (and RS up-links)	+ 20 Note 3
TS (indoor)	+ 12
Note 1: the total power delivered by a transmitter to the antenna of a station should not exceed 13 dBW, ITU RR S21.5 refers Note 2: CS EIRP density value given in the table is considered suitable for conventional 90 deg sectorial antennas. Administrations may consider to adjust this value if other type of antennas are used (e.g. decrease the limit for omni-directional antennas, or increase when narrow-sector or adaptive antennas are used) Note 3: If Administrations wish to consider higher EIRP limits (e.g. for improving coverage in remote rural areas), this should be achieved by using the high gain directional antennas, not by increasing output power, however the higher interference potential of EIRP increase should be carefully considered	

Table A2: EIRP density limits for CS and TS stations of PMP FWS

For further enhancing the efficiency, administrations may allow operators to apply mutual co-ordination at the block edge and at the service border edge for potential further relaxation of the above EIRP limits, depending on requirements for protecting other services or systems, such as PP FS. This could be reached, for instance, by taking advantage of mitigation techniques such as the shielding effect, limiting the height of Central Stations, or for stations that are located far from the service area boundary.

It should be noted that in some CEPT countries certain legacy systems in this band (e.g. WLL) were licensed with lower EIRP limits than shown on Table A2 (e.g. 6.5-7.5 dBW/MHz). If in such cases administrations consider introduction of new systems with power limits given in Table A2, the means to ensure mutual co-existence of new and legacy systems should be considered.

ANNEX 3

REFERENCE BLOCK EDGE MASK

1. Introduction

The block edge mask given in this annex was developed to ensure co-existence between PMP FWS applications only; different considerations would be required where the adjacent system is not a PMP FWS system, but for example ENG/OB or other.

The floor level in the mask provided in this annex has been based on co-existence studies reported in ECC Report 33; where the PMP FWS co-existence studies were mostly made with statistical tools and assumptions of typical radio systems, their deployment and service performance objectives. The reference points of the transition slope were chosen based on consideration of practical filters and various modulation envelopes. These studies and considerations may be subject to refinement as operational experience and system characteristics evolve. Therefore the block edge mask based upon these studies may also be subject to refinement.

Emissions from one operator's frequency block into another operator's frequency-adjacent block will need to be controlled. This was done in few other frequency bands by establishing fixed guard bands between the assignments. However, taking due account of the possible variety of broadband systems considered in this recommendation, different network and service requirements, and considering the expected broadening of the required bandwidth, it would be impossible to uniquely and efficiently set such guard bands and it is recommended that coordination and interference mitigation techniques be implemented between operators.

Alternatively, in this recommendation, a so-called Block Edge Mask (BEM) is established to achieve limitation of emissions into an adjacent frequency block, by enabling the operators to place the outermost radio channels with suitable guard-bands inside their assigned block, in order to reduce the interference potential with the operator of adjacent frequency blocks. Transmitter power and outermost channel's centre frequency could be traded-off in order to fulfil the block edge requirement.

BEM is generally designed on the basis of a small level of degradation in an assumed interference scenario with a low occurrence probability of a worst case (e.g. low probability of two directional antennas pointing exactly at each other). It is not therefore excluded that in a limited number of cases specific mitigation techniques might be necessary.

In particular when Central Stations (CS) are co-located on the same building, the statistical approach is not applicable and it is assumed that common practice of site engineering (e.g. vertical decoupling) is implemented for improving antenna decoupling as much as possible.

Also adjacent block receiver rejection concurs to a reduced interference scenario, however the study in Report 33 did not consider the effect of receiver selectivity since the technology neutrality assumption did not allow deciding on its typical parameters. Therefore it is not in the scope of this recommendation to set limits for it; nevertheless it is expected that ETSI standards will adequately cover the issue.

The BEMs given below were developed as a trade-off between the need to ensure co-existence between PMP FWS systems with technology neutral assumptions and practical feasibility of transmitter filters to match the recommended masks, while maintaining suitable frequency agility inside the assigned block.

The CS mask recommended in this Annex provides adjacent blocks (assumed to be sized from 4 typical system channels plus an internal guard band as recommended in Annex 1) with increasingly protected frequency areas:

- Internal guard bands' areas where protection is not offered unless the interested operators would practice active coordination;
- Outermost system channels' areas where protection is given with high probability, but in few worst cases coordination between CSs might be needed, preferably between the involved operators themselves, considering that in most cases the need for coordination may be avoided by operators choosing the innermost systems channels of the block that are more protected;
- Innermost system channels' areas where protection is given with very high probability.

2. Block edge mask for CS

In cases where the amount of spectrum available for PMP FWS applications allows licensing of multiple frequency blocks in the same geographical area, maximising spectral efficiency would require establishing some general rules for co-existence of adjacent frequency blocks. These would require either coordination and/or mitigation techniques or the application of a block edge mask. No such rules are necessary if only one block is made available for PMP FWS operations in a given frequency band/geographic area.

It should be also noted that when TDD or mixed FDD/TDD systems are placed in immediately adjacent blocks, the probability of occurrence of worst cases of interference between CSs is quite higher than in situations where only FDD are deployed. Therefore, even if the mask proposed in this annex would offer a suitably low probability of interference for such cases, when TDD systems are concerned additional mitigation techniques (geographic separation of stations, natural/physical shielding, etc) and/or additional co-ordination (including networks synchronisation) between operators should be implemented as far as possible.

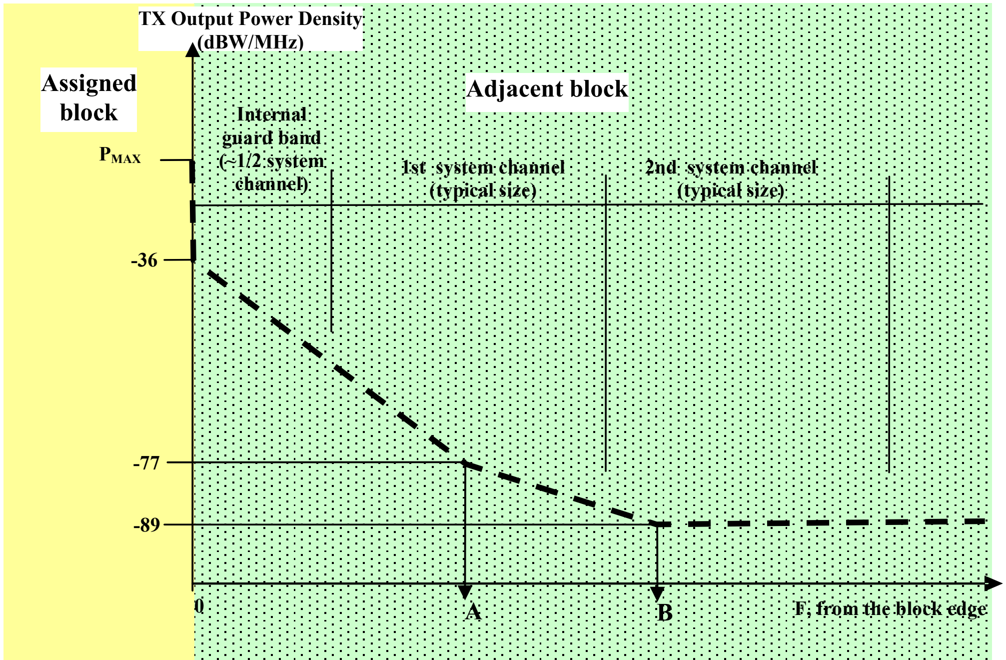
Figure A3 shows the recommended block edge mask limits for the CS of PMP FWA; the limits shown are the absolute maximum transmitter output power density values and intended to include tolerances and any ATPC range. The figures are supplemented by tabular description of mask curve in Table A3.

ECC Report 33 has shown that when no co-ordination or interference mitigation is applied, the less directional antennas (either CS or TS) generally produce more probability of interference; therefore out-of-block emissions in terms of EIRP should be more stringent for lower directivity (and consequently with lower gain) antennas. That is why the recommended block edge mask limits outside the block are described in this annex in terms of transmitter output power, allowing operators to make practical use of this phenomenon by obtaining higher EIRP when using highly directional hence less interfering antennas, while EIRP would be automatically lowered when low gain (e.g. omni-directional antennas) are employed.

The reference frequency ΔF=0 of the mask should be understood as the central division line between adjacent frequency blocks. If the blocks are immediately adjacent, then the mask reference frequency is precisely the border between the two assigned blocks and respecting the mask limits may require operators to employ appropriate guard band inside the assigned blocks. However, if an administration decides to introduce between neighbouring blocks external guard band of ~25% of the assigned blocks (see Annex 1), then the reference frequency ΔF=0 of the mask should be understood to be at the centre of guard band between neighbouring blocks.

It should be noted, that the occupied bandwidth of the channel carriers should always lie within the assigned block limits, regardless of its absolute power. In other words, the occupied bandwidth of all individual carrier emissions are required to fall within the spectrum block limit indicated by “0” in Figure A3. Only the out-of-band emissions of that transmitted carrier should be present within the portion indicated between the “0” and “20%” markers.

After the block assignment procedure, if operators of adjacent blocks agree to co-ordinate between themselves, then administration should not be enforcing the block edge mask requirement at the common border between those blocks. This would allow fully optimising the utilisation of outermost parts of the blocks and achieving maximal spectral efficiency.



Frequency offset break points for the CS mask	Definition (% of the size of the assigned block, Note)
A	20%
B	35%

Note: X% of the smaller of adjacent blocks, if blocks are of unequal size

Figure A3: Central Station Block Edge Spectral Density Mask

Frequency offset	CS Transmitter Output Power Density Limits (dBW/MHz)
In-band (within assigned block)	See Annex 2
ΔF=0	-36
0<ΔF<A	-36 - 41·(ΔF/A)
A	-77
A<ΔF<B	-77 - 12·((ΔF-A)/(B-A))
ΔF≥B	-89

Table A3: Tabular description of Central Station Block Edge Spectral Density Mask

3. Out-of-block emission limits for TS

It was considered that the block edge mask for Terminal Stations was not required since Report 33 has shown that the protection requirements would be sufficiently covered by applying current harmonised ETSI standards.

However, the applicability of the latter conclusion for TS limits with low gain non-directional antennas was verified for scenarios with predominant use of such terminals in indoor environment. If it is intended that the majority of a consistent population of TS with non-directional antennas will be used outdoors (e.g. on vehicles or for fixed outdoor installations), then administrations may wish to establish special radio interface requirements setting out-of-block power limits for non-directional outdoor TS, which would be up to 15 dB more stringent than noise floor limits given in ETSI EN 302 326-2, or, alternatively, limit the maximum allowed EIRP for these applications, according to the expected proportion of outdoor use.

4. Assessment of the block edge masks

The BEM presented in this Annex is intended as "normalised" to 1MHz; however, for assessment purpose, the resolution bandwidth (RBW), in particular in the out-of-band domain (which is likely related to the outermost transition zone), should be appropriate for the system under test (ref. ITU-R SM.1541).

Therefore, in case a 1 MHz RBW, which will give conservative results, might not be appropriate for frequencies up to B+1MHz (or −B−1MHz) from the block edges, the same RBW, recommended in ETSI EN 302 326–2 for spectrum density masks (for the actual channel bandwidth of system under test) may be used, provided that the BEM limits are re-normalised (tightened) by a factor:

$$10\log\left(1/RBW\big|_{MHz}\right).$$

In this latter case, discrete CW spectral lines may exceed the new re-normalised BEM by a factor:

$$10\log\left(1/RBW\big|_{MHz}\right) - 10\log N.$$

where N = number of actual discrete lines falling within ±0.5 MHz centred on each line.

Note: The above BEM limits shall not imply any relaxation of the limits for transmitter unwanted emissions in the spurious domain that are referenced to actual carrier centre frequency, for these the equipment should still meet the requirements according to ERC/REC74–01.

ANNEX 4

GUIDANCE FOR INTERFERENCE AVOIDANCE BETWEEN CO-FREQUENCY ADJACENT-AREA ASSIGNMENTS

1 Introduction

In order to assign frequencies to a number of competing FWA operators in any given area or territory, certain guidelines are needed in order to ensure that interference probability between these operators is minimised. These operators may be deploying differing technologies requiring co-existence guidelines at the top level to be as generic as possible.

In addition, the inter-operator co-ordination burden should be minimised and flexibility provided to cater for specific scenarios in order to help minimising any deployment constraints.

The same concept may be used for developing international agreements on utilisation of subject bands between neighbouring countries. However, the procedure recommended in this annex may be not suitable for co-ordination in the country border regions when different provisions are agreed via bi- or multi-lateral international agreements, e.g. based on the concepts of preferential frequency blocks.

For detailed description of the proposed methodology, see section 3 in ECC Report 33.

2 Main principle behind the proposed procedure

For a balanced use of the assigned blocks at the service area boundary, without overestimating the coordination areas, it is assumed that operators assigned with the same block, in adjacent areas, have to share the burden of co-existence the by increasing the PFD limit at the boundary to that equivalent to half the required separation distance based on calculations derived from the acceptable I/N at the receiver. This fully protects receivers located in the victim operator's licensed area at a distance equivalent to half the separation distance, but increases the chance that the victim will receive unacceptable interference at distances less than this. This reduces the co-ordination burden within a reduced area and minimises "over-protection". Careful choice of distances and PFD triggers can minimise the chance of unacceptable interference.

The concept is illustrated in the figure A4.1 where equal systems and antenna height are assumed. However, the impact of spherical diffraction attenuation makes the antenna height to play a role in the evaluation of D_{min} (the lower are the antennas the lower is the separation distance); when different antenna height are assumed, ECC Report 33 shows that, even if the two operators might evaluate $D_{min}/2$ differently, due to different antenna heights, their sum is still producing the required total D_{min} required as shown in Figure A4.2.

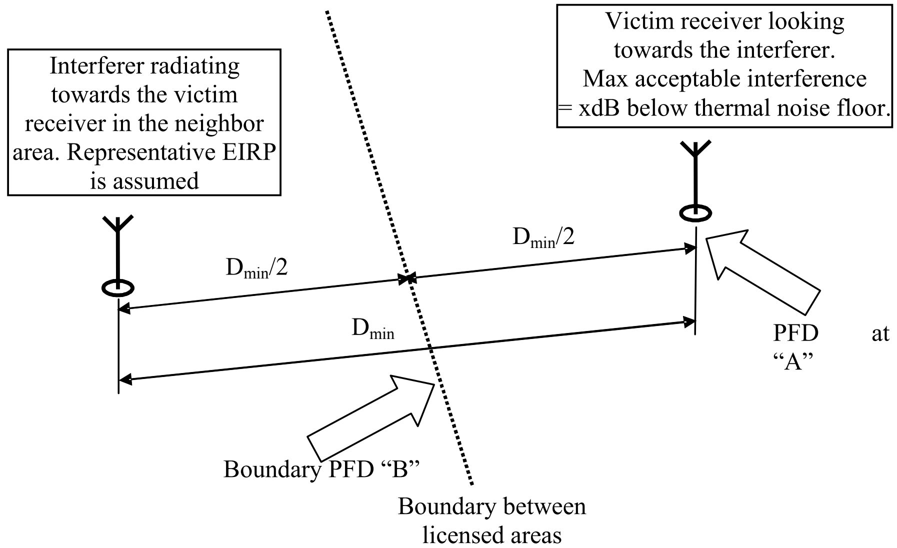


Figure A4.1: Defining PFD limit at geographical block assignment boundary (equal systems with same antenna heights)

In Figure A4.2 $(D_{min}/2)_A$ (evaluated on the base of PFD at the boundary by operator A without knowing different antenna height of operator B) is compensated by the fact that operator B, using higher antenna, would require a larger distance from the border for matching PFD at the boundary.

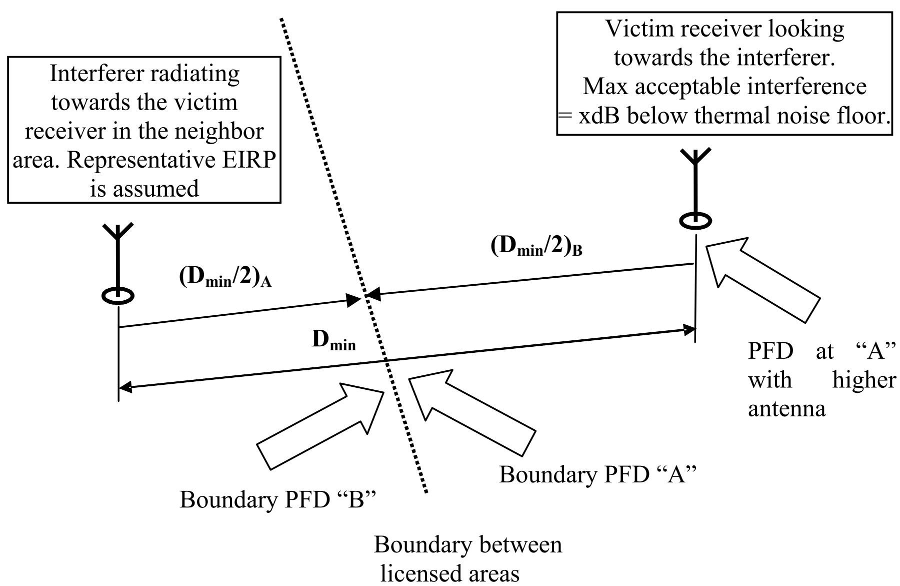


Figure A4.2: Defining PFD limit at geographical block assignment boundary (equal systems, different antenna heights)

No compensation is present for different EIRP, therefore the evaluation of PFD should be made assuming a common minimum value; operator wishing to go closer, could reduce EIRP beyond that value at risk of having interference or asking for co-ordination.

3 Proposed procedure

Administrations are recommended to request operators to apply the following process before installing a Central Station (CS):

a. The operator is considering the antenna height and EIRP of the proposed CS;

b. The operator is calculating the suitable value for the boundary PFD from Figure A4.3 (reprinted from Report 33) based on the characteristics of proposed CS: actual antenna height and on the actual eirp or some agreed for co-ordination purposed minimum EIRP value, whichever is the greatest;

c. The operator is determining using terrain-data propagation model whether he would meet such PFD at the licensed area boundary;

d. In case, the PFD level is exceeded at the licensed area boundary, the operator need to reach an agreement from the adjacent area operator.

It has to be noted that the lower is the antenna height, the higher are the diffraction attenuation and all other attenuation due to obstacles such as building, trees etc. generally reducing the probability of worst case occurrence; and operators are encouraged to use low antenna heights at the boundary.

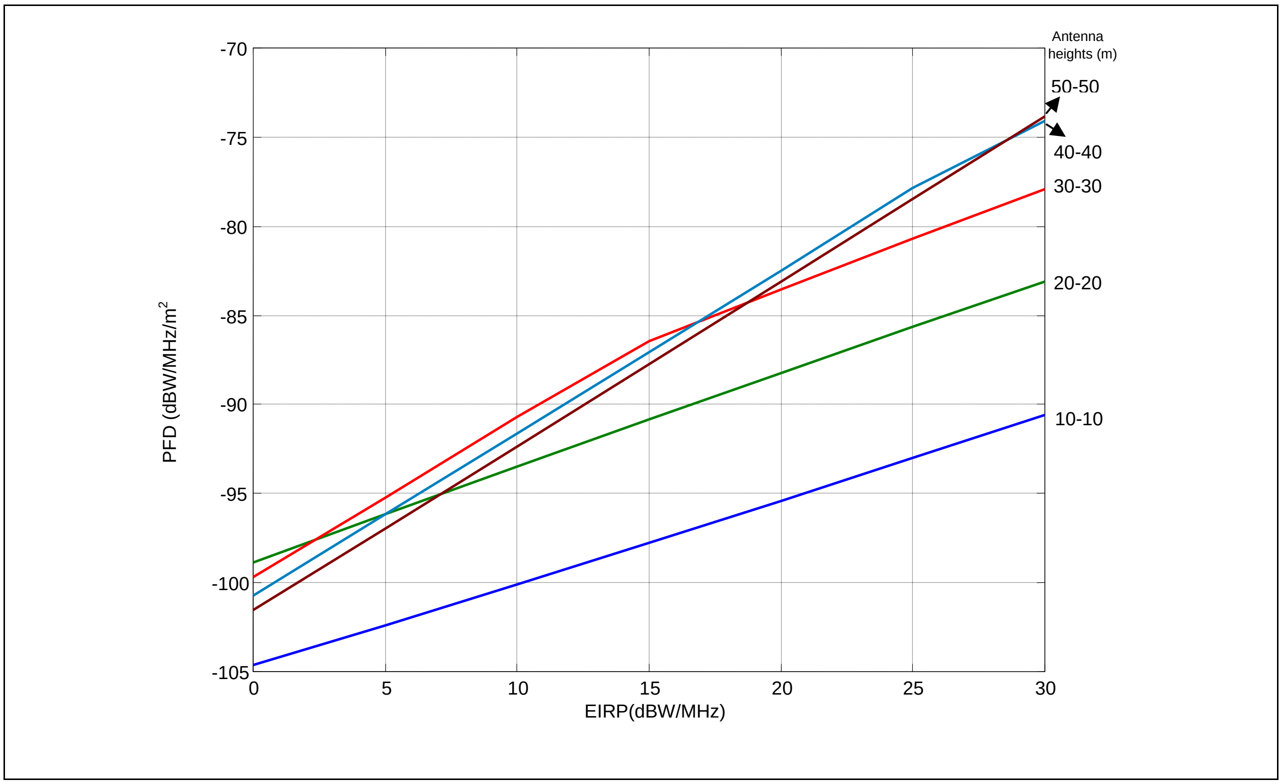


Figure A4.3: PFD at D_{min}/2 (half the minimum CS separation distance) vs. $EIRP_{tx}$

Note: the graphs in Fig. A4.3 were developed on the assumption of average case with propagation over flat land. Therefore, these curves will be over-conservative in cases of propagation over obstructed paths (e.g. mountains, hills), and over-optimistic for cases where spherical diffraction attenuation may be lower (e.g. broad river valleys, etc).

ANNEX 5

SOME EXAMPLES OF STANDARDISED PMP FWS TECHNOLOGIES

1 Introduction

A number of ETSI Standards have been developed defining the "minimum requirements" (i.e. the basic radio-frequency interface parameters and receiver sensitivity and interference robustness).

The ETSI EN 302 326-2 foresees system characteristics suitable for various basic access technologies (e.g. FDMA, TDMA, CDMA and any mixture of those) defining the parameters relevant to R&TTE Directive's Article 3.2 on essential requirements.

A number of new mixed technologies are also present on the market (e.g. TDMA/OFDMA) and more are expected to be designed for covering the increasing demand for new wide- and broadband services.

This annex notes some possibilities and their key characteristics based upon known (at the time of writing) standardisation activities. These key characteristics were kept in mind whilst developing the assignment plans detailed in the previous annexes. Their inclusion is not intended as a statement regarding their suitability, nor to grant them any "preferred" status, but merely serves to illustrate the degree of flexibility that needs to be included in the frequency planning for PMP FWS.

2 EP ETSI BRAN HIPERMAN (HM) and IEEE 802.16

ETSI EP TC BRAN has drafted the TS 102 177 "*HIPERMAN; Physical (PHY) layer HIPERMAN PHY*" and TS 102 178 "*HIPERMAN; Data Link Control (DLC) layer HIPERMAN DLC*", defining the basics for a standardized "multi-vendor" radio interface in bands below 11 GHz. The revision 1.3.1 of the HiperMAN standard defines the PHY and DLC for supporting Fixed/Nomadic applications.

TS 102 210 "*HIPERMAN; System profiles*" defines the interoperability profiles, the last available version at the publication of this document being 1.2.1.

The main characteristics of HIPERMAN standards, v. 1.3.1, which is harmonized with IEEE 802.16-2004 and the 802.16e amendment (see technical details below), include:

- All the PHY improvements related to OFDM and OFDMA modes, including MIMO for the OFDMA mode
- Adaptive modulation and coding
- Flexible channelisation, including the 3.5MHz, the 7MHz and 10MHz raster (up to 28MHz)
- Scalable OFDMA, including FFT sizes of 512, 1024 and 2048 points, to be used in function of the channel width, such that the sub-carrier spacing remains constant
- Up-link and down-link OFDMA (sub-channelisation) for both OFDM and OFDMA modes
- Adaptive antenna support for both OFDM and OFDMA modes
- MIMO support for OFDMA mode
- PMP system architecture is supported
- Improvements related to low power consumption and hand-over for load-balancing or best C/(I+N)– carrier over interference + noise – applicable also for fixed STs
- Capable to operate in paired spectrum allocations employing FDD and/or TDD; FDD terminal stations can operate in either full or half-duplex.

These standards provide for many new features, calling for different deployment scenarios, in particular with indoor terminals with omni-directional antennas, which have also been considered in a revision of ECC Report 33.