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

ECC RECOMMENDATION (01)04

RECOMMENDED GUIDELINES FOR THE ACCOMMODATION AND ASSIGNMENT OF MULTIMEDIA WIRELESS SYSTEMS (MWS) IN THE FREQUENCY BAND 40.5 – 43.5 GHz

Recommendation adopted by the Working Group "Frequency Management" (WGSE)

BACKGROUND

Multimedia Wireless Systems (MWS) are defined in the ERC decision ERC/DEC(99)15 as terrestrial multipoint systems which have their origin in telecommunication and/or broadcasting, including MVDS, and which provide fixed wireless access direct to the end user for multimedia services, and comply with the relevant European Telecommunications Standards. These MWS systems may offer different degrees of interactivity.

The term „Multimedia Wireless Systems (MWS)", has been introduced to cater for the phenomena of convergence between terrestrial FS and BS applications, whereby distributors of entertainment services (broadcasters) are wishing to provide interactive services and telecommunications operators are wishing to supply broader band two way services to wider markets. Therefore MWS are wireless systems which support information exchange of more than one type, such as text, graphics, voice, sound, image, data and video.

Within Europe this convergence can be seen in the standardisation work of ETSI. Projects are underway defining standards for Broadband Radio Access Networks (EP-BRAN) and specifically the HIPERACCESS family. The introduction of interactivity alongside broadband broadcast style delivery in microwave video distribution services (MVDS) is being tackled through the work of DVB-RCCL and the ETSI/EBU Joint Technical Committee. ETSI TM4 is developing a co-existence standard for MWS in the 40 GHz band. These approaches to the standardisation of BWA will enable technologies along with others that can clearly be classified as MWS. They are equally capable of providing broadband multimedia wireless access albeit with differing emphases and placing differing demands on the way radio spectrum needs to be assigned. Detail on the different approaches is highlighted in Annex 5 to this Recommendation.

INTRODUCTION

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.
Relatively large blocks are anticipated and will depend to an extent on the applications foreseen. Administrations should be aware of the spectrum engineering measures proposed in the annexes of this document 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 document that systems supporting both symmetric and asymmetric traffic are accommodated as well as systems that employ FDD and TDD techniques. No presumption is made regarding the architecture of any MWS network.

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 of co-ordination although more detailed co-ordination is encouraged as an inter-operator issue.

In order to cope with the often conflicting requirements of a number of technologies in terms of efficient and appropriate block assignments some compromise has been required to develop a reasonable assignment guidelines which balances any constraints as far as possible on any specific technology.

Edition of 10.10.01

Where appropriate, the impact of sharing with other services in the band has been taken into account as well as the requirement to cater for legacy services (e.g. analogue MVDS) within the 40 GHz band.

"The European conference of Postal and Telecommunications Administrations,

considering

a) that within the CEPT region the use of the band 40.5 - 43.5 GHz has been harmonised for Multimedia Wireless Systems (including MVDS).ERC Decision ERC/DEC(99)015 refers.

b) that Multimedia Wireless Systems (MWS) in the range 40.5 - 43.5 GHz can provide broadband services including telephony, video, media streaming and data services;

c) that several administrations have introduced MVDS in the band 40.5 - 42.5 GHz.

d) that MWS systems have substantial potential to enhance the availability of broadband telecommunication services to both residential and business customers;

e) that it is desirable to achieve a flexible frequency assignment plan that can accommodate both symmetrical and asymmetrical MWS traffic requirements, whilst remaining consistent with good spectrum management principles, including provision for inter-systems/services operation and overall spectrum efficiency;

f) 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;

g) that both time division duplex (TDD) systems and frequency division duplex (FDD) systems could be accommodated, provided that appropriate co-existence criteria can be met;

h) that in order to enhance the efficient use of the assigned block(s) according present and future available technology the operator should freely define and modify suitable channel arrangement(s) within the block(s) according to the selected technology(ies);

i) that it is desirable that the assignment of adjacent blocks to different operators is made without obligation for co-ordination between them; but co-ordination should nevertheless be encouraged in order to maximise the efficient use of the blocks;

j) that a flexible frequency assignment plan would enable MWS to co-exist with legacy systems e.g. MVDS in the same allocation where appropriate;

k) that the radio astronomy service is also allocated primary status in the range 42.5 - 43.5 GHz, and in some locations appropriate measures will be needed in the planning and deployment of MWS around radio astronomy installations to protect the radio astronomy service;

l) that guidance material is available to assist administrations with the assignment of frequency blocks to operators for fixed wireless access systems. (ERC Report No 97)

recommends

1) that administrations should consider the guidance in Annex 1 in order to create block assignments based upon an aggregation of frequency slots identified in Annex 2.

2) That administrations should consider the guidance in Annex 1 when considering the positioning of assigned blocks within the band;

3) that inter-operator protection should be ensured through the measures given in Annexes 3 and 4;

4) that blocks should be assigned in a manner that might assist future expansion of successful services, ideally without further regulatory requirements on the actual channel arrangements inside the blocks.

5) that administrations encourage inter-operator co-operation on co-existence issues to maximise utilisation of the assigned blocks."

Note:
Please check the ERO 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

Guidance for the preferred construction of frequency assignment plans for MWS

Steps leading to a recommended assignment plan

MWS may be provided by a number of technologies derived from both telecommunications origins and from broadcast distribution origins. The following recommended approach A1 (General Case) includes steps addressing the situation whereby no decision is taken beforehand by the administration regarding the technology anticipated. It provides the most flexibility and freedom for operators to choose how to make best use of the spectrum. An additional consideration to this general case is detailed in A2 that introduces the "reference frames" concept.

An alternative case is considered in approach (B) that caters for either the characteristics of specific systems[1] that might incur difficulties operating in assignments derived from approach A. Approach B, therefore implies some decision regarding aspects of the technology anticipated and limits the options and flexibility to accommodate other assignments within the band using approach A.

A1/ General case: no pre-judgement on present and future technology nor on the starting assignment points

1. Consider any constraints brought about by the need to share with other services.
2. Consider the appropriate block size, B for assignment. Although it is difficult to determine an absolute value for the optimum block size, considering the broadband nature of MWS it is anticipated that blocks of at least 250 MHz would seem to be an appropriate starting point for consideration. The provisions detailed later in these annexes are based upon assumptions that block size will be relatively large compared to any equipment specific channelisation scheme.
3. Knowing 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 offset by 1.5 GHz should be assigned to each operator irrespective of the technology.
     Note: A spacing of 1.5 GHz has been agreed as the most efficient in a band unconstrained by the need to share with other services. However in some areas it is possible that the band 42.5 - 43.5 GHz may not be available in which case the option of 1 GHz may be used.
   - For FDD systems, the definition of a single duplex spacing for symmetric systems of 1500 MHz is capable of facilitating a reasonable, economically viable range of duplex spacings for asymmetric FDD systems, whilst allowing TDD [2].
   - Asymmetric FDD systems can be accommodated in the paired equal blocks if the up and downstream transmission directions are allowed to be mixed within a block.
   - 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 into the assignment criteria, their use may be fitted in the general policy of paired symmetric block assignment.
   - If the entire band is not assigned, careful consideration should be given to the initial placement of operators to allow appropriate space for future new or expanded assignments.

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1 The systems under consideration are those that employ dynamic frequency allocation during their normal operation and are most prevalent in implementations of MP-MP networks (so-called "mesh networks").

2 For a generic coexistence enhancing, in the case of deployment of symmetric FDD systems the upper subband (42 - 43.5 GHz or 41.5 - 42.5 GHz whichever is applicable) should be used for the transmission from the terminals to the central station and the lower subband (40.5 - 42 GHz or 40.5 - 41.5 GHz whichever is applicable) for the transmission from the central station to the terminals.

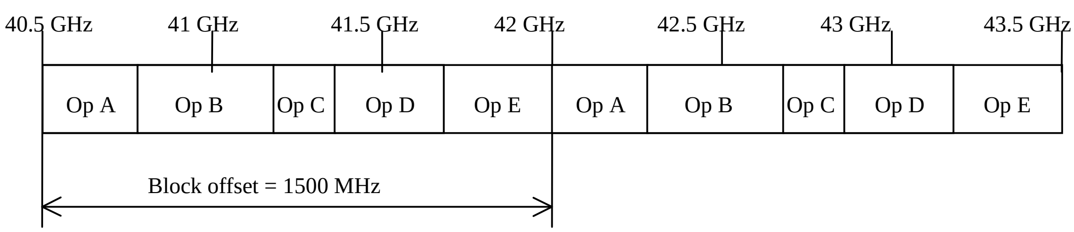
The concept of paired equal blocks offset by 1.5 GHz is described in figure 1.1 below:

Figure 1.1 : General concept of paired equal blocks

Each block will contain a technology specific channelisation scheme and guard bands as illustrated in Annex 2, Figure 2.2.

Figure 1.2 below gives an example scheme based on such principle where 5 different operators have been allocated different size of paired blocks.

Figure 1.2 : Example scheme based on the concept of paired equal blocks



It provides regulators the possibility to allocate the spectrum without a need to predetermine the technology to be used by the different operators and gives these latter the flexibility to deploy, mix or modify the technology they use :

- for FDD symmetric systems, it accommodates all systems with a duplex spacing of 1.5 GHz (see figure 1.3),
- for FDD asymmetric systems, allowing upstreams and downstreams to be implemented in the same block (see figure 1.4),
- for TDD systems, the two blocks are used separately by the operator to deploy same or different types of systems (see figure 1.5),
- a mixture of both FDD and TDD systems is possible either within blocks or in neighbouring blocks.

Figure 1.3 : Application with FDD symmetric systems (for one operator)

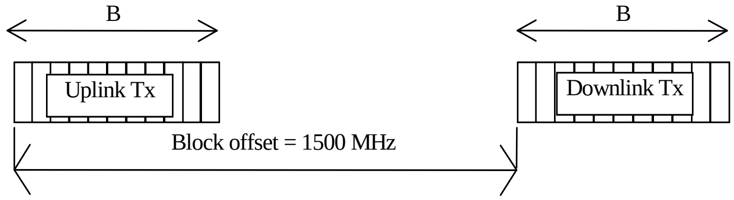
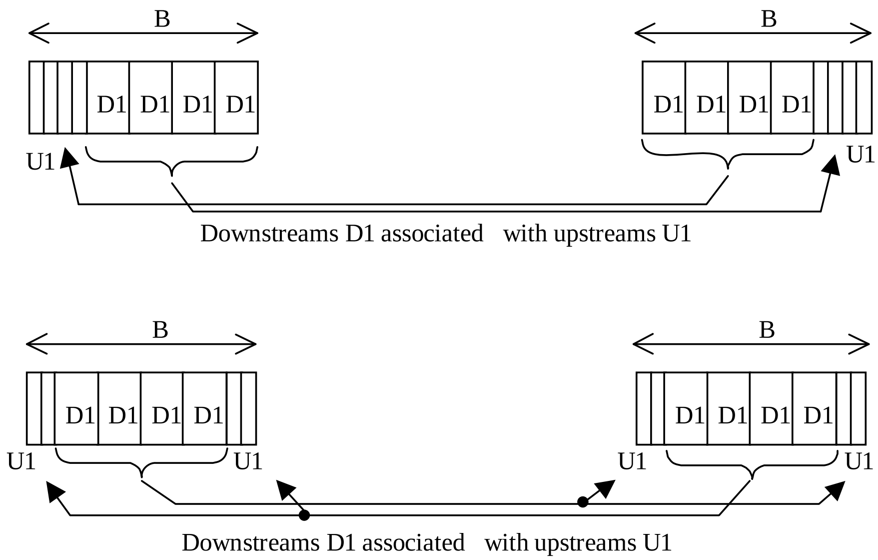
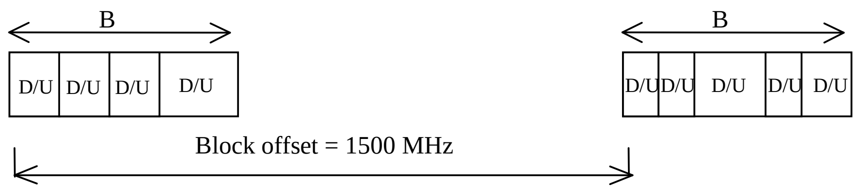


Figure 1.4 : Examples of application with FDD asymmetric systems (See Note)



Note: According to the system characteristics, different mixing of up-stream/down-stream channels is possible for enhancing the spectral efficiency,

Figure 1.5 : Application with TDDsystems ,(for one operator):



A2/ Additional consideration to the General case: No pre-judgement on present and future technology *but the starting assignment points pre-determined* by the "Reference Frame" concept.

In some cases, administrations may find it both convenient and economically preferable to start assignments at points that equally divide the band 40.5 - 43.5 GHz into sub-bands, so-called reference frames.

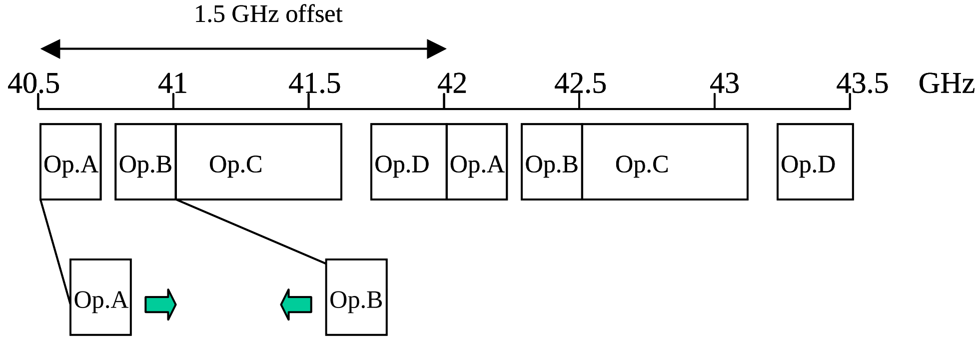
In this fashion, the development of a limited number of radio systems, based on the same patterns, will be facilitated. All operators, regardless of the technology used, might benefit from mass-produced radio filters, tailored on the reference frames, that are of paramount importance for low-cost MWS terminals. This might be a favourable characteristic but it might result in some restriction to the flexibility of assignments in term of sizes and numbers of actual blocks.

Moreover, the size of a reference frame should be coherent with the size of an assigned block bandwidth B, in order to keep the number of radio filters to an absolute minimum - ideally one for each block bandwidth B. Because of potential sharing issues in the band 40.5 - 43.5 GHz, the most logical sub-divisions are 3, 6 or 12 reference frames, 6 (i.e., reference frames of 500 MHz) being most in accordance with potential sizes of B.

Finally, it is advisable that, in the case of two assignments within a reference frame, the first one should start at the lower end upwards, while the second should start at the upper end downwards. This will add flexibility in the use of the spectrum, provisionally leaving a portion unassigned but with the possibility to further assign the band left in the middle to the operator who will show the best service deployment and penetration trend.

An assignment example using 500 MHz reference frames is shown in figure 1.6 below.

Figure 1.6: Example of the "reference frames" application in the assignment procedure.



B/ Alternative Case: Other assignment example when a pre-judgment on present and future technology is made

Some systems could use the channels in their assigned blocks in a manner whereby operation using blocks either widely spaced or symmetric, such as those used for the two directions of symmetric FDD systems, may incur difficulties. Therefore, if these systems are foreseen, administrations considering it desirable to predefine such technology as more favoured, might consider assignment plans that avoid such widely spaced or symmetric blocks. This could result in unpaired or asymmetric assignment plans.

ANNEX 2

Block Based Frequency Arrangement for 40.5-43.5 GHz Band

1 - Introduction

The flexibility of the slot frequency plan detailed in section 2 below is needed to facilitate assignments applicable to a number of technologies, some of which are highlighted in Annex 5. In addition the needs of legacy services and other primary users of the band need to be respected. However there is a need for a trade-off between providing flexibility and a “standard” approach that minimises options and equipment variants. The approach recommended in these annexes attempts to strike a balance between these two issues.

2 - Basic frequency allocation plan granularity based on 1 MHz slots for the band 40.5 to 43.5 GHz

This allocation plan consists of 3000 adjacent 1 MHz slots starting at 40.5 GHz as per Figure 2.1. Any number of these slots may be aggregated to form a block assignment..

1	2	3	4	5	....	3000

40.5 GHz 40.501 GHz 40.502 GHz 40.503 GHz………………………………….43.499 GHz 43.5 GHz

FIGURE 2.1

Slot start frequency can be identified by the following relationship:

For slot number n = 1 to 3000;

Slot start frequency = (40.499 + n* 0.001) GHz

3 - Primary features of the frequency architecture

Ultimately the assigned blocks would contain a channelisation scheme(s) defined by the operator according to the actual technology(ies) adopted; channels centre frequencies will not be regulated provided that they need to be arranged for meeting block-edge requirements given in Annex 3.

Note that :

- An assigned block contains an integral no slots.
- An assigned block will contain a number of channels, as defined by the operator, and spectrum needed (i.e. the guard bands of Figure 2.2) to avoid inter-operator interference (See Annexes 3 and 4).
- Clear unassigned spectrum could be left between blocks for future assignment.

4 - Relationship between elements of the block assignment and of the underlying frequency plan(s)

The diagram in Figure 2.2 illustrates the relationship between elements of the frequency plan consisting of frequency slots, operator assigned blocks, technology specific channelisation and guard-bands.

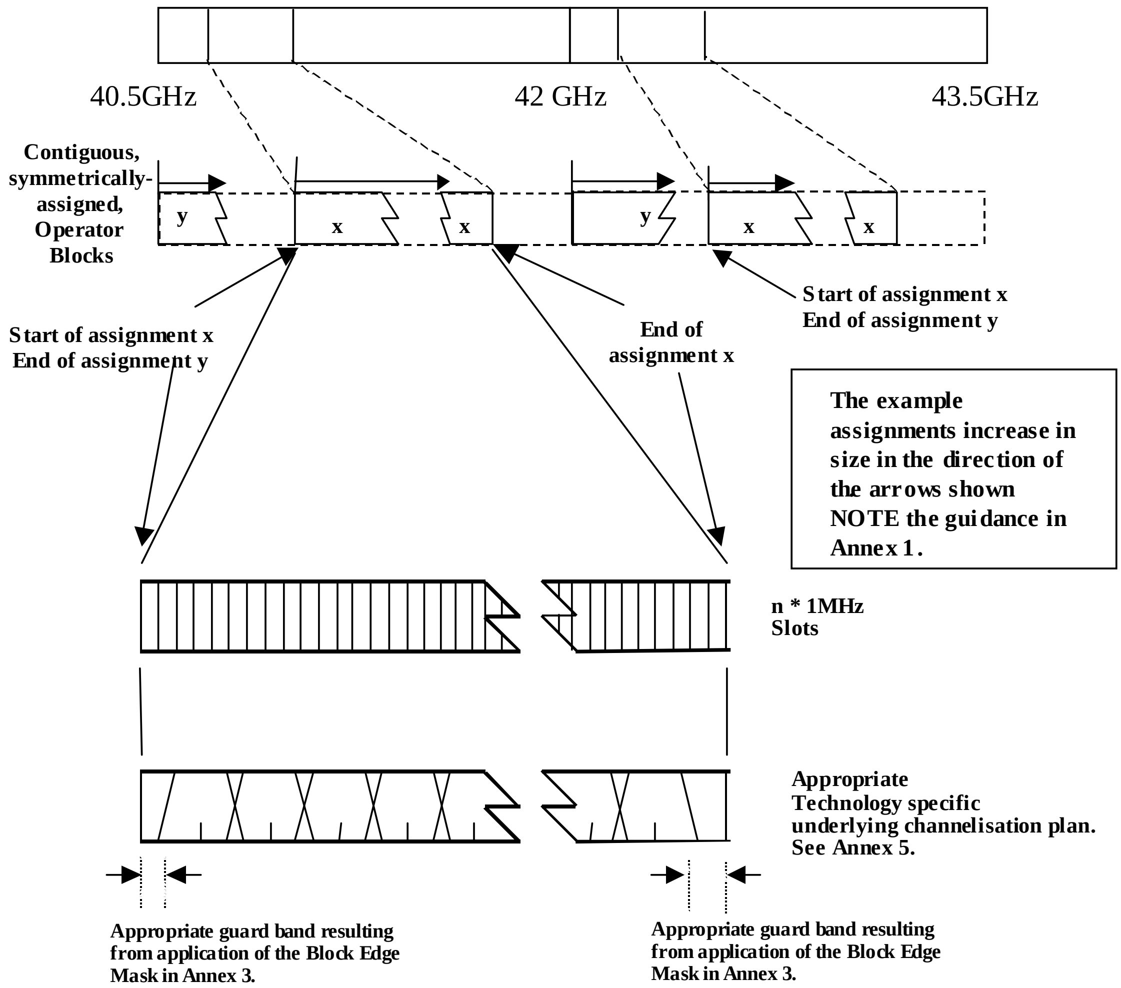


Figure 2.2: Frequency Plan Elements

ANNEX 3

Frequency Block Edge and EIRP Density Recommendations

Introduction

Emissions from one operators frequency block into a neighbouring block will need to be controlled. This can be done by blindly imposing fixed guard bands between the assignments, as recommended in other frequency bands.

Alternatively, in this recommendation, a so-called frequency block edge EIRP density emission mask is required in view of limiting emissions into a neighbouring block and to enable the operators to place the outermost radio channels with suitable guard-bands, inside their assigned block, in order to avoid co-ordination with the neighbour blocks.

Transmitter EIRP density and outermost channel centre frequency could be traded-off in order to fulfil the block- edge requirement. In this way a more efficient use of the spectrum may be expected.

The block-edge mask is applicable also to the outermost block-edges at the boundary with adjacent allocated bands. This would guarantee, in EIRP terms, guard-bands at band edges to facilitate adjacent band inter-service co-ordination

Maximum EIRP density within a block

Maximum EIRP density is generally set by administrations in order to define pfd levels for co-ordination distances between different geographical areas or for cross-border agreements. The following table 3.1 gives guidance, for possible maximum limits, based on currently available technology but already takes into account also some allowance for future development of higher power transmitters.

Station Type (Note 1)	Max EIRP spectral density (dBW/MHz) (Including tolerances and ATPC range)	Typical informative assumptions for deriving the EIRP limits (Note 2)	
		Maximum Power Spectral Density at antenna port	Maximum Antenna Gain
CS (and RS down-links)	+ 5	+15 dBm/MHz	20 dB
TS (and RS up-links)	+ 30	+15 dBm/MHz	45 dB

Note 1: From the point of view of applying the appropriate EIRP density and block edge mask, when MP-MP systems are considered, the mean value of the EIRP density, shown above for CS and TS, will apply. In addition any MP-MP station providing co-frequency coverage to a defined area, without addressing any specific TS (in terms of antenna radiation pattern), should be considered as CS.

Note 2: In actual applications trade off in these values is possible provided that EIRP limits are met.

Table 3.1 : Maximum Allowed Transmitter EIRP Spectral Density

Block edge EIRP density mask

For a sensible and cost-effective regulation, a block edge mask is generally designed on the bases of a small level of degradation in an assumed scenario with a low occurrence probability of a worst case (e.g. two directional antenna pointing exactly each other).

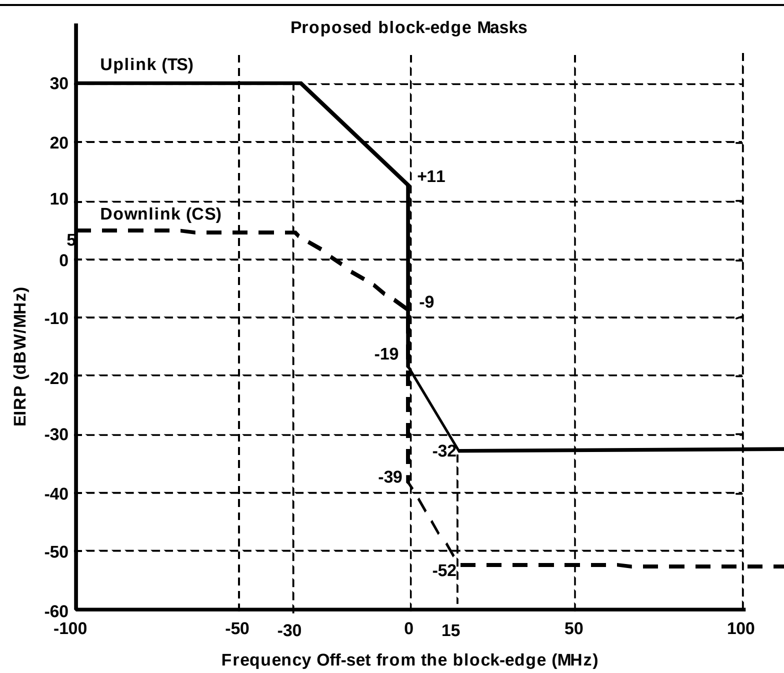
It is not therefore excluded that in a limited number of cases specific mitigation techniques might be necessary.

In particular when CSs 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 this 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.

However to ease the RX filtering in order to reject adjacent block interfering carriers, a 30 MHz EIRP density decaying portion near the edge is provided in the recommended mask reported in figure 3.1.

Figure 3.1 shows the block edge mask; the limits shown are absolute maximum and intended to include tolerances and any ATPC range:



Note 1: The out-of-block EIRP limit shown is for wide-band/noise-like emissions and is extended to the entire 40.5-43.5 GHz band; CW emissions are subject to the limit set by ETSI EN 301 390 at the antenna port.

Note 2: Notwithstanding the above EIRP limits, the equipment shall meet, if resulting in more stringent requirement, the spurious emission limits set by EN 301 390, referenced to the antenna port section.

Figure 3.1 : Block Spectral Density Mask

The 15 MHz decaying portion into the adjacent block, shown in Figure 1 will, from one side, allows wide band systems near to the edge without the need of large guard band (accommodating for their 3rd order intermodulation portion) and, from the other side, will discourage any smaller band system to be placed too close to the edge (because of the higher interference level experienced by the receivers). In this way a balanced guard band will be maintained between the two adjacent blocks, independently form the actual system deployed.

The application of the mask to MP-MP systems should follow the same guidance given in Note 1 to Table 3.1.

Moreover, for further enhancing the efficiency, administrations are not expected, after the block assignment procedure, to enforce the block-edge requirements to neighbour operators who will apply mutual co-ordination at the block edge in view to optimise the guard bands. In that case only the maximum "in-block" EIRP/power density apply while the "out-of-block" noise floor will apply only from a "mutually agreed" starting point within the adjacent block.

ANNEX 4

Inter-operator and International co-ordination both co-frequency and in adjacent frequencies

Introduction

In order to assign frequencies to a number of competing MWS operators in any given area or territory, certain guidelines are needed in order to ensure that co-existence issues between these operators are 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 to help minimise any deployment constraints.

Interference Scenarios

Work has been done in a number of groups , ETSI TM4[3], ERC Report 99[4], IEEE802.16.2[5] to examine the intra-service co-ordination requirements for FWA and BFWA that could be appropriate to MWS services in the 42 GHz band. Two distinct co-ordination scenarios are addressed, namely:

- Co-existence between two or more BFWA systems operating in the same radio spectrum and in adjacent geographic areas (Scenario 1)
- Co-existence between two or more BFWA systems operating in the same geographic area and in adjacent radio spectrum (Scenario 2).

The investigations have shown that co-existence is feasible in both scenarios providing measures are taken to minimise the risk of interference close to geographic boundaries and near frequency block edges.

Scenario 1

Co-existence can be based upon limiting the amount of interference into a neighbouring victim receiver. Commonly this is based upon an agreed level of interference below receiver thermal noise causing an increase in receiver noise floor with a consequent impact on link budget. The level of co-frequency interference is dependant chiefly upon separation distance, interfererer EIRP and victim receiving system parameters. Therefore the following steps can be taken to control the environment:

- The application of a limit on the power flux density (PFD) at the licensed service area boundary that individual BFWA transmitters may generate.
- A requirement to co-ordinate all transmitter stations where the specified PFD limit at the licensed service area boundary is exceeded.
- Determination of the PFD level at the service area boundary should take account of attenuation due to terrain and other obstructions.
- Inter-service boundaries should be defined as far as possible to minimise the requirement for co-ordination, by avoiding major population centres and taking advantage of prominent terrain features.

Applying the Co-ordination Triggers

There is no absolute solution to providing guaranteed interference free environment without squandering spectrum or insisting on unnecessary constraints on deployment. There is scope to apply the co-ordination triggers in ways that balance the requirement to control the interference environment with the need to make best use of the spectrum.

As an example, the scenario 1 approach above refers to separation distances and the protection of victim receivers by limiting the interference into those receivers. To minimise the impact on the victim operator the receivers located at the licensed area boundary can be protected with an appropriate PFD limit based upon an

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[3] TR 101 853: Rules for Co-existence of P-P and P-MP systems using different access methods in the same frequency band.
[4] ERC Report 99: The analysis of the coexistence of two FWA cells in the 24.5-26.5 GHz and 27.5-29.5 GHz bands.
[5] IEEE 802.16:Draft Recommended Practice for Coexistence of Broadband Wireless Access Systems.

acceptable I/N . However, this will maximise the "co-ordination separation distance" into the interferers operating area but give the greatest level of comfort to the victim operator.
Alternatively, the burden of co-existence can be shared between the operators 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 is illustrated in the figure below. This fully protects receivers located into the victim operators 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 an interferers area and minimises "over protection". Simulations of multiple interferer scenarios on victim receivers in the worst case locations show the probabilities of unacceptable interference to be low. Consideration of real world effects (terrain etc) help mitigate against unacceptable interference. Careful choice of distances and PFD triggers can minimise the chance of unacceptable interference.

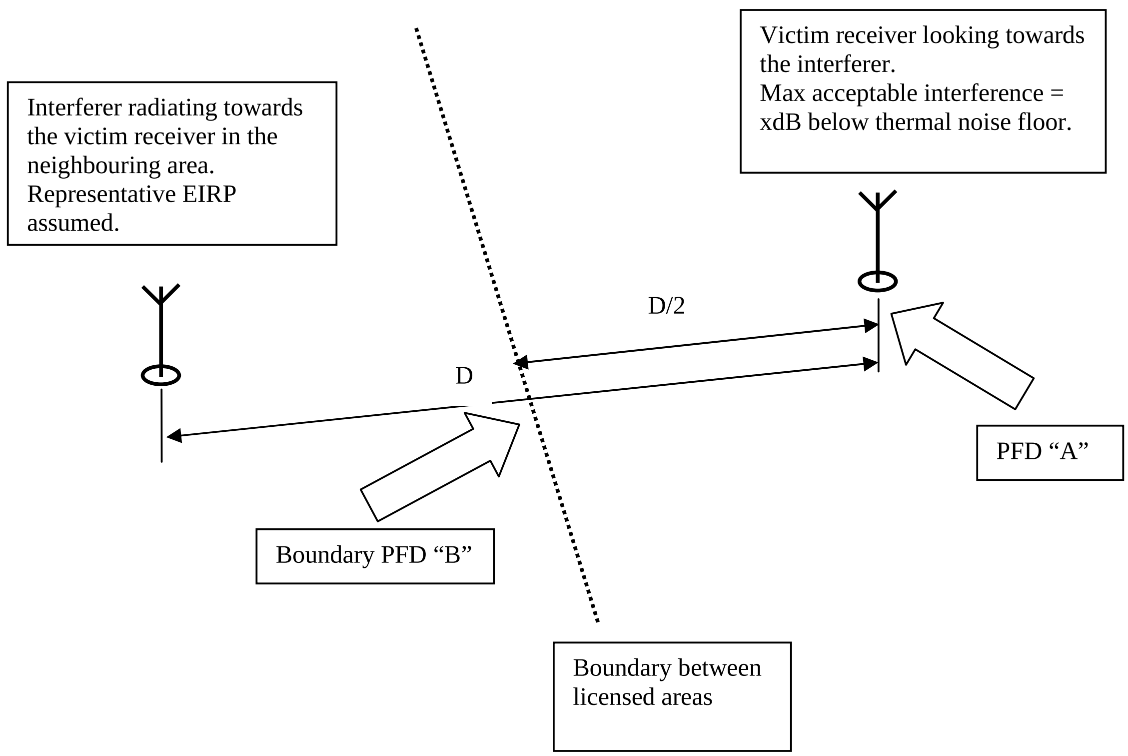

Figure 4.1

Boundary Power Flux Density limit (referring to Figure 4.1)

Some studies suggest that, based on minimum coupling loss calculations, a suitable value for the boundary PFD (PFD "B") is -98.5 dBW/MHz/m^2 . This is derived from a PFD at the victim receiver (PFD "A") = -107.4dBW/MHz/m^2 based upon an acceptable I/N=-10dB.. The PFD limit corresponds to a maximum distance from the service area boundary of 18 km . (This is consistent with a separation distance of 36km and a main beam coupling between a PMP base station transmitter generating an EIRP of 0.5 dBW/MHz towards a victim base station employing a 15 dBi gain antenna).
This limit of –98.5dBW/MHz/m^2 is applicable for any interfering station type.

Other studies have concluded that a figure of –97 dBW/MHz/m^2 corresponding to maximum distance of 15km might be more appropriate.

It is recommended that a boundary PFD of **–98dBW/MHz/m^2** is adopted as a boundary co-ordination trigger threshold.

Effect of Multiple Interferers

Statistical modelling of multiple interferer scenarios has shown that, when allowance is made for the limited probability of a line of sight path between interferers and victim, and of the deployment of down tilted base station antennas in PMP networks, application of thePFD limit will ensure substantially interference free co-existence between adjacent service areas for both PMP and mesh architectures.

Base station to base station interference only becomes significant when 20% or more of the potential interfering base stations have a line of sight path to the victim. Even with 40% of potential interferers visible, the interference limit in 99% of trials is exceeded by only 3 dB. This is still 7 dB below the assumed victim receiver noise floor.

Base station to Subscriber station interference exceeding the limit (I/N= -10 dB) in the subscriber station was experienced for 3% of trials when 10% of potential interfering base stations are visible, increasing to 40% of trials when 40% of the potential interferers are visible. However, the highest level of interference likely to be encountered even with 40% interferer visibility is only 5 dB above the limit. Such a margin would in practice have little if any effect on network performance. This is because very few subscriber stations are likely to be operating so close to their receiver threshold level or indeed so close to the licence area boundary as assumed for the analysis. In practice the probability of more than one or two interfering base stations being visible is slight, because of the relatively low height of the subscriber antennas.

Scenario 2

Frequency separation can be used as a means of limiting the amount of interference into a victim receiver in a neighbouring frequency block. This is achieved through application of the “Block Edge Mask” defined in Annex 3.

It is noted that, to help minimise the risk of interference between operators in adjacent blocks, techniques known as autonomous or quasi-autonomous frequency assignment are under study by the relevant standards bodies.

International Co-ordination

The process of applying a boundary co-ordination trigger can also be applied to international borders. The mechanism for providing protection remains the same, being based upon a tolerable I/N at the victim receiver.

Therefore, in the general case, a boundary PFD = -98dBW/MHz/m^2 should be applied as a trigger for co-ordination at the international boundary.

In order to coordinate efficiently at an international boundary, it could be useful to consider that preferential frequency blocks are defined for use near to the boundary, with different blocks being used on each side of the boundary.

ANNEX 5

Some examples of MWS technologies

Introduction

A number of technologies are expected to be able to meet the requirements of MWS. This annex notes some possibilities and their key characteristics based upon known (at the time of drafting) standardisation activites. 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 or to provide any "preferred" status but merely serves to illustrate the degree of flexibility that needs to be included in the frequency planning for MWS.

EP BRAN HIPERACCESS (HA)

ETSI technical report TR 101-177 Requirements and Architectures for Broadband Fixed Radio Access Networks (HIPERACCESS) shows both residential and business users as potential customers and includes a range of expected services from basic telephony through video-on-demand to Internet and web serving applications.

The main characteristics of HA include:

- Provision of up to 132Mbit/sec in the downlink directions and up to 88Mbit/sec in the uplink direction ;
- Channelisation and modulation scheme as follows:
- Down-link 28 MHz using 4/16/64 QAM adaptive;
- Up-link 28 MHz using 4/16 QAM adaptive;
- Symmetrical band capability, although at any point in time the traffic to and from a specific end user need not necessarily be symmetrical; it is noted that the degree of asymmetry can inherently range from around 1:1 to around 1:5
- The system architecture is P-MP;
- The access scheme is TDM/TDMA;
- Intended to operate in paired spectrum allocations employing FDD in either full or half-duplex operation (TDD is also optionally possible);

HIPERACCESS Channel Plan

BRAN HA suggests a "virtual channel plan" approach. The virtual channel plan can be overlaid on the slot raster in Annex 2 and provides, given the regulatory flexibility, a way to plan HA block assignments along with assignments to operators of other systems.

DVB System (Variant 1) (eg. EN 301 199 + 300 421 /300 748) or ITU-T DNR J.116 System

These systems have evolved from the uni-directional distribution systems detailed in EN 300 748, Framing structure, channel coding and modulation for MVDS at 10 GHz and above, which is itself, based on EN 300 421 (Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for 11/12GHz satellite services) to include a return path with the provision of an Interaction Channel (See Figure 2A in DNR J.116 for a reference model). EN 301 199 refers to the provision of an interaction channel for LMDS. The broadband downlink is based around MPEG-2 transport which can transport "video entertainment" services as well as data services.

General characteristics:

Downstream	
Bit rate	Conform to EN 300 421
Channel bandwidth	Conform to EN 300 421 (from 28 to 50 MHz)
Modulation	QPSK
FI Frequency range	950 to 2150 MHz
Transmission frame	MPEG-2 TS
Randomisation	$1+X^{14}+X^{15}$
Outer coding	Reed-Solomon (204,188,T=8)
Inner coding	1/2 , 2/3 , ¾ ,5/6 , 7/8
Shaping filter	Square-root raised-cosine

Upstream	
Bit rate	3.08 Mbit/s for grade C
	6.176 Mbit/s for grade D
Channel spacing	2 MHz for grade C
	4 MHz for grade D
Modulation	DQPSK
FI Frequency range	5 to 65 MHz or 400 to 700 MHz
Outer coding	Reed-Solomon (59,53,T=3)
Randomisation	$1+X^{5}+X^{6}$
Shaping filter	Square-root raised-cosine

Additional Characteristics

- Each broadband downlink channel capable of supporting up to 68Mbit/sec depending on coding scheme and channel bandwidth, although more typically around 34Mbit/sec.
- Channel spacings for downlink specified in ETS 300 748 and range from 26 MHz to 54 MHz depending on coding scheme, although typically a value around 33 MHz is employed.
- Interaction channel downlink might be incorporated into the high capacity downlink data stream resulting in an asymmetric FDD system. Interaction channel uplink might operate in the same frequency band as the downlink or potentially in a completely different frequency band.
- Two way Interaction Channel could operate independently to the higher capacity downlink in an FDD arrangement employing TDMA in the uplink.
- Intermediate Frequency allocation options indicate that an asymmetrical RF assignment would be necessary although the IF ranges are not.
- P-MP is the expected deployment scenario.
- No specific frequency bands nominated but none excluded. Distribution systems complying with ETS 300 748 are currently employing the 40 GHz band in some areas.

General requirements

- The frequency allocation should enable large bandwith channels (28 to 50 MHz) for downstream channels and small bandwidth channels (2 or 4 MHz) for upstream channels. 40 MHz blocks for downstream and 4 MHz (or a multiple of 4 MHz) blocks for upstream could be convenient.
- The frequency allocation should allow selection by the operators of differently sized frequency blocks for upstream and downstream. This would take advantage of the large choice of asymmetry ratio allowed by the standard depending on targeted services (highly asymmetric for VOD, moderately asymmetric for internet, nearly symmetric for data and telephony).
- The frequency allocation should include a minimum frequency spacing (for example 500 MHz) between upstream and downstream channels to enable low cost duplexer and single antenna at the user terminal.

DVB System (Variant 2): CABLE-MODEM-BASED 42 GHz MWS SYSTEM (eg. DVB-C EN 300 429, Docsis 1.0, Davic 1.2)

Introduction

Since the late '90's, the availability of Cable-Modem technology has allowed Cable-Networks to offer telephony and high speed data services, together with premium price movie and video channels.

Cable modem technologies was developed to provide data transmission over HFC (Hybrid-Fiber-Coax) networks, based on Internet Protocol (IP) and permitting popular Ethernet 10baseT or 100baseT data interfaces. This mature multimedia "wired" technology has now reached CPE prices (Customer Premises Equipment) accepted by residential market; some millions of customers are now using Cable-Modem for high speed data transfer in North America.

Cable-Modem technology and a 42 GHz radio platform can be combined. Two consortium are providing technology and standards for CM operation:

MCNS-DOCSIS: US developed **M**ultimedia **C**able-**N**etwork **S**ystem, **D**ata **O**ver **C**able **S**ystem **I**nterface **S**pecification.

DVB/DAVIC: **D**igital **V**ideo **B**roadcasting / **D**igital **A**udio **VI**sual **C**ouncil Interoperability Consortium.

Both standards are based on FDD approach with 6 MHz or 8 MHz down-stream channels according to traditional terrestrial TV canalisation, located in VHF/ UHF band (70 – 862 MHz) and up-stream channel bandwidth placed in the 5 to 65 MHz frequency range.

Different modulation schemes are supported, ranging from 4 to 256 QAM depending on the adopted standard, for data throughput in excess of 36 Mbps per down-stream channel. For MWS applications, only 4 QAM or 64 QAM are generally used.

Both MAC protocols are similar: All Cable Modems listen to all frames transmitted on the downstream channel upon they are registered and accept those where the destination match the Cable Modem itself. Time Division Multiple Access is the adopted method for accessing the Cable Head-End. Time slots can be granted for transmission by particular CMs or for contention by all Cable-Modems. As a consequence, multiple up-stream channels are used per each down stream. Up-stream channels support both 4 and 16 QAM (4 QAM for MWS applications) in a bandwidth ranging from 0.2 to 3.2 MHz, to a maximum throughput rate of 4.5 Mbps.

Adopting these standards, Cable Modem operation can be easily translated in the 42 GHz MWS region, implementing a powerful asymmetrical wireless data link for residential and small-office/home-office customers. Customer Premises Equipment can be based on low-cost Cable Modem, providing popular 10BaseT data interfaces, and DVB-C or DVB-S standard set-top-boxes for digital video channels.

In addition, CM input and output frequency bandwidths are compatible with standard Master Antenna TV (MATV) cabling system; therefore, a combination of MWS radio platform and, Cable-Modem technology is simplifying the building distribution of multimedia signals (last yard connection).

A wide spectrum of IP-based Multimedia services, including basic telephony over IP, video telephony and video conferences, Video-on-demand (including DVB broadcasting if required) and high speed Internet access and Web applications, can be straightforwardly implemented.

Main characteristics include:

- Point Multi Point system architecture.
- Single carrier / multi-carrier operation allowed.
- Down link data capacity per channel up to 36 Mbit/sec and up to 4.5 Mbit/sec in each uplink channel.
- Asymmetrical FDD operation, consistent with the frequency plan proposals for the 40.5-43.5 GHz band. Additionally for specific end user needs, greater symmetry can be realised by using more up-stream channels.
- Multi Frequency TDMA adopted;
- 6 or 8 MHz down stream data channels, 0.2 – 3.2 MHz up stream channels (according to the selected CM standard);
- 4 and 64 QAM Modulation scheme for down stream data channels (according to the selected CM standard);
- 4 QAM Modulation scheme for up-stream data channels;
- DVB-C (according to EN 300 429) or DVB-S (EN 300 421) down stream video distribution;

Key features are reported in the following referenced documents:

Standards:

- **DOCSIS 1.0** Data Over Cable System Interface Specification**.**
- **DAVIC 1.2** Digital Audio VIsual Council
- **EN 300 429** DVB Specification. Framing Structure, channel coding and modulation for cable systems.
- **EN 300 421** DVB Specification. Framing Structure, channel coding and modulation for 11/12 GHz Satellite Services
- **EN 300 748** Digital Video Broadcasting (DVB) ; Multipoint Video Distribution System (MVDS) at 10 GHz and above
- **ES 200 800** DVB Specification. Interaction Channel for Cable TV distribution systems (CATV)
- **EN 301 199** DVB Specification. Interaction channel for Local-Multipoint Distributions Systems (LMDS)

Bandwidth Allocation

- **Data and Video channels coexistence**

  Cables modem technologies have been developed for using the same TV cable network in order to provide high speed data services, together with premium video distribution; therefore, in MWS operation at 42 GHz, they can coexist as well with digital TV channels.

  The frequency plan can be in agreement with the proposals for a “Frequency Allocation Plan for the band 40.5 - 43.5 GHz given in this document.

  Generally, DOCSIS (or Euro-Docsis) down-stream channels, adopting 64 QAM modulation scheme, can coexist with DVB-C signals in order optimise MS Central Station output power requirements. Docsis Cable Modem and standard CATV (DVB-C) set-top-boxes are used as Customer Premises Equipment.

  DVB/DAVIC down-stream allows QPSK (4 QAM) modulation, optimising MWS range and interference robustness. In this case DVB-S channels can be combined with data signals in order to have a homogeneous QPSK multi-carrier. As an alternative, DVB-C video contents can be added as well; in this case, a mixed QPSK and 64 QAM multicarrier signal is obtained, allowing different service availability over the same coverage area (lower link availability for video distribution – 64 QAM – compared with two-way data traffic – QPSK modulated).

- **Block spacing**

  Because of the video channels, Cable-Modem based MWS spectrum can be strongly asymmetric; in this case we must define the minimum block spacing, that is defined as the spectrum between the end of down stream block and the beginning of the up stream block (not the space between down and up stream related channel). A suitable solution for block distance for MWS deployment should be at least 800 – 1000 MHz in order to allow a reasonable low cost duplex filter in the Terminal Station; block distance greater than 1500 MHz being preferred.

IEEE 802.16.1: *Draft* Standard Air Interface for Fixed Broadband Wireless Access Systems

This draft standard, sponsored by the IEEE LAN MAN Standards Committee, specifies the air interface of fixed point to multipoint broadband wireless access systems that provide multiple services. It includes the MAC layer and the PHY layer and includes a PHY layer implementation broadly applicable to systems operating between 10 and 66 GHz.

The PHY layer provides for two downlink modes (A and B). Mode A is specifically based on a continuous transmission stream for use in FDD systems. Mode B supports a burst format allowing implementation of adaptive modulation schemes for both FDD and TDD operation. Modulation schemes covering QPSK, 16 QAM or 64 QAM are optional in both downlink and uplink. Channel bandwidths ranging from 12.5 MHz through 28 MHz to 50 MHz are envisaged according to baud rates anticipated which themselves range from around 10Mbaud to around 40MBaud.