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

REVISED ECC RECOMMENDATION (01)04

(Revised, Rottach-Egern, Februay 2010)

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

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

BACKGROUND

Multimedia Wireless Systems (MWS) in the 42 GHz band (40.5 – 43.5 GHz) have been defined in the ERC Decision ERC/DEC/(99)15 as terrestrial multipoint systems which have their origin in telecommunication and/or broadcasting, and which provide fixed wireless access direct to the end user for multimedia services. These MWS 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.

The standardisation work for FWA and MWS frequency bands higher than ~11 GHz was completed in ~2000/2002 years with the introduction of interactivity alongside broadband broadcast style delivery in microwave video distribution services (MVDS) which has been tackled through the work of DVB-RCCL and the ETSI/EBU Joint Technical Committee. At the same time ETSI TM4 developed a European standard EN 301 997-2 for MWS in the 42 GHz band. It was then thought that these approaches to the standardisation of Broadband Fixed Wireless Access (BFWA) would have enabled these technologies along with others that can clearly be classified as MWS.

However, the introduction of BWA applications in the bands lower than 6 GHz have reduced the economic interest of most operators for MWS in this 42 GHz band. In the year 2008, very few point-to-multipoint (P-MP) systems are actually deployed in the 42 GHz band and in a number of CEPT countries the 42 GHz band was totally unused.

Nevertheless, the need for point-to-point links (P-P) for large data capacity, over short hops, e.g. for transport infrastructures needed by multimedia services carried by BWA applications, in particular for forthcoming LTE systems in bands lower than 6 GHz , is rapidly increasing. Historical P-P bands such as 23 GHz and 38 GHz are already crowded and new bandwidth is needed. This 42 GHz band, which propagation characteristics are very similar to the 38 GHz, represents its natural extension.

INTRODUCTION

For a better response to the national market demand, the following coherent options are envisaged for the long-term use of the 42 GHz band :

1. Mixed and flexible use of different technologies (e.g. P-P and P-MP with both FDD and TDD techniques) using block assignment with Block Edge Mask (BEM) methodology within the band.
2. Use of channel arrangement for deployment of P-P systems through conventional link by link assignment..
3. Flexible band segmentation for the use of both the above methodologies

Accordingly, different guidance on the band usage are recommended:

1. 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 or P-P links within the blocks. However, it is generally assumed that in this frequency band significant antenna directivity is always present, e.g. for MWS, the CS are using sectorial antennas (typically 90° per sector) and TSs employ high gain directional antennas . For P-P, as well, TSs employ high gain directional antennas.

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 balance any constraints, as far as possible, on any specific technology.

2. A conventional radio frequency channel arrangement for link by link assignment of P-P systems may be adopted in the whole 42 GHz band.

3. A flexible band segmentation can be adopted, catering for applications requiring block assignment according (1) above and conventional radio frequency channel arrangement according (2) above in different paired portion of the band.

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 42 GHz band.

"The European Conference of Postal and Telecommunications Administrations,

considering

a) that within CEPT the use of the band 40.5 - 43.5 GHz has been harmonised for Multimedia Wireless Systems and for P-P Fixed Wireless Systems; revised. ERC Decision ERC/DEC/(99)15 refers;

b) that Multi-Point (MP) systems (P-MP or MP-MP) can provide Broadband Fixed Multimedia Wireless services in the range 40.5 - 43.5 GHz including telephony, video, media streaming and data services;

c) that there is the need for P-P links for large data capacity transport, e.g. for mobile networks applications, the deployment of which is expected to rapidly grow in bands lower than 6 GHz.;

d) that it is desirable to achieve flexible frequency assignment plans that can accommodate both symmetrical and asymmetrical MP traffic requirements, as well as P-P links, in particular for transport applications in MWS networks and in mobile networks, whilst remaining consistent with good spectrum management principles, including provision for inter-systems/services operation and overall spectrum efficiency;

e) 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;

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

g) 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);

h) that it is desirable that the assignment of adjacent blocks to different MWS 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;

i) that a flexible frequency assignment plan would enable MP MWS and P-P systems to co-exist with legacy systems e.g. MVDS in the same band, where appropriate;

j) that the deployment of P-P links may result in greater spectrum efficiency when using conventional link-by-link assignment within a dedicated radio frequency channel arrangement;

k) that the band 40.5 – 42.5 GHz is co-primary allocated to broadcasting-satellite service and ECC/DEC(02)04 states that Earth stations shall not claim protection against FS systems;

l) that the radio astronomy service is also allocated with a primary status in the range 42.5 - 43.5 GHz; in some locations appropriate measures will be needed in the planning and deployment of MP MWS and P–P systems around radio astronomy stations to protect the radio astronomy service;

m) that guidance material is available to assist administrations with the assignment of frequency blocks to operators for fixed wireless access systems. (ERC Report 97);

n) that the guidance of ERC Report 97 has been extended in this recommendation to the definition of BEM for MP MWS TSs (both TDD and FDD) with directional antenna. This guidance can also be appropriately applicable to randomly deployed P-P links (generally assumed FDD).

recommends

1. that administrations wishing to adopt mixed and flexible use of different technologies, for both fixed MWS and for P-P links, within the band should:

   1.1 consider the guidance in Annex 1 in order to create block assignments based upon an aggregation of frequency slots identified in Annex 2;

   1.2 consider the guidance in Annex 1 when considering the positioning of assigned blocks within the band;

   1.3 ensure inter-operator protection through the measures given in Annexes 3 and 4;

   1.4 assign blocks in a manner that might assist future expansion of successful services, ideally without further regulatory requirements on the actual channel arrangements inside the blocks;

   1.5 encourage inter-operator co-operation on co-existence issues to maximise utilisation of the assigned blocks. Section A3.3 of Annex 3 provides also guidance on this aspect;

2. that administrations wishing to use a radio frequency channel arrangement for conventional coordinated deployment of P-P links should consider the radio frequency channel arrangement in Annex 5;

3. that administrations wishing to adopt a flexible use of the band for both assignment methodologies, blocks of frequency according recommends 1 and assigned P-P links according recommends 2, should consider the use of flexible band subdivision in Annex 6;

4. that for international coordination purpose, it is necessary that neighbouring administrations commonly agree to select one of the two options presented in Annex 6. For this purpose option A of Annex 6 is considered preferable whenever RAS coordination is required in the band 42.5 - 43.5 GHz because of the easiness coordination with P-P systems. Option B may be agreed when there are restrictions in using Option A."

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/ERC Recommendations.

ANNEX 1

Guidance for the preferred construction of frequency assignment plans for fixed MWS and P-P links according recommends 1

Steps leading to a recommended assignment plan

Fixed MWS may be provided by a number of multipoint technologies derived from both telecommunications origins and from broadcast distribution origins. In addition, access networks need considerable high capacity connections, typically P-P, that may be conveniently deployed in the 40.5 - 43.5 GHz band.

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 or of the required P-P links, 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 convenient for P-P systems and 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.

[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 only 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:

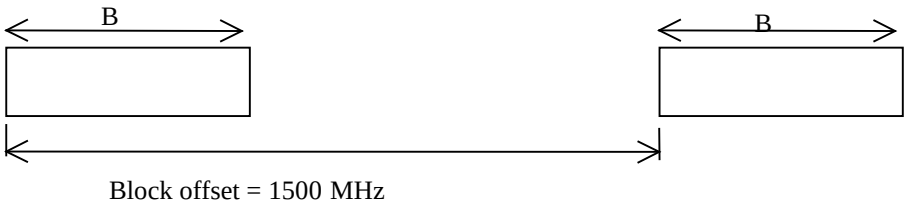


Figure 1.1: General concept of paired equal blocks

Each block may 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.

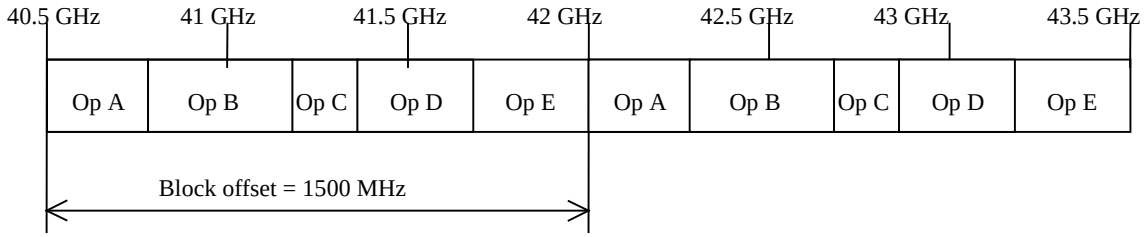


Figure 1.2: Example scheme based on the concept of paired equal blocks

It provides regulators the possibility to allocate the spectrum without a need to predetermine the technology (either for P-P or MP systems) 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 go/return links or upstreams and downstreams to be implemented in the same block (see figure 1.4),
- for TDD systems (either P-P or MP), 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.

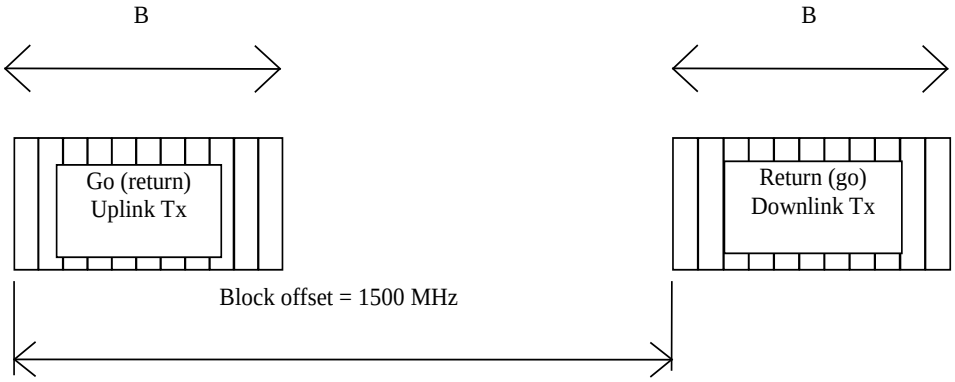


Figure 1.3: Application with FDD P-P and P-MP sysmmetric systems (for one operator)

Go (return) D1 associated with Return (go) U1
Downstreams D1 associated with upstreams U1

Go (return) D1 associated with Return (go) U1
Downstreams D1 associated with upstreams U1

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

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

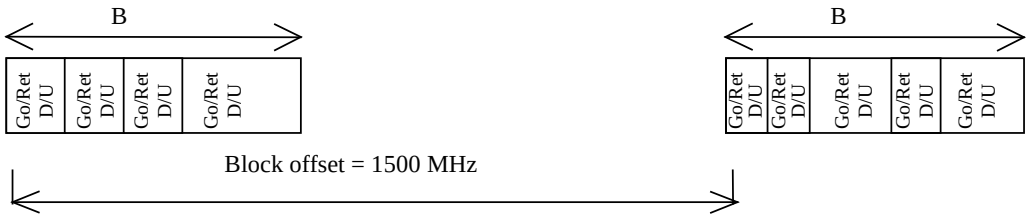


Figure 1.5: Application with TDD systems (for one operator)

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.

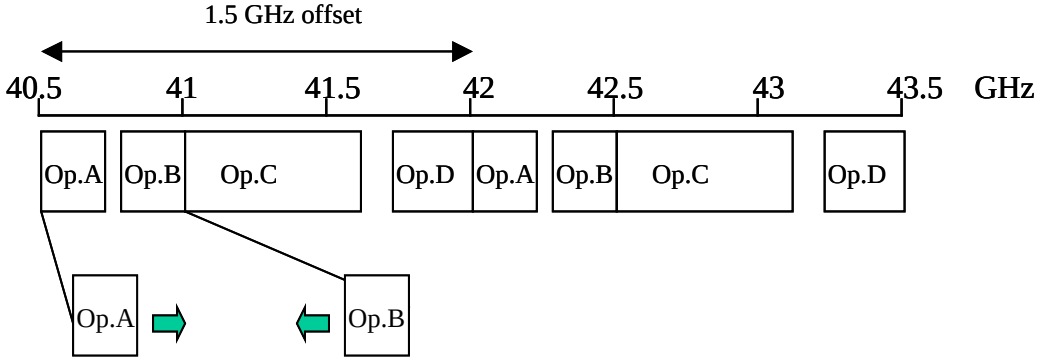


Figure 1.6: Example of the "reference frames" application in the assignment procedure.

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 according recommends 1 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. 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..

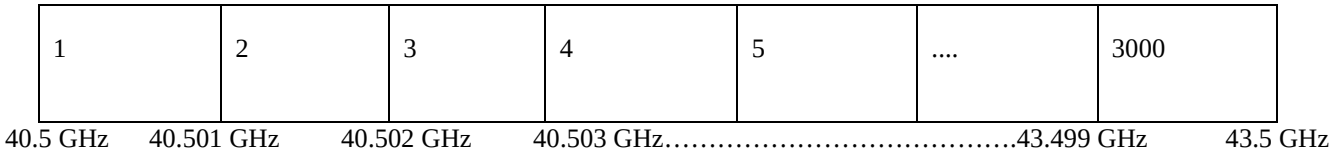


Figure 2.1: Basic frequency allocation plan granularity based on 1 MHz slots

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.

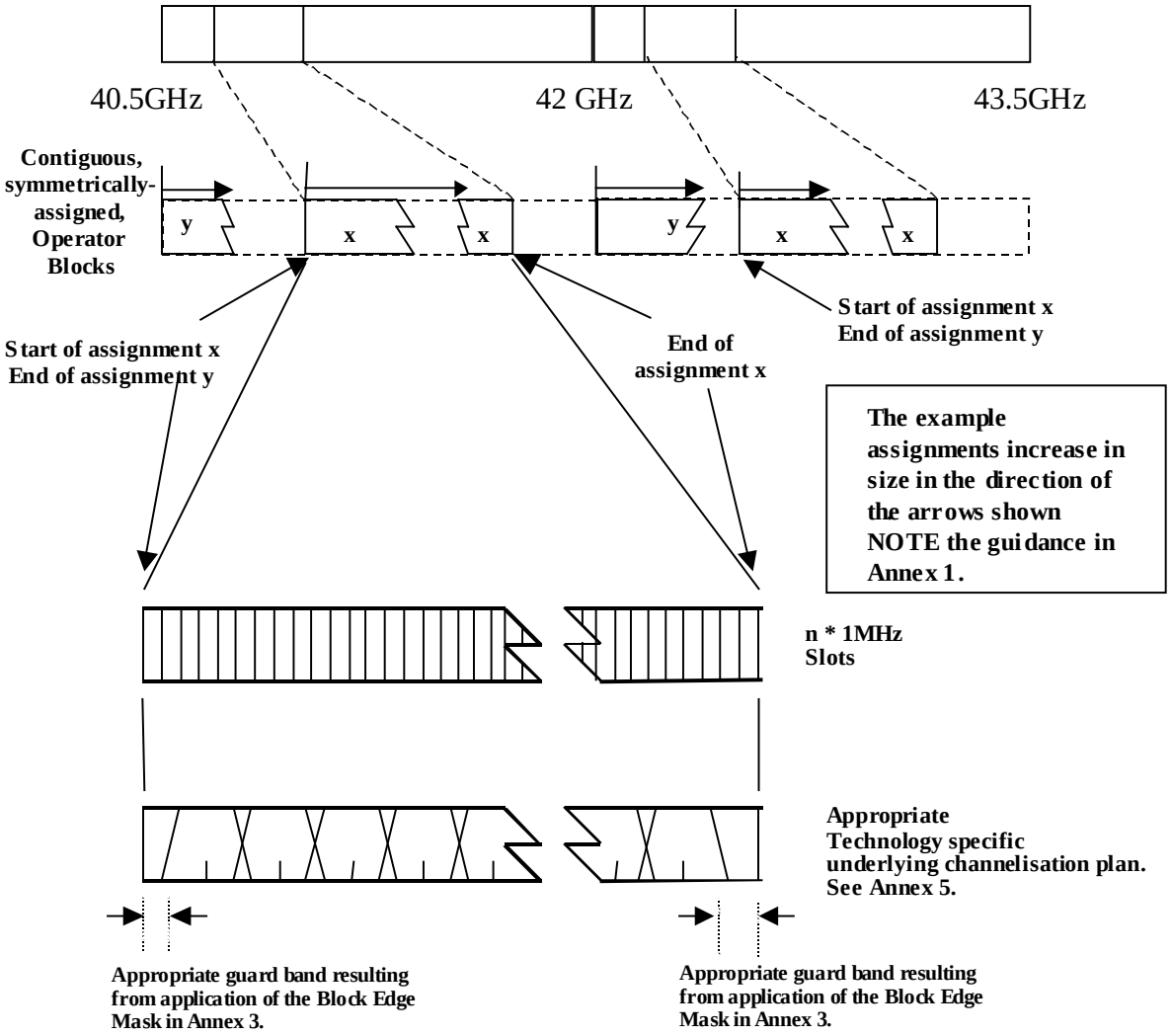


Figure 2.2: Frequency plan elements

ANNEX 3

Frequency Block Edge and EIRP Density Recommendations for deployments according recommends 1

A3.1 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

A3.2 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 and high gain antennas associated to point-to-point links.

Station Type (Note 1)	Max EIRP spectral density (dBW/MHz) (Including tolerances and ATPC range) (Note 3)	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 dBi
TS (and RS up-links)	+ 30	+15 dBm/MHz	45 dBi (0.4 m)
P-P links	+ 40	+ 20 dBm/MHz	50 dBi (0.8 m)
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. Note 3: It should be noted that according RR Art. 21.3 the max. EIRP output power shall be less than +55 dBW			

Table 3.1: Maximum Allowed Transmitter EIRP Spectral Density

A3.3 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).

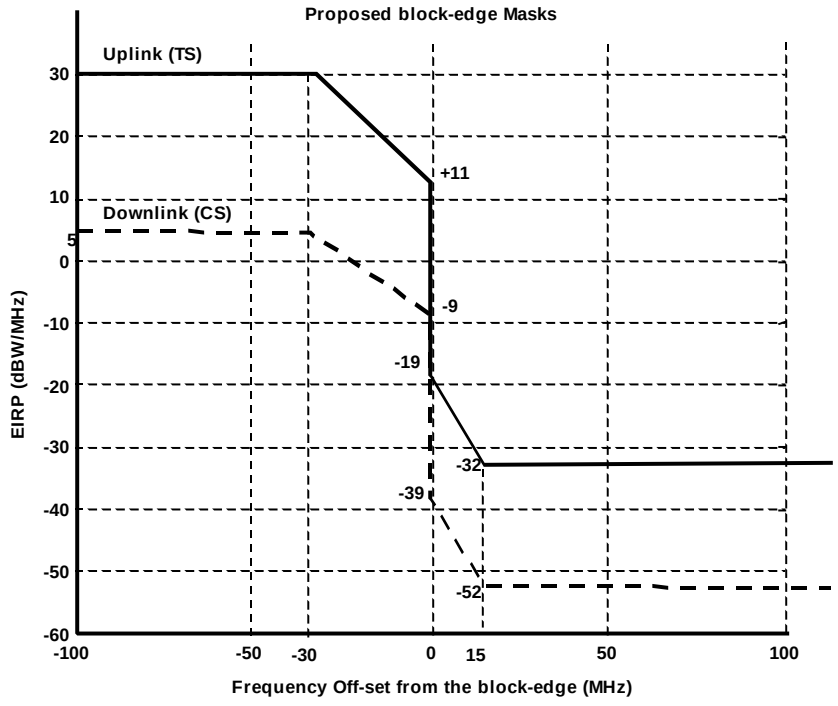
It is not therefore excluded that in a limited number of cases specific mitigation techniques might be necessary.

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 in case of TS or P-P stations with directional antennas there might be very unfortunate cases where, on innermost frequencies of contiguous blocks, wanted and interfering systems antenna boresight are pointing each other within their main lobe angle. Besides the fact that their possible mutually blocked paths might suggest a change of one or both locations, common practice in network planning are easily found (e.g. revert go/return frequency in P-P or change the frequency of the sector with one more central inside the block).

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 (BEM); the limits shown are absolute maximum and intended to include tolerances and any ATPC range:



Note 1: The Uplink (TS) mask is intended applicable also to P-P systems
Note 2: 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 3: 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 – Block Edge Mask (BEM)

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 up to the band limits.

ANNEX 4

Inter-operator and International co-ordination both co-frequency and in adjacent frequencies deployment according recommends 1

Introduction

In order to assign frequencies to a number of competing MWS and/or P-P 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[1][2], CEPT (ERC Report 99[3]), IEEE802.16.2[4] to examine the intra-service co-ordination requirements for FWA and BFWA (CS and TS) that could be appropriate to MWS and P-P in the 42 GHz band. Two distinct co-ordination scenarios are addressed, namely:

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

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[1] TR 101 853: Rules for Co-existence of P-P and P-MP systems using different access methods in the same frequency band.
[2] EN 301 997: Multipoint equipment; Radio equipment for use in Multimedia Wireless Systems (MWS) in the frequency band 40,5 GHz to 43,5 GHz
[3] 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.
[4] IEEE 802.16: Draft Recommended Practice for Coexistence of Broadband Wireless Access Systems.

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 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.

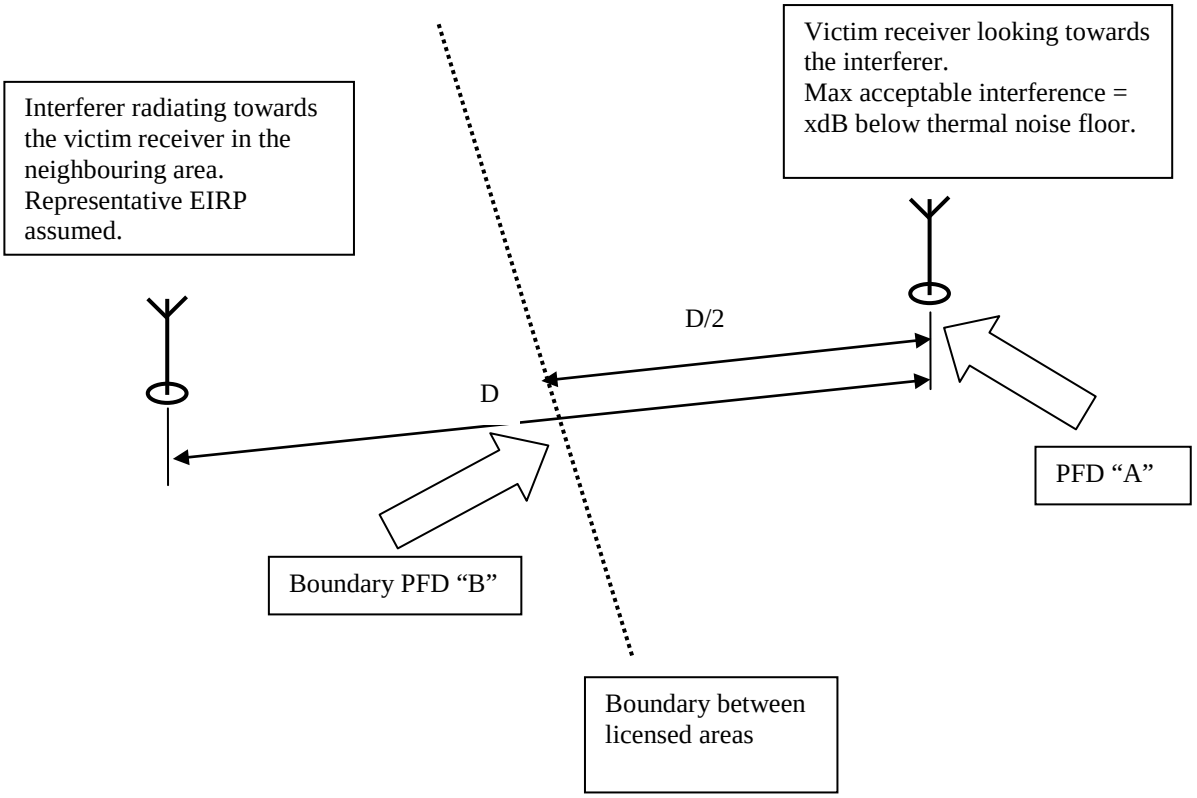


Figure 4.1: Example of PFD boundary limit

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 P-MP networks, application of the PFD limit will ensure substantially interference free co-existence between adjacent service areas for both P-MP and mesh architectures. That may be considered true also for P-P links deployed on different buildings, where the direction and elevation are randomly distributed.

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

Radio frequency channels arrangement according recommends 2

DERIVATION OF CENTER FREQUENCY OF RADIO FREQUENCY CHANNELS

Note: While the BEM in block assignment offers additional mitigation for coexistence with other radio services in adjacent bands, conventional radio frequency channel arrangements are assumed to need guard bands at the band edges and between innermost channels. The latter also simplified the mixed deployment according recommends 3 (see Annex 6).

The radio-frequency channel arrangement for carrier separations of 112 MHz, 56 MHz, 28 MHz, 14 MHz and 7 MHz shall be derived as follows:

Let fo be the reference frequency = 42 000 MHz;
f_n be the centre frequency of a RF channel in the lower half of the band (MHz);
f'_n be the centre frequency of a RF channel in the upper half of the band (MHz);

then the frequencies of individual channels are expressed by the following relationships:

a) for systems with a carrier spacing of 112 MHz:

lower half of band: $f_n = f_o - 1\,506 + 112\,n$ MHz

upper half of band: $f'_n = f_o - 6 + 112\,n$ MHz

where:

n = 1, 2, 3, …….., 12

b) for systems with a carrier spacing of 56 MHz:

lower half of band: $f_n = f_o - 1\,478 + 56\,n$ MHz

upper half of band: $f'_n = f_o + 22 + 56\,n$ MHz

where:

n = 1, 2, 3, . . . 25

c) for systems with a carrier spacing of 28 MHz:

lower half of band: $f_n = f_o - 1\,464 + 28\,n$ MHz

upper half of band: $f'_n = f_o + 36 + 28\,n$ MHz

where:

n = 1, 2, 3, . . . 50

In addition, the use of channel with index n = 0 may be considered with the agreement of the administrations concerned.

d) for systems with a carrier spacing of 14 MHz:

lower half of band: $f_n = f_o - 1\,457 + 14\,n$ MHz

upper half of band: $f'_n = f_o + 43 + 14\,n$ MHz

where:

n = 1, 2, 3, . . . 101

In addition, the use of channels with index n = –1 and 0 may be considered with the agreement of the administrations concerned.

e) for systems with a carrier spacing of 7 MHz:

lower half of band: $f_n = f_o - 1\,453.5 + 7n$ MHz

upper half of band: $f'_n = f_o + 46.5 + 7n$ MHz

where:

$n = 1, 2, 3, \ldots 202$

In addition, the use of channels with index n = –3, –2, –1 and 0 may be considered with the agreement of the administrations concerned.

Table 5.1: Calculated parameters according to Recommendation ITU-R F.746

XS **(MHz)**	***n***	f_1 **(MHz)**	f_n **(MHz)**	f'_1 **(MHz)**	f'_n **(MHz)**	Z_1S **(MHz)**	Z_2S **(MHz)**	***YS*** **(MHz)**	***DS*** **(MHz)**
112	1, ..., 12	40606	41838	42106	43338	106	162	268	1 500
56	1, ..., 25	40578	41922	42078	43422	78	78	156	1 500
28	1, ..., 50	40564	41936	42064	43436	64	64	128	1 500
14	1, ..., 101	40557	41957	42057	43457	57	43	100	1 500
7	1, ..., 202	40553.5	41960.5	42053.5	43460.5	53.5	39.5	93	1 500

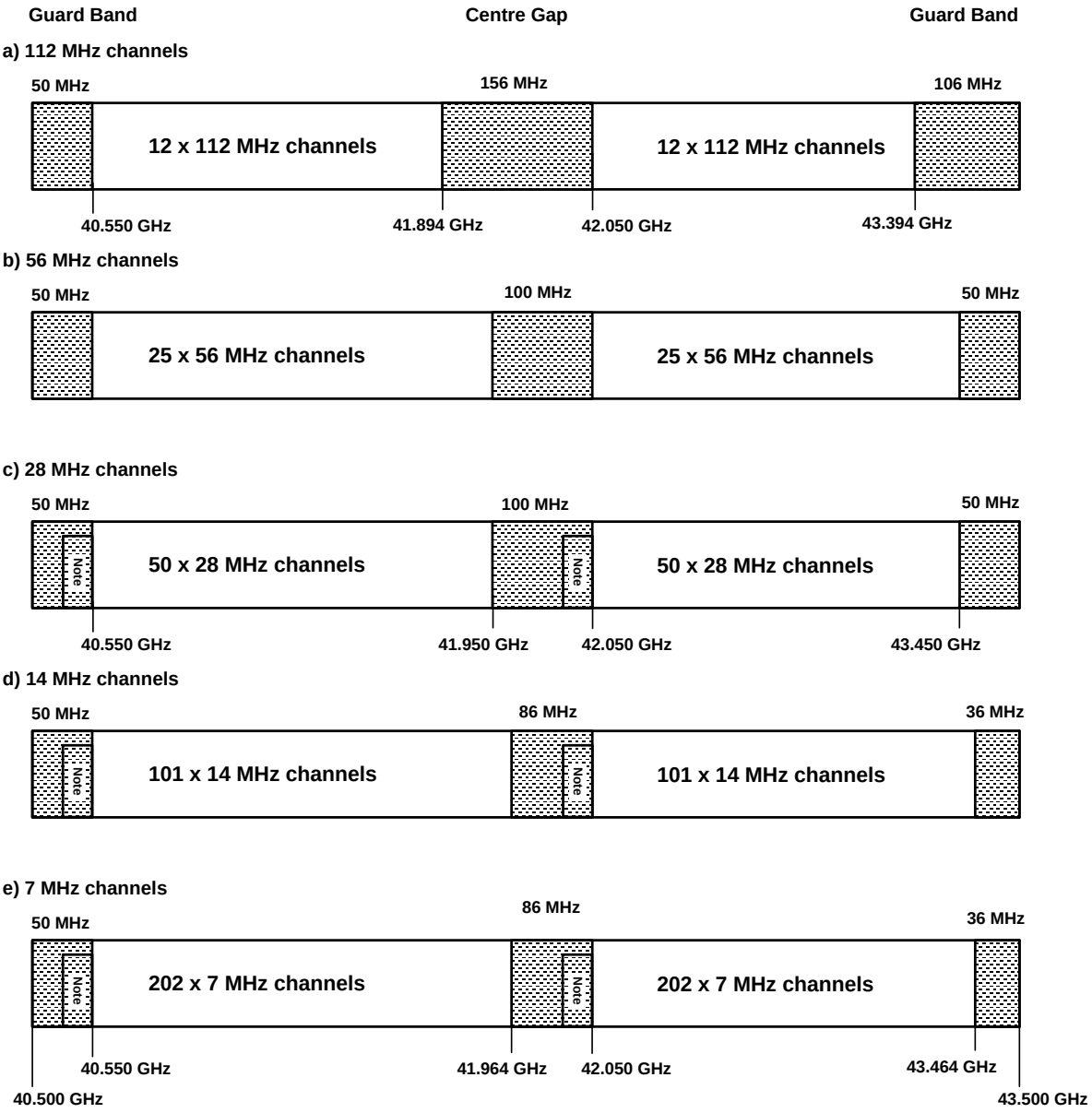
XS: separation between centre frequencies of adjacent channels.

YS: separation between centre frequencies of the closest go and return channels.

Z_1S: separation between the lower band edge and the centre frequency of the lowest channel in the lower sub-band.

Z_2S: separation between centre frequency of the highest channel in the upper sub-band and the upper band edge.

DS: duplex spacing ($f'_n - f_n$).



Note: 28 MHz for additional 7, 14 and 28 MHz channels with the agreement of administrations concerned

Figure 5.1: Occupied Spectrum from 40.5 to 43.5 GHz

ANNEX 6

Flexible band segmentation, according recommends 3, for joint use of block and radio frequency channels arrangements

A flexible joint use of the two methodologies described in recommends 1 and 2 may be obtained initiating the deployment of blocks (according recommends 1) from the lowest frequency borders upwards and of coordinated P-P radio frequency channels from the highest frequency borders downwards (option A, see Figure 6.1) or vice versa (option B, see Figure 6.2).

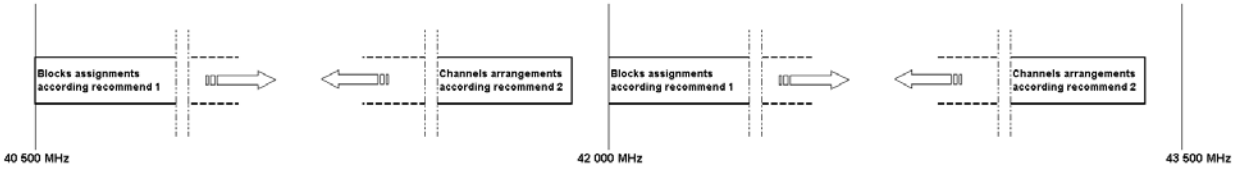


Figure 6.1: Flexible deployment method: option A (preferred)

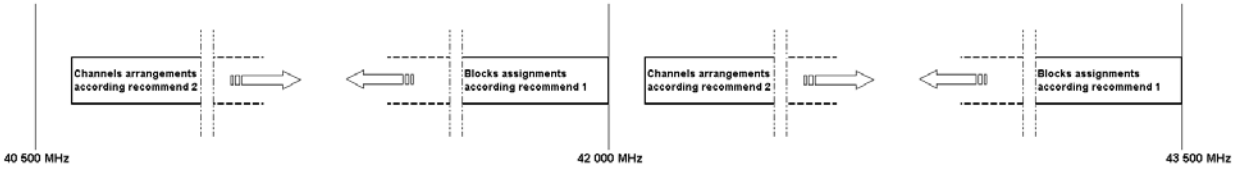


Figure 6.2: Flexible deployment method: option B