Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Broadband Fixed Wireless Access in the 40GHz Band**
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Re:	Call for comments on the draft Recommended Practice for BFWA co-existence.(802.16.2-00/01)
Abstract	Provides information and proposals for the 802.16.2 recommended co-existence practice document regarding use of the 40GHz band in Europe for BFWA. This covers frequency plan developments and co-ordination guidelines.
Purpose	Gain acceptance for inclusion of the proposals in the Recommended Practice for BFWA co-existence.
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Broadband Fixed Wireless Access in the 40GHz Band

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Introduction

Interest in BWA in Europe is growing with licensing taking place in the 26GHz and 28GHz frequency bands in many countries and a recent decision to harmonise use of the 40.5-43.5GHz band for Multimedia Wireless Systems (MWS). MWS are defined as terrestrial broadband fixed wireless access systems with origins in both telecommunications and broadcasting services. They include systems providing uni-directional distribution (e.g. Multipoint Video Distribution Systems - MVDS) through to fully symmetrical bi-directional systems.

The concept of MWS was developed and continues to be refined within the European Regulatory Bodies (CEPT Frequency Management Working Group) as an answer to the evolution of MVDS to provide broadband telecommunications services. MWS need not be restricted to operation in the 40GHz band and are viewed as an opportunity for a variety of technical solutions delivering a range of broadband services.

To support this growing interest there are a number of activities under way addressing standards, co-existence and spectrum engineering for MWS and one key topic is that of frequency band planning. This paper seeks to provide input to the co-existence recommended practice on the approach to band planning being taken for this 40GHz band. It should be noted that whilst the basic principles of this approach are agreed there is continuing discussion over the detail which is unlikely to be resolved within the timeframe for this version of the practice document.

Band Plan Requirements

There are many pressures on an appropriate band plan brought about by the perceived spread of technologies that might be deployed in the band. Therefore the following considerations are being taken into account in developing this plan:

- Accommodation of systems supporting both asymmetric and/or symmetric traffic.
- Digital MVDS.
- Make provision for both FDD and TDD operation.
- Accommodation of more than one operator must be possible in the same geographical area.
- Criteria for inter-operator protection.
- Where FDD is required duplex spacing needs to be practicable.
- Duplex spacing has to be chosen to allow efficient band planning.
- Accommodate legacy services, e.g analogue MVDS.
- Planning for growth.
- Need to protect Radio Astronomy service.
- The impact of possible band sharing with satellite services.

Frequency block assignments

In order to satisfy these requirements block assignments based upon a slot frequency plan are deemed appropriate. The plan slots would have no relationship with equipment channelisation and be expected to be something smaller than the narrowest anticipated channel width. To facilitate band planning, FDD systems with symmetrical uplink and downlink spectrum requirements should settle on a fixed duplex spacing. These issues

continue to be examined and close liaison continues with the equipment standardisation bodies (principally ETSI BRAN and TM4)

Inter-Operator protection

It is proposed that inter-operation protection should be assured through a "block edge mask", out of block emission limits and power flux density limits for co-frequency assignments. Results of initial studies carried out by one administration and yet to be further verified are put forward in the accompanying proposal for the co-existence document.

Proposed text for the Recommended Practice Document

In order to reflect this work taking place in relation to a frequency band other than those currently covered in the practice document the following text is proposed:

Section 6:

Within some regions a frequency plan is under development for Multimedia Wireless Systems (MWS) in the band 40.5-43.5GHz. Consideration is being given to a number of points in order to develop a so-called "slot" frequency plan which provides the basis for block assignments to a number of potentially competing operators within the band for MWS. The key points under consideration are:

- *Accommodation of systems supporting both asymmetric and/or symmetric traffic.*
- *Digital MVDS.*
- *Make provision for both FDD and TDD operation.*
- *Accommodation of more than one operator must be possible in the same geographical area.*
- *Criteria for inter-operator protection.*
- *Where FDD is required duplex spacing needs to be practicable.*
- *Duplex spacing has to be chosen to allow efficient band planning.*
- *Accommodate legacy services, e.g analogue MVDS.*
- *Planning for growth.*
- *Need to protect Radio Astronomy service.*
- *The impact of possible band sharing with satellite services.*

Frequency plan slots would be aggregated in a contiguous manner to form block assignments which can be consistent with the MWS technology to be deployed. The plan slots would have no relationship with equipment channelisation and be expected to be something smaller than the narrowest anticipated channel width associated with any MWS system. A figure of either 1MHz or 2MHz is under consideration at present. Once assigned the slot boundaries would become meaningless and have no significance regarding equipment channelisation or the way the operator makes use of the band.

This concept is illustrated for 2MHz slots in the figure below:

Frequency allocation plan based on 2MHz slots for the band 40.5 to 43.5 GHz

This allocation plan consists of 1500 adjacent 2 MHz slots starting at 40.5 GHz as per Figure 1. Any number of these slots may be aggregated to form a block assignment. Assignments may be paired in a contiguous or non-contiguous manner for FDD operation or unpaired for TDD operation.

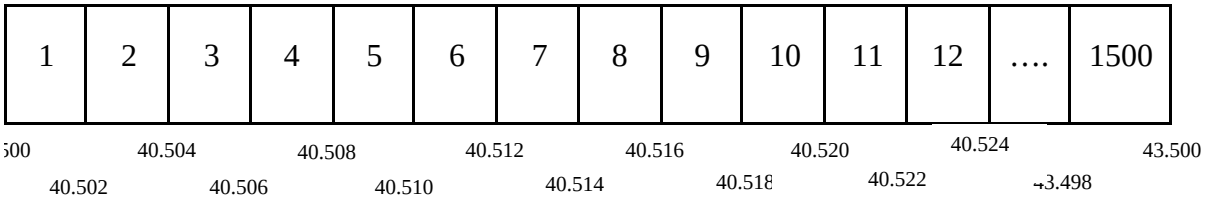

FIGURE 1

Slot start frequency can be identified by the following relationship:

For slot number n = 1 to 1500;

Slot start frequency = (40.498 + n* 0.002) GHz

Once assigned, the slot boundaries become meaningless other than those coincident with the frequency block boundaries.

End of section 6 proposal

Inter-operator protection

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.

Work carried out in the UK has looked at the issue of inter-operator co-ordination and text for the co-existence document is proposed based upon that work. In the UK it is likely that licensed areas will abut.

Proposed text for the Recommended Practice Document

Section 7:

In some areas work has been done to examine the intra-service co-ordination requirements for broadband fixed wireless access (BFWA) 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 band edges. The measures that are proposed are:

Scenario 1:

- *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.*
- *Co-ordination shall not be required beyond a certain distance from the service area boundary, this distance being a function of the transmit EIRP and whether the interferer is a point to multipoint base station or a subscriber station.*
- *Operators in adjacent service areas should avoid co-polar, co-channel operation within 5 km of their service area boundary.*
- *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.*

Scenario 2:

- *For services operating in adjacent spectrum within the same geographical area and utilising significantly different RF channel bandwidths, each operator should maintain a guard band equal to a single channel spacing. Transmissions may only take place within this guard band by mutual agreement between the two operators concerned.*
- *For services operating in adjacent spectrum within the same geographical area and utilising identical RF channel bandwidths, each operator should maintain a guard band equal to half the channel spacing.*

Scenario 1

Co-ordination requirements for adjacent geographic areas

Boundary Power Flux Density limit for co-ordination

*Investigations have concluded that individual BFWA transmitters should be co-ordinated when the **PFD** generated at the network's service area boundary exceeds the following value:*

42 GHz: -98.5 dBW/MHz/m^2

- ***PMP Base Station co-ordination***

*For a PMP **base** station transmitter generating an EIRP of 0.5 dBW / MHz (= 15 dBW in 28 MHz bandwidth), these PFD limits correspond to maximum co-ordination distances from the service area boundary of:*

42 GHz: 18 km

This maximum co-ordination distances is that at which co-ordination will be required under free space propagation conditions and are functions of EIRP. These are also the minimum distances at which a base station receiver with a directly aligned line of sight path towards the network service area boundary and a 15 dBi gain antenna will be protected against interference from individual interferers in adjacent networks.

- ***Subscriber Station co-ordination (PMP and Mesh)***

*Where uplink ATPC is deployed, and assuming a maximum transmitter EIRP of 11.5 dBW / MHz, the maximum co-ordination distances from the network service area boundary for PMP **subscriber** stations and mesh network **node** stations are:*

42 GHz: 10 km

- ***High Density Mesh Networks***

*Characteristics of proposed mesh networks suggest a higher density of potential interferers. This could be up to 50 times higher and the possibility of line of sight paths could be higher (perhaps 50% or more). Increasing the separation reduces the probability of a line of sight path and assuming a four cell re-use the probability at a minimum re-use distance of around 10.5km assuming 3km cell radius, could reduce to <20%. Therefore it is recommended that **co-channel co-polar subscriber station operation is avoided within 5km of a service area boundary**.*

- ***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 these limits will ensure substantially interference free co-existence between adjacent service areas for both PMP and mesh architectures. In all cases below the acceptable interference threshold is equivalent to 10dB below the receiver noise floor.

In the base station to base station case, with the guidelines above in place, trials show that with no base station antenna downtilt there remains a high probability of interference above the acceptable threshold. With only 10% of potential interferers visible from an adjacent service area there is a 1% chance of interference exceeding the threshold by 7dB. This rises to 60% chance if 40% of interferers are visible. However if base station antenna downtilt is assumed (9 degrees) then with 10% of interferers visible the limit is never exceeded and with 40% of interferers visible then there is a 1% chance of exceeding the interference limit by only 3dB.

In the base station to terminal station case, with the guidelines above in place and base station antenna downtilt, trials show that with 10% of potential interferers visible from an adjacent service area there is only a 1% chance that the interference limit is exceeded by 1dB. When 40% of interferers are visible, for a 1% chance, the exceedance rises to a 5dB.

For both the terminal station to base station case and terminal station to terminal station case, with assumptions appropriate to terminal station transmissions (e.g. ATPC, rain fade correlation on boresight) there is a less than 0.1% chance of interference exceeding the threshold with the guidelines above in place.

For high density mesh networks, assuming a 10km separation for co-channel operation across a service boundary then with 20% of potential interferers visible the probability of exceeding the interference criteria is less than 0.1% . If 100% of interferers were visible there is a <0.1% chance of exceedance greater than 7dB.

These are summarised in the following table:

Interference case	*BS downtilt*	*Interference Threshold Exceedance*	*Interferers visible (LOS)*
BS – BS	*No*	*7dB, 1%.* *7dB, 60%*	*10%* *40%*
BS – BS	*Yes*	*Zero* *3dB, 1%*	*10%* *40%*
BS – TS	*Yes*	*1dB, 1%* *5dB, 1%*	*10%* *40%*
TS – BS or TS	*Yes*	*<0.1%*	*40%*

- ***Service Area Boundaries***

It is recommended that licence area boundaries should, as far as possible, avoid major population centres to minimise the need to co-ordinate large numbers of stations. There is also likely to be merit in aligning boundaries with significant terrain features where these lie between major population centres.

Scenario 2

Co-ordination requirements for adjacent band working in the same geographic area based upon work so far:

On the basis of current technology, and receiver and transmitter characteristics specified by the current standards (including substantive drafts where available),

- *a guard band equal to one channel spacing should be allowed at the edges of each operator's spectrum assignment. This will permit co-existence between operators even when there is a significant difference in the channel bandwidth of the two networks. With these guard bands in place, the chance of exceeding the interference threshold is less than 0.1% for all scenarios except that of a high density mesh network. In this case there is a 1% chance of threshold exceedance.*

- *Transmissions could be viable within the guard band subject to detailed co-ordination between operators. Such co-ordination for example could be based on the use of orthogonal polarisation or by agreement on an area by area basis. Alternatively the guard bands may be suitable for conveyance of narrower bandwidth signals, e.g. for network control purposes or voice telephony.*

- *Where two networks share the same channel bandwidth, the co-ordination guard band may be reduced to half the channel spacing. Statistical trials show that with these guard bands in place the chance of exceeding the interference threshold is less than 0.1% for all scenarios except that of a high density mesh network. In this case there is a 1.5% chance of threshold exceedance.*

End of section 7 proposal