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Re:	Contribution to the discussion in the 802.16.2 working group. **(Revision 1)**
Abstract	This paper details an approach concerning inter-operator co-ordination triggers for co-frequency operation in adjacent BFWA licensed areas. **Revision 1 adds text proposals based upon draft 7 of the Recommended Practice Doc.**
Purpose	Contribution to the 802.16.2 group dealing with the draft Recommended Practice for BFWA co-existence.
Notice	
Release	
Patent Policy and Procedures	

Adjacent Area Co-ordination and Co-existence

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Introduction

The latest draft of the Co-existence Recommended Practice document details a methodology for the co-ordination of FWA stations located in adjacent (or nearby) geographical areas and operating on the same frequencies. The methodology employs a Power Flux Density (pfd) limit applied at the licence area boundary, in order to establish whether the level of interference into a neighbouring area is acceptable.

Compliance is based upon an aggregation of all the potential interference from the interfering region. The pfd limit proposed is such that the interference does not increase the noise floor of a victim receiver at the boundary by more than 0.5dB (I/N=-10dB).

This implies that an operator will need to carry out calculations based upon his entire expected roll out prior to deployment to ensure that his network as a whole does not cause interference in excess of the limit. If it does then it would seem that he will either have to re-engineer his expected deployment or enter into negotiations with the affected operator regarding the acceptability of the expected interference level.

This so-called “multiple interferer” approach would appear to be providing a safe approach ensuring 100% protection to neighbouring operators but could be difficult for the following reasons:

- It assumes that the interfering operator will know his full deployment in his area from the outset.
- Any reconfiguration of his network would seem to require a complete re-evaluation of interference from the entire network.
- It does not recognise that usually the interference into the neighbouring area can be attributed to only a few interfering stations.
- No account of the statistical nature of the interference leading to an over protective situation unnecessarily constraining operator deployment.

Alternative Approach

An alternative approach which recognises the statistical nature of the interference can be employed that decreases the burden on the operator to co-ordinate, allowing him to deploy in an unconstrained fashion in parts of his licensed area albeit with an increased risk of interference near the boundary. Additionally he needs only consider the interference impact of certain stations on a case by case basis. This can be achieved by defining a boundary pfd trigger level applied on a single interferer basis in conjunction with a co-ordination zone along the licensed area boundaries, shared equally between the operators. The single interferer trigger limit needs to be tested only once in a Monte-Carlo style simulation in order to test its adequacy and assess the likelihood of harmful interference into a neighbouring licensed area.
In effect, the co-ordination distance, which is based on EIRP, forms the first trigger for co-ordination action followed if required by calculation of boundary pfd. If the boundary pfd exceeds the threshold then some further action is required to either re-engineer the interfering station or to enter into a negotiation with the neighbouring operator.

This leads to a higher pfd trigger level at the boundary and a consequent higher level of interference over parts of the neighbouring licensed area but the assessment laid out in this paper suggests that the probability of harmful interference is maintained at an acceptably low level.

Derivation of the Co-ordination Triggers for Base Stations (Hubs)

There are two aspects to the process of defining co-ordination triggers resulting initially in a co-ordination zone and secondly in an associated boundary pfd trigger level. These can be derived using the following procedure:

Using typical operational characteristics of both the transmitting station (interferer) and the co-channel victim receiving system calculate the minimum separation distance based upon a directly aligned Minimum Coupling Loss calculation and an agreed maximum tolerable interference level at the receiver input.

Having established the minimum separation distance for the worst case alignment divide the distance equally about the boundary of the two licensed areas. With the same assumptions about the victim receiver system re-calculate the pfd at the mid-point which is the licensed area boundary. This will be the boundary pfd trigger level.

Assessment of the Co-ordination Triggers for Base Station to Subscriber Stations alignment

Having determined the acceptable pfd level at the boundary based on the base station to base station case above, this can be checked using an interfering subscriber station to see whether the limit is adequate or needs adjustment to cater for the different characteristics. In the directly aligned case the victim base station is assumed to be set back from the boundary by the distances calculated in the process above. The interfering subscriber station is assumed to pointing towards a base station located at the licensed area boundary looking into its own service area. Subscriber station ATPC is assumed and for the directly aligned case, correlated rain fading is assumed. It is further assumed that the subscriber station will be operating at maximum EIRP when located at the cell edge.

For the parameters assumed in Annex 1 a maximum cell radius can be calculated to determine how far into the interfering network area the subscriber should be for the worst case interference scenario. The resultant interfering power from the subscriber station can now be calculated at the victim base station.

If this is below the interference threshold then this implies that the previously calculated pfd is adequate for this scenario also.

In order to assess the co-ordination distance requirement, it is assumed that the subscriber station EIRP in the scenario above is reduced by the rain fade margin for the directly aligned case. However care needs to be taken about this assumption at angles away from the bore sight condition where rain fade and maximum EIRP may not be correlated although antenna discrimination can be taken into account.

Examples of these calculations are given in Annex 3.

Application of the triggers

The trigger levels are being developed in the UK to allow the Regulatory Authority to set some top level guidelines to identify the need for an operator to carry out some action to facilitate co-existence with neighbouring operators. It is recognised that, in themselves, they do not guarantee complete interference free co-existence.

The co-ordination distance trigger and single entry pfd limit are then applied in the following manner:

An operator calculates the required EIRP dependant co-ordination distance based on MCL, as detailed above. If his intended deployment falls outside the required co-ordination zone then he needs take no further action. If his intended deployment falls within the co-ordination zone then he needs to calculate the resulting pfd at (or beyond) the licensed area boundary taking into account all relevant propagation factors, terrain and clutter to establish whether his deployment will result in a pfd greater than the limit. For assessing subscriber station interference, due attention needs to be paid to the possibility of uncorrelated rain fading in certain directions.

If the pfd threshold is exceeded then he should take steps to reduce the EIRP in the direction of the boundary by either re-pointing or introducing further blockage. Alternatively, depending on the demography of the adjacent licensed area there might be the possibility of negotiation with the adjacent operator to agree a new “virtual” licence area boundary for the purposes of co-existence.

Testing the co-ordination distance and pfd trigger level

This approach results in the possibility of interference at a victim receiver greater than the interference threshold due to signals from a number of interfering sources in an adjacent region. Therefore the proposed pfd trigger level needs to be tested in a multiple interferer scenario in order to test its adequacy.

Annex 2 details the Monte Carlo testing carried out to test these trigger levels.

Results of the co-ordination trigger threshold statistical analysis

The simulations carried out to test these trigger levels were undertaken for both the 28GHz and 40GHz frequency bands which are both under consideration in the UK for BFWA licensing.

Using the methods detailed above and based upon the technical parameters detailed in Annex 1, the following pfd levels have been derived for application at the licensed area boundary:

28GHz Band; -102.5dBW/MHz/m^2
40GHz Band; -98.5dBW/MHz/m^2

These are associated with the following co-ordination distance requirements based on the typical EIRP's detailed in Annex 1, such that any deployment within this distance of the boundary requires a check of the resultant boundary pfd. They are dependant upon the type of station:

For PMP Hub (Base Station)
28GHz Band; 27.5km
40GHz Band; 18km

For Subscriber Stations
28GHz Band; 16km
40GHz Band; 10km

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 as shown in the plots below:

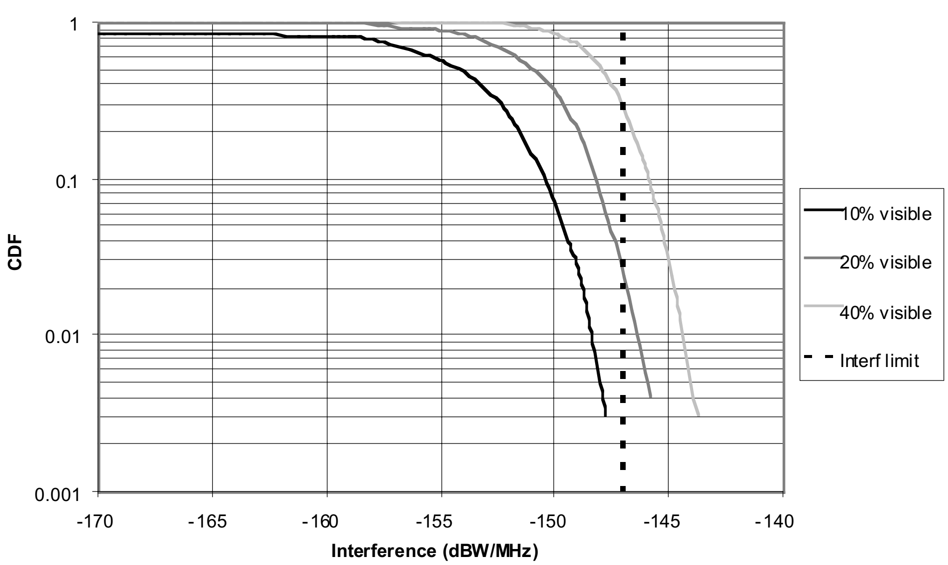

Figure 1:Interference CDF for base station to base station scenario (27.5GHz).

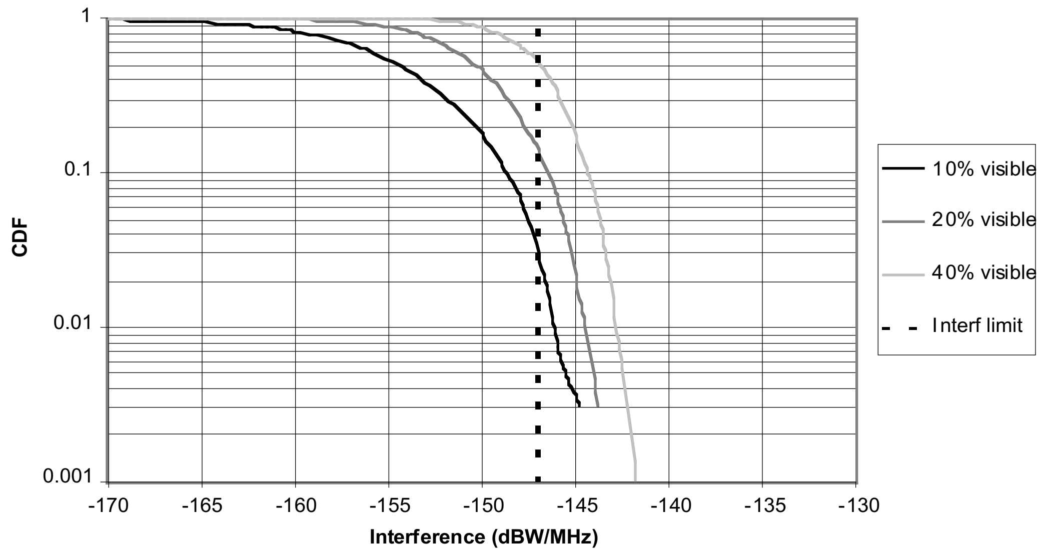

Figure 2:CDF for Base-to-Subscriber interference (27.5GHz)

It can be seen from Figure 1 that interference only becomes significant when 20% or more of the potential interfering base stations have a line of sight path to the victim (the 10% curve lies completely below the interference limit equivalent to I/N=-10dB). 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.

It can be seen from Figure 2 that 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. It is also possible that in mature networks a choice of base or node stations will be available, enabling susceptible subscriber stations to be oriented away from potential interference sources. Base station to subscriber station interference is therefore not considered to be a significant factor if the proposed boundary pfd limits are observed.

Results for interference from subscriber stations into either base stations or subscriber stations show no exceedance of the interference threshold even with 40% of the adjacent interferers visible.

Sensitivity of the Results

As might be expected the results are extremely sensitive to certain parameters used in carrying out the multiple interferer evaluations. One important example is that of antenna downtilt for Base Station deployment. The CDF plots above were derived based upon an assumption of 9 degrees of Base Station Antenna downtilt but Fig 3 below shows that only a few degrees variation can significantly change the result.

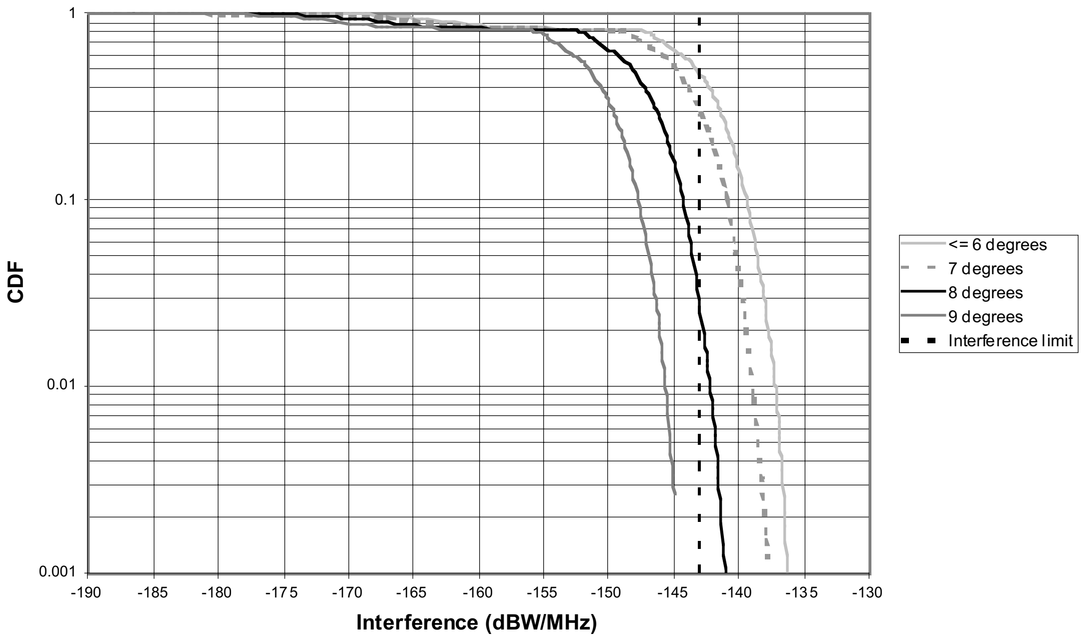

Figure 3: Interference CDF for base station to base station scenario (10% visibility and different base station antenna downtilts) NOTE: Limit shown is at –143dBW/MHz equivalent to I/N=-6dB[1].

Although the plot shows, that under certain conditions, the risk of interference may be sufficiently low, some might consider the situation rather too sensitive and look for further comfort. However it should also be borne in mind that for some scenarios the parameter values and simulation could be pessimistic. For example, it assumes complete coverage of the adjacent licensed area and the antenna pattern is assumed to completely fill the RPE given by the antenna standard and that the victim is located at the licence area boundary minimising terrain and clutter losses.

Proposals for the Recommended Practice Document

It is understood that there is no absolute solution to BFWA co-existence but merely degrees of co-existence that may be facilitated by putting place certain procedures and recommendations. The procedure described above when compared to the proposals in the current draft of the recommended practice could be considered as an alternative approach which may be equally applicable in certain situations. It is clear that the results are extremely sensitive to assumptions made regarding, for example, the number of interferers visible in an adjacent licensed region or the amount of antenna down tilt assumed at a base station and therefore sensitive to the type of terrain and deployment scenario.

It is proposed therefore that the recommended practice should document a process like that described here that can be evaluated by potential operators or regulators against the multiple interferer approach currently detailed in the practice document. To accompany these, what may be considered two extremes, an indication of the sensitivities and of alternative approaches which lay between these two examples could be given for guidance. For example, an interference threshold of I/N = -6dB may be deemed sufficient or more stringent boundary pfd trigger levels could be imposed to provide more protection. These may help to reduce the co-ordination burden and increase the flexibility for an operator.

Text Proposals for the draft Recommended Practice Document

Proposed new text below is highlighted.

Recommendation 1: Adopt a "x dB below receiver thermal noise in the victim receiver criterion" as being a value of interference from each interfering operator which is "acceptable." The document institutes this approach in recognition of the fact that it is not practical to insist upon an “interference-free” environment. Having once adopted this concept, there are some important consequences:

Each operator acknowledges that he is willing to accept a degree of degradation in his receiver sensitivity from each other operator. In some regard, the –x dB value becomes the definition of “coexistence.”

Depending upon the particular deployment environment, an operator may have interference contributions from multiple CoCh and AdjCh operators. Each operator should include design margin in his system which is capable of simultaneously accepting the compound effect of interference from all other relevant operators.

The design margin in above should be included preemptively at initial deployment, even if the operator in question is the first to deploy in a region and is not experiencing interference.

All parties should recognize that, in predicting signal levels, which result in the –x dB interference value, it is difficult to be precise in including the aggregating effect of multiple terminals, the effect of uncorrelated rain, etc. Therefore, all parties should be prepared to acknowledge claims of interference even if the particular prediction method which was used to substantiate the –x dB value suggests that there should not be any.

Suitable values for x are –6dB or –10dB. These are consistent with ITU-R Recommendations (Ref: ITU-R F-???) that suggest values for inter-service interference limits in to the Fixed Service. These figures correspond to a degradation in receiver threshold of 1dB or 0.5dB respectively.

Recommendation 2: Each operator should take the initiative to collaborate with other known operators prior to initial deployment and at every relevant system modification. This recommendation should be followed even if an operator is the first to actually deploy in a region. To encourage this behavior, the document introduces the concept of using either power spectral flux density values or co-ordination distances to “trigger” different levels of initiatives taken by an operator to give notification to other operators triggers. The specific trigger values and their application to the two deployment scenarios are discussed in Section 7. In some regulatory environments, the fact that the “triggers” were properly analyzed and that the proper cooperative initiative was made can be used as evidence of operating in good faith to promote coexistence.

Section 7:

Deployment & Co-ordination

The following paragraphs provide recommended structure processes to be considered for co-ordinating the deployment of BWA systems in order to minimize interference problems. Two alternative approaches are proposed for the adjacent area / co-channel case which reflect the range of possibilities for guidelines for successful co-existence. The two alternatives are put forward with the intention that operators / administrations can note the implications of each approach and determine that most appropriate for their circumstances.

The methodology described in section 7.1.1a), is based upon calculation of the pfsd at the licensed area boundary compared to the pfsd trigger level derived from the agreed interference threshold for a victim receiver placed at that boundary. In determining the exported interference the aggregation of all the potential interferering sources into the interfering region is considered.

The methodology described in section 7.1.1 b) is a two stage process based upon a co-ordination distance from the licensed area boundary that is dependant upon transmitter EIRP which in turn triggers a calculation of the pfsd at the boundary resulting from this single interferer. This is compared to a second pfsd trigger which determines whether further inter-operator co-ordination is required.

Note that national regulation and / or international agreements may impose tighter limits than the following and will take precedence in this case.

This methodology should facilitate identification of potential interference issues and should minimize the impact in many cases, but compliance with this process will not guarantee avoiding interference problems.

It is recommended that a similar methodology apply to both co-frequency/adjacent area situations as well as

NOTE in the following, “coordination” as a minimum implies a simple assessment showing the likelihood of interference, AND it may imply a detailed bi-lateral negotiation between operators to mitigate problem areas for the benefit of both systems.

Section 7.1.1

a) “Multiple Interferer approach”

[All the existing text currently in section 7.1.1 and 7.1.2 of draft 7 to be inserted in this section]

b) “Single Interferer approach”

An alternative approach which recognises the statistical nature of the interference can be employed that decreases the burden on the operator to co-ordinate, allowing him to deploy in an unconstrained fashion in parts of his licensed area albeit with an increased risk of interference near the boundary. Additionally he needs only consider the interference impact of certain stations on a case by case basis. This can be achieved by defining a boundary pfd trigger level applied on a single interferer basis in conjunction with a co-ordination zone along the licensed area boundaries, shared equally between the operators. The single interferer trigger limit can be tested in a Monte-Carlo style simulation in order to test its adequacy and assess the likelihood of harmful interference into a neighbouring licensed area.
In effect, the co-ordination distance, which is based on EIRP and an interference threshold at the victim of I/N = -10dB, forms the first trigger for co-ordination action followed if required by calculation of boundary pfd. If the boundary pfsd exceeds the threshold then some further action is required to either re-engineer the interfering station or to enter into a negotiation with the neighbouring operator.

The co-ordination distance from the licensed area boundary is effectively half the minimum seperation distance for a worst case minimum coupling loss situation between interferer and victim.

The boundary pfsd trigger is based upon the acceptable I/N at the victim receiver but reflected back to the boundary based on half the calculated MCL co-ordination distance. Therefore the licensed area boundary pfsd trigger is somewhat higher than the pfsd at the victim receiver based on the acceptable I/N. Consequently, a higher level of interference potential exists over parts of the neighbouring licensed area but the acceptibility of this situation can be assessed by examining the probability of harmful interference.

The co-ordination distance trigger and single entry pfd limit are then applied in the following manner:

An operator calculates the required EIRP dependant co-ordination distance based on MCL, as detailed above. If his intended deployment falls outside the required co-ordination zone then he needs take no further action. If his intended deployment falls within the co-ordination zone then he needs to calculate the resulting pfd at (or beyond) the licensed area boundary taking into account all relevant propagation factors, terrain and clutter to establish whether his deployment will result in a pfsd greater than the limit. For assessing subscriber station interference, due attention needs to be paid to the possibility of uncorrelated rain fading in certain directions.

If the pfd threshold is exceeded then he should take steps to reduce the EIRP in the direction of the boundary by either re-pointing or introducing further blockage. Alternatively, depending on the demography of the adjacent licensed area there might be the possibility of negotiation with the adjacent operator to agree a new “virtual” licence area boundary for the purposes of co-existence.

Using the methods detailed above and based upon the technical parameters detailed in Annex [x], the following example pfsd levels have been derived for application at the licensed area boundary in the frequency bands identified:

28GHz Band; -102.5dBW/MHz/m^2
40GHz Band; -98.5dBW/MHz/m^2

These are associated with the following co-ordination distance requirements based on the typical EIRP’s detailed in Annex [y], such that any deployment within this distance of the boundary requires a check of the

28GHz Band; 27.5km
40GHz Band; 18km

For Subscriber Stations
28GHz Band; 16km
40GHz Band; 10km

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 can ensure substantially interference free co-existence between adjacent service areas as shown in the plots detailed in Annex [z].

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Annex 1

Assumed System Parameter Values

For the purposes of the calculating appropriate co-ordination zones, pfd trigger levels and Monte Carlo testing, the following system,deployment and propagation parameter values were assumed:

Assumed parameters for interference analysis:

Nominal channel bandwidth:	28 MHz
Base station EIRP:	15 dBW = 0.5 dBW/MHz
Base station antenna gain:	15 dBi
Base station antenna radiation pattern:	EN 301 215 class CS2
Base Station antenna downtilt	9 degrees
Subscriber station EIRP:	26 dBW = 11.5 dBW / MHz
Subscriber station ATPC assumed.	RX input level maintained at 5dB above the threshold for BER=10^{-6}.
Subscriber station antenna gain	32 dBi (PMP); 26i dB (mesh)
Subscriber station antenna 3dB beam width	4° (PMP); 9° (mesh)
Subscriber station antenna radiation pattern:	EN 301 215 class TS1
Subscriber station receiver threshold (10^{-6} BER)	-111 dBW (QPSK) = -125.5 dBW / MHz
Nominal operating level (threshold +5dB)	-106 dBW
Receiver noise figure	8 dB (42 GHz) 7 dB (28 GHz)
Interference limit (kTBF – 10 dB)	-146 dBW / MHz (42 GHz) -147 dBW /MHz (28 GHz)
Atmospheric Attenuation	0.16 dB/km at 42GHz 0.12 dB/km at 28GHz
Rain attenuation	7.2dB/km at 42GHz 4.6dB/km at 28GHz

Annex 2

Multiple Interferer Statistical Analysis (Base Station to Base Station)

For modelling purposes we have assumed the scenario illustrated in Figure A2.1, with a base station density of 0.009 per km^2. It is assumed that interferers may be visible up to a distance of 60 km from the base station, and that those within 27.5 km of the service area boundary have their EIRPs reduced accordingly to maintain the boundary pfd limit. The victim base station antenna is located at the service area boundary and assumed that it subject to a minimum 9 dB shielding in order to allow deployment at the boundary. This is considered to be the worst case location in terms of the probability of line of sight interferer visibility. At higher interferer densities, the cumulative interference is likely to fall because of the corresponding reduction in.

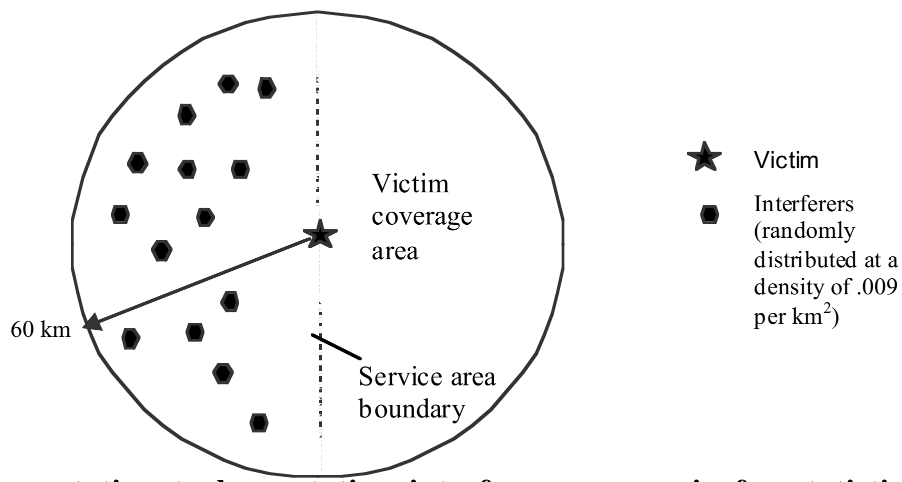

Figure A2.1: Base station to base station interference scenario for statistical analysis

Results are presented for three scenarios, with 10%, 20% and 40% of the interferers visible to the base station. If horizontally aligned base station antennas are assumed (i.e. no downtilt), there is a high probability that the interference limit will be exceeded (this is in fact not surprising, since the 55 km separation distance derived in calculating the co-ordination zone and pfd trigger was determined from a minimum coupling loss analysis of a single interferer and victim). However, when account is taken of the base station antenna downtilt that is likely to be deployed in practice to facilitate intra-network frequency re-use, cumulative interference is reduced to more acceptable levels, as shown in Figure 1.

Multiple Interferer Statistical Analysis (Subscriber Station to Base Station)

In this scenario, the interference geometry is once again as defined in Figure A2.1, with each interferer a transmitting subscriber station and the victim a PMP base station, located at the service area boundary with 9 dB shielding required in order to operate at the service area boundary.
Although there will be far more subscriber stations than base stations, the nature of multiple access means that, for PMP systems, the cumulative interference generated by subscriber stations associated with a given base station transceiver will be no greater than the interference generated by that base station. It can be assumed therefore that the density of interfering subscribers at any instant will be no more than the density of interfering base stations. Since subscriber stations deploy ATPC, the exported interference from each cell will be time varying as different subscribers access the base station, but will average out at less than that produced by the base stations. The interference level is further reduced since correlated rain fading can be assumed when the victim lies within the interferer's antenna boresight. The interference CDFs for various interferer visibilities, taking account of these factors, is illustrated in Figure A2.2 below. An instantaneous co-channel interferer density of 0.009 per km^2 is assumed.

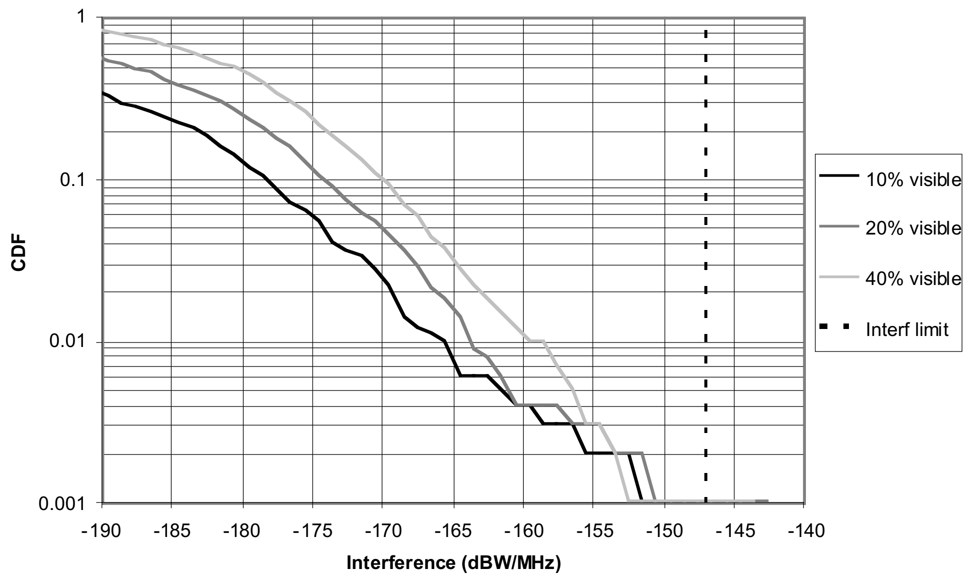

Figure A2.2: CDFs for subscriber station to base station interference (geographically adjacent PMP networks)

Multiple Interferer Statistical Analysis (Subscriber Station to Subscriber Station)

The same methodology was used to assess this case. As above no exceedance of the interference threshold was observed.

Annex 3

Worst Case Interferer Calculations

Base Station to Base Station

Basic Link Budget equation: $\mathbf{P_{rec} = EIRP_{tx} - FSPL - L_{atmos} + G_{rec}}$

Where:

P_{rec} is the interference power at the receiver input

FSPL is the free space path loss =20 log $(4\pi R_{min}/\_)$

L_{atmos} is the atmospheric loss ($0.16R_{min}$ dB at 42GHz or $0.12R_{min}$ dB at 42GHz)

G_{rec} is the receiver antenna gain in the direction of the interferer

R_{min} is the minimum seperation distance.

To meet the interference criterion for each band detailed in Annex 1:

R_{min} = 36km for 40.5GHz, **therefore co-ordination distance = 18km.**

R_{min} = 55km for 27.5GHz, **therefore co-ordination distance = 27.5km.**

Antenna Aperture $A_e = G_{rec} + 10 \log (\_^2/4\pi) = -35.24$ dBm^2 at 27.5GHz and a 15dBi antenna gain.

$= -38.60$ dBm^2 at 40.5GHz and a 15dBi antenna gain.

Power Flux Density: $\mathbf{pfd = P_{rec} - A_e}$

P_{rec} at 18km for 40.5GHz = -137.1dBW/MHz

P_{rec} at 27.5km for 27.5GHz = -137.7dBW/MHz

Therefore Boundary pfd: For 27.5GHz = -102.5dBW/MHz/m^2

For 40.5GHz = -98.5dBW/MHz/m^2

Subscriber Station Interference

A maximum cell size R_{max} ,needs to be determined based upon the parameter values in Annex 1. From the maximum Base Station EIRP, Subscriber Station antenna gain and Nominal subscriber receiver operating level a maximum path attenuation can be calculated.

Maximum Path Attenuation (FSPL + Atmospheric Loss + Rain Fade) = 153dB.

Therefore Maximum Cell Size: R_{max} = 2.6km for 40.5GHz

R_{max} = 4.1km for 27.5GHz

It is assumed that worst case interference occurs when the subscriber station is at the cell edge and looking towards a serving base station at the boundary and beyond to a victim base station located within the neighbouring network by the co-ordination distance.

Therefore worst case distance: For 40.5GHz = 20.6km

For 27.5GHz = 31.6km

Max EIRP = 11.5dBW/MHz, assuming the path in the cell is subject to rain fading, the effective EIRP at the victim is assumed to be reduced by the cell radius multiplied by the rain attenuation figures given in Annex 1.

Interfering Power: $\mathbf{P_{rec} = EIRP_{tx} - FSPL - L_{atmos} + G_{rec}}$

These two figures are both marginally below the Interference limit detailed in Annex 1.

Allowing for the effective EIRP after rain fading, co-ordination distances can be calculated.
Co-ordination Distance: 13km at 27.5GHz
8 km at 40.5GHz

However it is possible that a combination of non direct alignment close to bore-sight and of rain fading not affecting the interference path could cause higher EIRP in the direction of the boundary.

Assuming a maximum EIRP from the subscriber station and a 10° off-boresight angle towards the boundary, then by reference to the antenna pattern referred in Annex 1, the maximum EIRP towards the boundary could be –5.5dBW/MHz.

Therefore **Co-ordination Distance: 16km at 27.5GHz**
10km at 40.5GHz

Annex 4

Useful Background plots

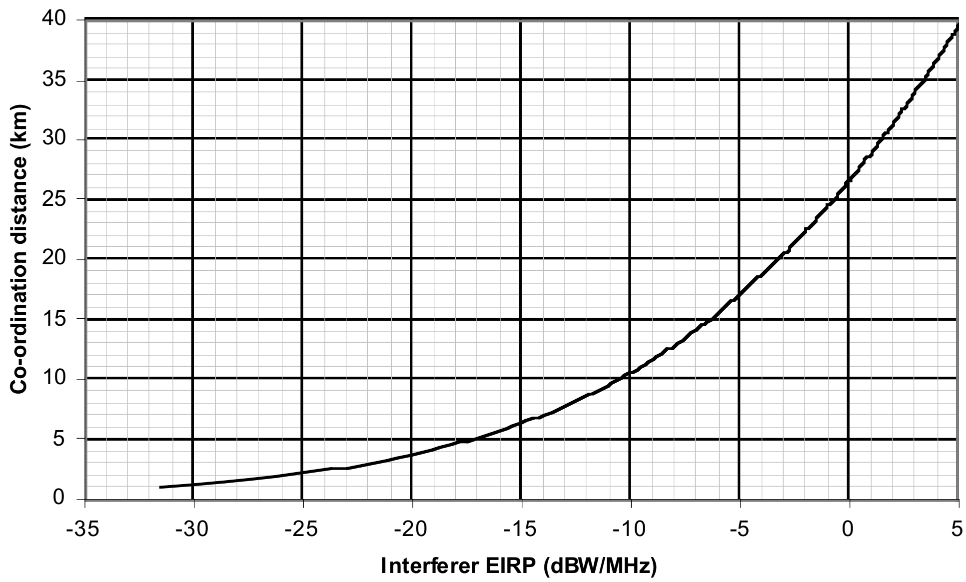

Figure A4.1: Co-ordination distance from service area boundary as a function of transmitter EIRP) at 27.5 GHz

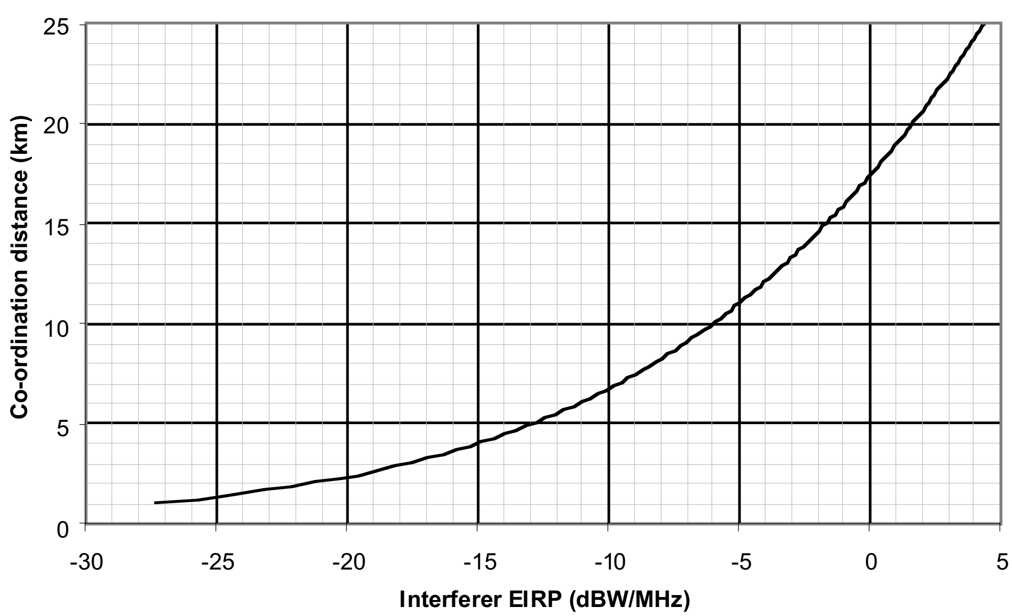

Figure A4.2: Co-ordination distance (from service area boundary) as a function of interferer EIRP) at 40.5GHz

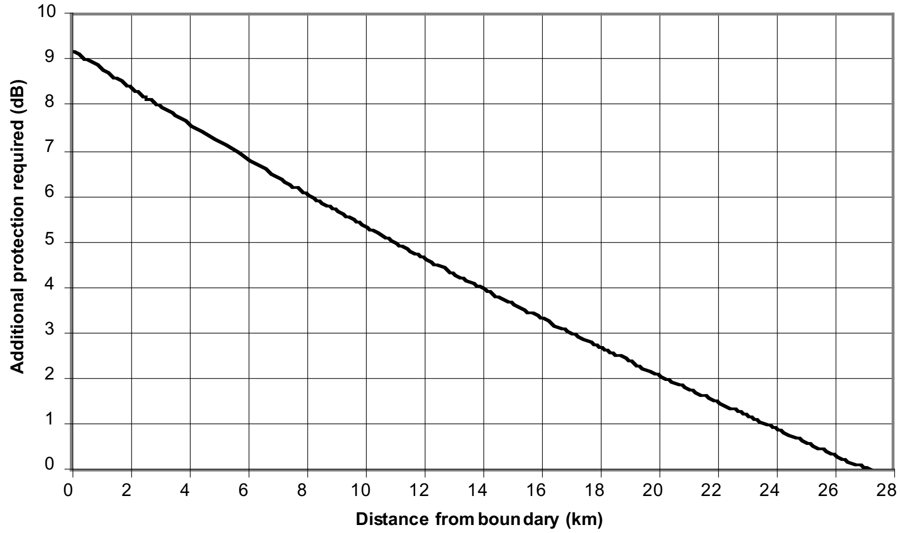

Figure A4.3: **Additional shielding or off-axis discrimination required for base station as a function of distance from service area boundary (28 GHz band)**

Figure A4.4 **Additional shielding or off-axis discrimination required for base station as a function of distance from service area boundary (42 GHz band)**