Project	**IEEE 802.16 Broadband Wireless Access Working Group**
Title	**IEEE 802.16.2, Recommended Practices to Facilitate the Coexistence of Broadband Wireless Access (BWA) Systems: Working Document, Rev. 1**
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Re:	This is a working document leading toward "Recommended Practices to Facilitate the Coexistence of Broadband Wireless Access (BWA) Systems," authorized under IEEE PAR 802.16.2.
Abstract	IEEE 802.16.2, IEEE Recommended Practices to Facilitate the Coexistence of Broadband Wireless Access (BWA) Systems, specifies the design, installation and test parameters for Broadband Wireless Access systems pertinent to coexistence. This document provides coexistence support for systems designed to be compliant with 802.16 standards. The contents follow the outline established at Session #3 (13-17 September 1999). The contents are revised per inputs provided at Session #4 (8-11 November 1999). Changes are in red.
Purpose	This is a working document to be reviewed by 802.16 working group members prior to Session #5 (10-14 January 2000). It will serve as the basis for our discussions at that meeting. It will also be the basis for further development. **This working document has not been approved or voted upon.**
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IEEE 802.16.2, Recommended Practices to Facilitate the Coexistence of Broadband Wireless Access (BWA) Systems

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1. Introduction

This document provides guidelines for minimizing interference in Broadband Wireless Access (BWA) systems. Pertinent coexistence issues are addressed and recommended engineering practices provide guidance for system design, deployment, co-ordination and frequency usage. The document covers the 10 to 66 GHz frequencies in general, but is focused on the range of 20 to 40 GHz.

1.1 Scope

This document provides recommended practices for the design and coordinated deployment of broadband wireless access (BWA) systems to minimize interference so as to maximize system performance and/or service quality. The intent of this document is to define a set of consistent design and deployment recommendations for Broadband Wireless Access (BWA) systems. These recommendations, if followed by manufacturers and operators, will allow a wide range of equipment to coexist in a shared environment with minimum mutual interference. This practice provides recommendations in three specific areas. First, it recommends limits for both in-band and out-of-band emissions from BWA transmitters through parameters including radiated power, spectral masks and antenna patterns. Second, it recommends tolerance levels for certain receiver parameters, including noise floor degradation and blocking performance, for interference received from other BWA systems as well as from other terrestrial and satellite systems. Third, it recommends band plans, separation distances, and power spectral flux density limits to facilitate coordination and to enable successful deployment of BWA systems with tolerable interference. The scope includes interference between systems deployed across geographic boundaries in the same frequency band and systems deployed in the same geographic area in different frequency bands (including different systems deployed by a single license-holder in sub-bands of the licensees authorized bandwidth). The scope does not cover coexistence issues due to intra-system frequency re-use within the operator's licensed band, and it does not consider the impact of interference created by BWA systems on non-BWA terrestrial and satellite systems.

1.2 Assumptions

1.3 Document Organization

1.4 Definitions

For purposes of this document, the following definitions are made:

A. Three frequency ranges are defined.

- Range 1: 10 GHz To 23.5 GHz
- Range 2: 23.5 GHz To 43.5 GHz
- Range 3: 43.5 GHz To 66 GHz

B. ***Occupied bandwidth*** for a single carrier is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5% of the emitted power. This is also known as the 99% bandwidth.

For transmitters in which there are multiple carriers, contiguous or non-contiguous in frequency, the occupied bandwidth is to be the sum of the occupied bandwidths of the individual carriers.

1.5 Medium Overview

1.6 Referenced Standards

2. System Overview

3. Equipment Design Parameters

3.1 Transmitter

3.1.1 Maximum EIRP Spectral Density

These limits apply to the mean EIRP spectral density produced over any continuous burst of transmission. The spectral density shall be assessed with an integration bandwidth of not more than 1 MHz; i.e. these limits apply over any 1 MHz bandwidth.

3.1.1.1 Base Station: 14 dBW/MHz (Frequency Range 23.5 –43.5 GHz)

BWA base stations or hubs conforming to the equipment requirements of this practice shall not produce an EIRP power spectral density exceeding 14 dBW/MHz. These limits apply to the mean EIRP spectral density produced over any continuous burst of transmission. (Any pulsed transmission duty factor does not apply.) The spectral density shall be assessed with an integration bandwidth of not more than 1 MHz; i.e. these limits apply over any 1 MHz bandwidth.

3.1.1.2 Subscriber: 30 dBW/MHz (Frequency Range 23.5 –43.5 GHz)

BWA subscriber stations conforming to the equipment requirements of this practice shall not produce an EIRP spectral density exceeding 30 dBW/MHz. These limits apply to the mean EIRP spectral density produced over any continuous burst of transmission. (Any pulsed transmission duty factor does not apply.) The spectral density shall be assessed with an integration bandwidth of not more than 1 MHz; i.e. these limits apply over any 1 MHz bandwidth.

3.1.1.3 Repeaters

3.1.1.4 Inband Intercell Links

3.1.2 Emissions

3.1.2.1 Spectral Mask – (E. Yurtkuran)

3.1.2.2 In-Block (R. Chan)

3.1.2.3 Out-of-Block (R. Chan)

3.1.2.3.1 Emission Bandwidth

For the purposes of this discussion, the following definition of occupied bandwidth is made:

Occupied bandwidth for a single carrier is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5% of the emitted power. This is also known as the 99% bandwidth.

For transmitters in which there are multiple carriers, contiguous or non-contiguous in frequency, the occupied bandwidth is to be the sum of the occupied bandwidths of the individual carriers.

NOTE: Add figures for clarification in all paragraphs below.

3.1.2.3.1.1 Unwanted emissions

Unwanted emissions comprise of out-of-band emissions (emission on a frequency or frequencies immediately outside the ***occupied*** bandwidth), spurious emissions and harmonics. They are to be measured when the transmitter is operating at the manufacturer's rated power and modulated as in section 6.2. Unwanted emissions are to be measured at the output of the final amplifier stage or referenced to that point. The ***occupied*** bandwidth (B_o) shall be stated in the test report by the certification applicant.

Single-carrier and multi-carrier tests are described below. If multicarrier operations are intended, then both tests are required.

3.1.2.3.1.1.1 Single carrier tests

For the 24 GHz band, testing shall be performed at either blocks B and D or B' and D', depending upon which sub-band the transmitter under test is designed to operate. Likewise, for the 38 GHz band, testing shall be performed at either blocks B and M or B' and M'.

The purpose of specifying the tests at the inner blocks (e.g. block B and not A) is to avoid the attenuating effects of any RF filters that may be included in the transmitter design. Note that although testing is specified for only two blocks (to reduce the number of test runs required) the transmitter is expected to perform similarly for all remaining blocks within the assigned band.

For testing in block B (B'), set the carrier frequency close to the bottom edge, f_L, of block B (B'), record f_L and plot the RF spectrum. Likewise, perform the highest frequency test of block D (D') (in the case of 24 GHz) or block M (M') (in the case of 38 GHz) with the carrier frequency near the upper edge, f_U, of the block.

It is to be noted that the SRSPs permit licensees to have more than one frequency block (Tables 1 and 3) for their systems. Equipment intended to have an occupied bandwidth wider than one frequency block per carrier shall be tested using such a wideband test signal for the section 6.3.3(1) requirement.

For the 28 GHz band (25.35-28.35 GHz), the single carrier test is performed in a similar manner as above, with the exception that, for test purposes, the lower and upper edges of the carrier must be offset a minimum of 40 MHz from the lower and upper edges of the assigned band. The purpose of the 40 MHz minimum offset is to avoid the attenuating effects of any RF filters.

3.1.2.3.1.1.2 Multi Carrier tests

This test is applicable for multi-carrier modulation. It applies equally to multi-transmitters into a common power amplifier. Note that the multi-carrier transmitter must be subjected to the single carrier testing, described above, in addition to the tests specified below.

For multi-carrier testing, the single carrier test method of 6.3.1 can be used except that the single carrier is replaced by a multi-carrier modulated signal that is representative of an actual transmitter. The number of carriers should be representative of the maximum number expected from the transmitter, and be grouped side by side near the lower end of the assigned band (in the case of the 28 GHz band) or block B (in the case of the 24 and 38 GHz bands), with guardbands, f_{LG} and f_{UG} (lower and upper guardband respectively), if required by the design of the equipment. Likewise test near the upper edge of the assigned band or top blocks (D' or M'). Record their spectrums, the number of carriers used and the guardband sizes ($f_{LG,}$ f_{UG}). The guardband is the frequency separation between the edge of the assigned band and the edge of the occupied emission.

The user manual shall contain instructions, such as details on the minimum guardband sizes required and the maximum number of carriers or multi-transmitters permitted, to ensure that the radios remain compliant to the certification process.

3.1.2.3.1.1.3 Minimum standard

Unwanted emissions spectral density shall be attenuated by A (dB) below the total mean output power as follows:

(1) For a single carrier transmitter (see section 3.1.2.3.1.1.1) :

In any 1.0 MHz reference bandwidth, outside the assigned band/channel block, and removed from the identified edge frequency of the occupied emission by up to and including $\pm$200% of the ***occupied*** bandwidth (i.e. 2 B_o): at least $A = 11 + 40\ f_{offset}/B_o + 10 \log_{10} (B_o)$, dB, where B_o is in MHz and f_{offset} = frequency offset from the edge of the occupied bandwidth.

Attenuation greater than 56 + 10 $\log_{10}(B_o)$, dB, or to an absolute level lower than -43 dBW/MHz, is not required. For emissions in which the occupied bandwidth is less than 1 MHz, the required attenuation is to be calculated using A= 11 + 40 f_{offset}/Bo , dB.

(2) For a multi-carrier transmitter or multi-transmitters into a common final stage amplifier (see section 3.1.2.3.1.1.2):

The mask is to be the same as in (1), using the ***occupied*** bandwidth that is defined for multi-carrier transmitters in section 5.6.1. The total mean power is to be the sum of the individual carrier/transmitter powers. Guardbands if used in the equipment design must also be used in testing the spectrum mask.

Note: Several transmitters into a common non-active antenna cannot use the multi-carrier mask for the composite signal. In this case the appropriate mask applies to the individual transmitter.

(3) In any 1.0 MHz band which is removed from the identified edge frequency by more than ±200% of the **occupied** bandwidth : at least 43 + 10 $\log_{10}(P_{mean})$ dB (i.e. –43 dBW), or 80 dB below P_{mean}, whichever is less stringent. P_{mean} is the mean output power of the transmitter (or, in the case of multi-carriers/multi-transmitters, the sum of the individual carrier/transmitter powers) in watts.

The search for unwanted emissions shall be from the lowest frequency internally generated or used in the device (local oscillator, intermediate or carrier frequency), or from 30 MHz, whichever is the lowest frequency, to the 5th harmonic of the highest frequency generated or used, without exceeding 40 GHz.

3.1.2.4 Out of licensed band: wideband TX noise, spurious, regulatory limits (R. Chan, L Langston)

3.1.3 Frequency Stability +/- 10 PPM (Keith Doucet)

The system must operate within a frequency stability of +/- 10 parts per million over a temperature range for which the equipment is designed to operate. (**NOTE**: This specification is only for the purposes of complying with ***coexistence*** requirements. The stability requirements contained in the PHY specifications may be more stringent.) NOTE: It is highly recommended that the CPE transmit frequency be controlled by using a signal from the downstream signal(s).

The RF frequency should be measured:

(a) at temperatures of [TBD] °C at the manufacturer's rated supply voltage. The frequency stability can be tested to a lesser temperature range provided that the transmitter is automatically inhibited from operating outside the lesser temperature range. If automatic inhibition of operation is not provided, the manufacturer's lesser temperature range intended for the equipment is allowed provided that it is specified in the user manual.

(b) at 85% and at 115% of rated supply voltage, with temperature at +20 °C .

Minimum Standard:

The RF carrier frequency shall not depart from the reference frequency (reference frequency is the frequency at 20°C and rated supply voltage) in excess of ± 10 ppm.

In lieu of meeting the above stability value, the test report may show that the frequency stability is sufficient to ensure that the occupied bandwidth emission mask (see section 3.1.2.3.1.1) stays within the licensee's frequency band, when tested to the temperature and supply voltage variations specified above. The emission tests shall be performed using the outermost assignable frequencies which shall be stated in the test report.

3.1.4 Upstream Power Control (**H. Sandler,)**

[BWA subscriber stations conforming to the equipment design parameters of this practice shall not transmit an EIRP spectral density of more than 15 dBW/MHz under unfaded conditions (conditions where the propagation loss is close to free-space). This requirement is met if the maximum EIRP spectral density produced by the equipment is always less than 15 dBW/MHz, or it may be met by employing adaptive transmit power control to reduce EIRP spectral density below this limit during unfaded conditions.]

The task group recommends that a table of rainfall attenuation as a function of frequency be developed and inserted. In addition, different C/I requirements should be taken into consideration. In general, this section will be re-worked.

3.1.5 Downstream Power Control

3.1.5.1 Rain Effects

3.1.5.2 Clear Air Effects

3.2 Receiver

3.2.1 Selectivity (Keith Doucet)

One receiver selectivity profile which covers image rejection, IF selectivity, baseband selectivity, etc.

Task group reviewed Keith's submission, and agreed that it was a good start, but (with Keith's concurrence) felt that the section should be expanded.

3.2.1.1 Base Station

3.2.1.2 Subscriber

3.2.2 Linearity (Reza)

Reza presented contribution on linearity. Task group recommended not making linearity an explicit requirement within the practice. Use only reduction in receiver threshold as the metric. However, linearity is one parameter that contributes to this figure of merit. Further discussion is needed.

3.2.2.1 Base

3.2.2.2 Subscriber

3.3 Antenna (**Reza,**)

The general approach described below was agreed upon. However, the task group did not agree with the proposed mask for the subscriber antenna—too tight on main beam/first sidelobe transition. The mask will be reviewed, and members will provide additional contributions.

3.3.1 Overview

Antenna design challenges vary from one frequency range to another. While achieving a certain level for a parameter might be easy at lower frequencies, it might prove to be difficult at higher frequencies or vice versa. Also, the number of coexisting systems varies from one frequency band to another. The amount of interference pollution, therefore, varies across the broad frequency range of interest of 802.16. Having said the above, in order to come up with antenna requirements for a more or less homogeneous environment, three frequency ranges are defined.

- Range 1: 10 GHz To 23.5 GHz
- Range 2: 23.5 GHz To 43.5 GHz
- Range 3: 43.5 GHz To 66 GHz

Most of the BWA systems will operate within the Range 2. Therefore, Range 2 is the focus of the Coexistence Task Group and this document.

3.3.1.1 Antenna Classes

There are various classes of antennas. The performance of the antenna can be divided into three classes. Depending on the performance and the type of environment the antennas will be operating in, antennas are divided into electrical and mechanical classes. These classes help service providers is selection of antennas that are just right for the deployment environment without the excess cost of unnecessary high-performance antennas if the interference environment is a benign one.

In each of the three frequency ranges mentioned above, antennas are divided into three classes with respect to electrical performance. The main factor distinguishing among classes is the level and severity of interference in the environment. It should be noted here that the final decision on the selection of an antenna class is for the service provider to make. The following are only recommended guidelines.

3.3.1.1.1 Electrical Class 1

Class 1 antennas are meant for operation in environments in which interference levels are insignificant. This could be due to many factors including

- absence of coexisting systems in the same geographical area
- conservative reuse creating a benign self-interference environment
- coexisting systems being far enough such that the power spectral density flux density resulting from those systems is negligible

In such conditions, less complicated, low-cost antennas with minimum requirements specified in this document could be deployed.

3.3.1.1.2 Electrical Class 2

Class 2 antennas are meant for operation in environments in which interference levels could be potentially significant and cause problems under certain conditions. Factors contributing to the interference being upgraded from insignificance (in case of class 1) to potentially significant (in case of class 2) are:

- Existence of at least one coexisting system in the same geographical area
- A reuse pattern which may cause self-interference problems in certain areas
- Proximity of coexisting systems such that the interferers' power spectral density flux density is not negligible.

In such conditions, antennas with higher levels of discrimination in side lobes and back lobes need to be deployed to guarantee the acceptable performance of the system.

3.3.1.1.3 Electrical Class 3

Class 3 antennas are meant for operation in environments in which interference levels are highly significant. Factors contributing to highly significant interference are

- Existence of several coexisting systems in the same geographical area
- Aggressive reuse pattern which creates significant self-interference levels throughout the network
- Extreme proximity to a coexisting system, e.g. adjacent cells.

In such conditions, highly efficient antennas with optimum pattern and very low side lobes and high front-to-back ratio need to be deployed to guarantee the performance of the system.

3.3.1.1.4 Mechanical Classes

In order to capture the environmental effects on antennas and their performance while operating within a BWA network, two mechanical classes are proposed. These two classes are heavy duty and normal duty. The use of high-gain, pencil-beam subscriber antennas at rooftops creates a unique situation in regard to vibrations and lateral movements of the antenna structure due to wind. Half a degree deviation from the orientation set by network planners could potentially lead to several dB losses in signal strength. However, while hurricane-prone areas require heavy-duty antenna systems, other areas could benefit from cheaper, normal-duty antennas.

3.3.2 Base Station (J. Holyoak)

3.3.3 Subscriber (Reza)

3.4 Other

3.4.1 EMI/EMC Parameters (Leland)

4. System Design

4.1 Receiver Sensitivity Degradation Tolerance => 1dB over No (Related to I/N) (Reza)

4.2 Subscriber TX lock to prevent transmissions when no received signal present -Erol

4.3 Fail-safe mechanisms for excessive frequency error, etc. (list of parameters) Leland

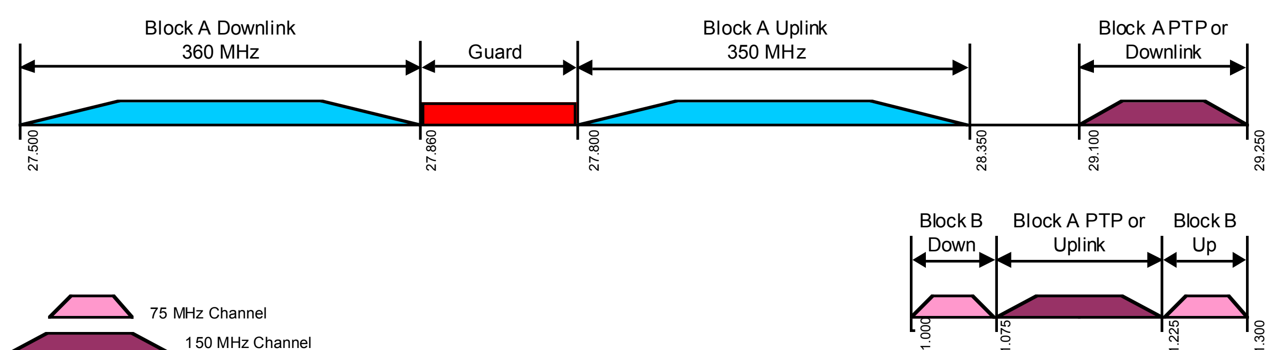
5. Propagation Model (B. Meyers, H. Sandler

6. Interference Scenarios (H. Sandler, J. Garrison, Remi Chayer

7. Frequency Plans (J. Garrison, B. Meyers, Remi Chayer Leland

7.1 Band Plans

The following reference band plan will be used for coexistence for the US LMDS band.



802.16 LMDS A and B

- Within the 27.5 to 28.35 GHz band, no FDD downstream transmitters will radiate more than -30 dBm/MHz power above 27.925 GHz and no upstream FDD transmitters will radiate more than -30 dBm/MHz power below 27.925 GHz.

- Within the 27.5 to 28.35 GHz band, the FDD BST output power into the antenna shall be less than or equal to -40 dBm/MHz above 27.925 GHz
- Within the 27.5 to 28.35 GHz band, the FDD CPE output power into the antenna shall be less than or equal to -70 dBm/MHz below 27.925 GHz
- Within the 27.5 to 28.35 GHz band, no FDD system BST will transmit on frequencies greater than 27.925 GHz
- Within the 27.5 to 28.35 GHz band, no FDD system CPE will transmit on frequencies below 27.925 Ghz
- For FDD systems, Block B downstream is 31.0 to 31.075 GHz and upstream is 31.225 to 31.3 GHz for BST to CPE systems
-

There was some opposition to the proposed band plan. In particular, one proposal for an FDD implementation is to **reverse** the upstream/downstream bands. Further discussion is needed.

7.2 Minimum TX/RX Frequency Separation

7.3 IFL Interference (J. Van der Star)

The task group felt that the proposed approach was a good start, but further development was needed before any recommendation could be considered. Also, the task group made specific recommendations: interference should address baseband and IF interference and coexistence issues; a power spectral density profile be defined to be used as an interference susceptibility guideline; the practice be written around performance guidelines and not specific implementations.

8. Deployment & Co-ordination (R. Chan, J. Garrison, G. Robbinson, K. Doucet, R. Chayer)

The task group agreed that the following process is acceptable, but that the process flow chart presented earlier by R. Chan be inserted.

8.1 Co-ordination Process

8.1.1 Coordination Distance [co-channel & adj channel) Keith Doucet

Distance is used as the first trigger mechanism for coordination between adjacent licensed operators. If he boundary of two service areas is within 60 km of each other, then the coordination process is invoked. Refer to Annex A [Canadian paper on coordination] for a detailed description of the process.

A distance of 60 km is used based upon several considerations including radio horizon calculations and propagation effects. The radio horizon is defined as:

$$R_h = 4.12(\sqrt{h_1} + \sqrt{h_2})$$

where:

R_h = Radio Horizon (km)

h_1 = Height of radio 1 above clutter (m)

h_2 = Height of radio 2 above clutter (m).

The table below presents the horizon range for different radio heights above average clutter.

Table XX. Horizon range for different radio heights (in kilometers).

	Height of Radio 1 (m)								
Height of Radio 2 (m)	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*
10	*26*	*31*	*36*	*39*	*42*	*45*	*47*	*50*	*52*
20	*31*	*37*	*41*	*44*	*48*	*50*	*53*	*55*	*58*
30	*36*	*41*	*45*	*49*	*52*	*54*	*57*	*59*	*62*
40	*39*	*44*	*49*	*52*	*55*	*58*	*61*	*63*	*65*
50	*42*	*48*	*52*	*55*	*58*	*61*	*64*	*66*	*68*
60	*45*	*50*	*54*	*58*	*61*	*64*	*66*	*69*	*71*
70	*47*	*53*	*57*	*61*	*64*	*66*	*69*	*71*	*74*
80	*50*	*55*	*59*	*63*	*66*	*69*	*71*	*74*	*76*
90	*52*	*58*	*62*	*65*	*68*	*71*	*74*	*76*	*78*

The worst case interference scenario involves two base stations, as they are typically located on relatively high buildings/infrastructures and hence have greater radio horizon distances. A typical height for a base station is 65 m above ground level, or 55 m above clutter, assuming an average clutter height of 10 m. This produces a radio horizon of 60 km. There will be cases where the base station equipment may be located on higher buildings which would produce a greater radio horizon. However, these base stations tend to tilt their antennas downward which effectively reduces the amount of power (interference) that can be directed towards the adjacent base station. The next section examines power levels in more detail.

8.1.2 Use power spectral flux density KeithDoucet

This section addresses the maximum power flux density that can be tolerated as a result of co-channel interference originating from an adjacent licensed operator. The amount of interference generally considered acceptable or tolerable is one which produces a degradation of 0.5 dB to the system's C/N (this degradation is usually taken into consideration in the link budget analysis). For the noise floor to increase by 0.5 dB, the interference power level must be 6 dB below the receiver's thermal noise floor. Assuming a typical receiver noise figure of 6 dB, then the thermal noise power spectral density of the receiver is calculated as follows:

$$N_o = 10Log(kT_o) + N_F$$
$$N_o = -144 + 6 = -138 \text{ dBW/MHz}$$

where,

No = Receiver thermal noise power spectral density (dBW/MHz)
kT_o = Equipartition Law (-144 dBW/MHz)
N_F = Receiver noise figure (6 dB)

At 6 dB below N_o, the interference power level (I_{tol}) into the receiver is -144 dBW/MHz (-138 – 6).

The spectral power flux density (pfd) at the antenna aperture is calculated as follows:

$$pfd = \frac{\Pr}{Ae} = \frac{\Pr}{\lambda^2 \frac{G}{4\pi}} = \Pr - 10Log(\lambda^2) - G + 10Log(4\pi)$$

where:

Pr = interference power level into receiver (-144 dBW/MHz)
Ae = effective antenna aperture
λ = wavelength
G = antenna gain.

Assuming an operating frequency of 28 GHz (λ=.011m) and a typical base station antenna gain of 20 dBi, then the tolerable interference level is given as:

Pfd_{BTS} = -144 - 10Log($.011^2$) – 20 + 10 Log(4π) = -144 + 39 – 20 + 11 = -114 dBW/MHz-m^2

Note that the base station receiver is considered only in this analysis (not the subscriber). This is primarily due to the fact that BTS' are typically located on high buildings/structures with omni directional coverage which tend to increase their probability of achieving line of sight (LOS) to adjacent licensed area transmitters. Subscribers, on the other hand, tend to be situated at low altitudes (~15 m) which significantly reduces the probability of LOS (due to obstacles/clutter) to adjacent area systems. Furthermore, subscribers have highly directional antennas (narrow beamwidths) which further reduces the probability that they will align with an interference source from an adjacent area.

The –114 dBW/MHz-m^2 represents the first PFD trigger level of the coordination process described in Annex A [Canadian paper on coordination].

A sample calculation is given below to determine the feasibility of meeting the pfd limit described above. The formula for pfd is as follows:

$$pfd_{victim} = P_{TX} + G_{TX} - 10\log(4\pi) - 20\log(R) - A_{losses}$$

where;

P_{TX} = transmitter power (- 25 dBW/MHz)
G_{TX} = transmitter antenna gain in the direction of the victim receiver (18 dBi)
R = range (60000 m)
A_{losses} = atmospheric losses, ~ 0.1 dB/km

Using the radio horizon range of 60 km from above, the pfd at the victim base station receiver antenna is:

$$pfd_{victim} = -25 + 18 - 10\log(4\pi) - 20\log(60000) - 60*.1$$
$$= -120 \text{ dBW/MHz-m}^2$$

The –120 value is much lower than the –114 tolerable level, therefore, the 60 km range is considered reasonable as a first level trigger point. Note that the above pfd calculation assumes free space propagation and clear line of sight, i.e. complete first Fresnel zone clearance. In reality, partial penetration of the Fresnel zone at these distances will occur which will introduce as much as 6-15 dB of extra attenuation to the interfering signal towards the victim receiver, thus reducing the range at which potential interference can occur.

8.2 Mitigation Leland

8.2.1 Antennas

8.2.2 Shielding

8.2.3 Frequency

8.2.4 Spatial Separation

Appendix A - Test and Measurement / Hardware parameter summary

Appendix B – Spatial Separation Details

Appendix C - Glossary