Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Calculation of Interference between Co-existing Multi-radio Systems and Their Required Minimum Separation Distance**
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Re:	PHY: Multi-Radio Coexistence; in response to the TGm Call for Contributions and Comments 802.16m-08/033 for Session 57
Abstract	This contribution proposes for calculation of interference between ~~the~~ co-existing multi-radio systems and their required minimum separation distance
Purpose	To be discussed and adopted by TGm for the 802.16m SDD.
Notice	
Release	
Patent Policy	

Calculation of Interference between Co-existing Multi-radio Systems and Their Required Minimum Separation Distance

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1. Introduction

In this contribution we study the interference between the IEEE 802.16m system and other system and determine their required minimum separation distance for allowed interference level. Due to the rapid development of communication technologies, communication systems to meet various requirements have been developed and produced. Each system has its own working frequency and bandwidth, various systems with close working frequencies may be unable to operate in normal fashion due to the mutual interference; therefore the study of interference effect has been continuously proposed and the determination of minimum separation distance between close communication systems is one of the important issues in the study.

2. Determination of Minimum Separation Distance

2.1 System Spectrum Distribution and Interference Evaluation

In the evaluation of frequency sharing, it is based on the permitted interference level at the antenna terminal of the interfered or victim system. In order to ensure satisfactory co-existence of the 802.16m system and other system, it is important to be able to predict the interference level between these two systems to reasonable accuracy. Various prediction processes and models have been discussed, proposed and accepted by international communication organizations; and can be utilized in the prediction of interference between systems. ITU-R Recommendation P.452-8 [2] that has been accepted and adopted by ITU and CEPT is an evaluation model to assess the interference on the radio systems at microwave frequencies.

The required minimum attenuation loss, in dB, of the interfering system on the victim system can be determined from the following equation [3]:

$$L_{\min} = P_t + G_t + G_r + L_r - I_{\max} \qquad (1)$$

P_t: the transmit power of the interfering system in the reference bandwidth, in dBW
G_t: the transmitter antenna gain of the interfering system, in dBi
G_r: the receiver antenna gain of the victim receiver, in dBi
L_r: Power loss of the interfering signal
I_{max}: Maximum permissible interference power

The interfering signal power loss L_r for the 802.16 m interfering system can be derived through a power spectral density of the 802.16 m system. Assume the 802.16m system has N sub-carriers with rectangular pulse; its power spectral density can be expressed as:

$$S_S(f) = \sum_{i=0}^{N-1} \frac{P_s}{R_s} sinc^2(\frac{f}{R_s} - i) \quad (2)$$

where P_s is the power of a single 802.16m sub-carrier and R_s is the sub-carrier frequency spacing and $\sin c(x) = \sin(\pi x) / \pi x$.

Assume the other system has a rectangular power spectral density as:

$$S_v(f) = \frac{P_v}{W_v} rect(\frac{f}{W_v}) \quad (3)$$

where P_v and W_v are the transmitting power and the bandwidth of the other system.

In the following it shows the spectrum overlapping of the 802.16m and the other systems, where the bandwidth W_v is assumed to be greater than the bandwidth of the 802.16m system.

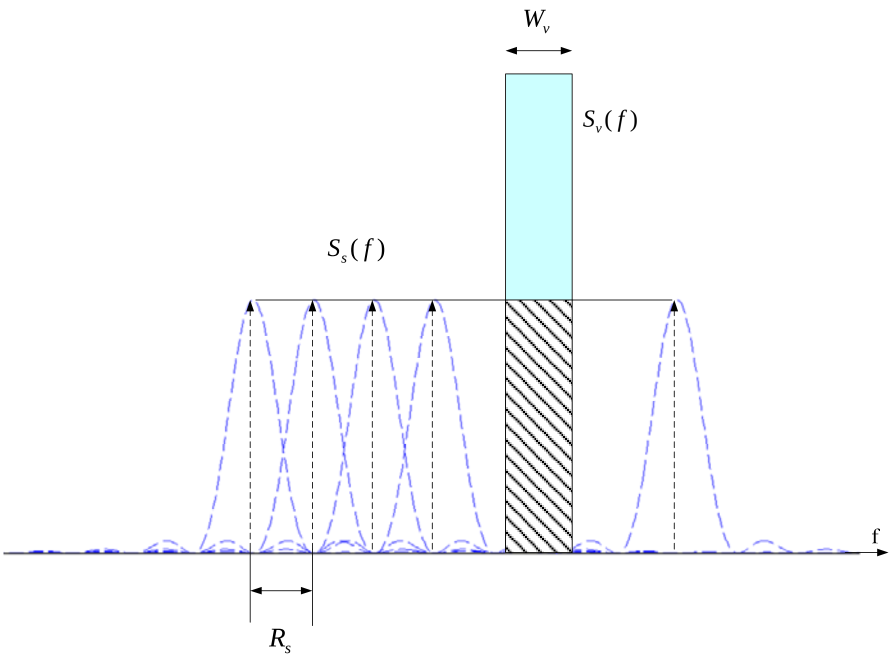

Fig. 1 PSD of 802.16m interferer overlapping PSD of other system

The interfering signal power attenuation can be expressed by the spectrum overlapping ratio as:

$$L_r = 10 \log_{10} \left(\frac{\int_{f_c - W_v/2}^{f_c + W_v/2} S_s(f) df}{P_t} \right) \quad (4)$$

2.2 The Prediction of Minimum Separation Distance

From the predicted interfering signal power attenuation loss as derived in the above, the antennas gains of the interfering and the victim systems it can determine the minimum separation distance required between systems to ensure their co-existence with proper system performance.

The free space path loss can be found from the following equation:

$$L_{\min}(path\,loss) = -10\log\left(\frac{\lambda^2}{((4\pi)^2 d^2)}\right) = -10\log\left(\frac{(\frac{c}{f})^2}{((4\pi)^2 d^2)}\right) \qquad (5)$$

where c is the light velocity in meter, f is the system's center frequency ($f = f_c$) and d is the distance in meter.

By using the derived equations (1) – (5) we list in the following the simulation results of the minimum required separation distance between these two systems when the interfering signal power varies from 0 dBW to 17 dBW. In the simulation it assumes that it has cluster loss of 20 dB in the communication path and it has return loss of 70 dB or 50 dB on the transmitting and receiving antenna.

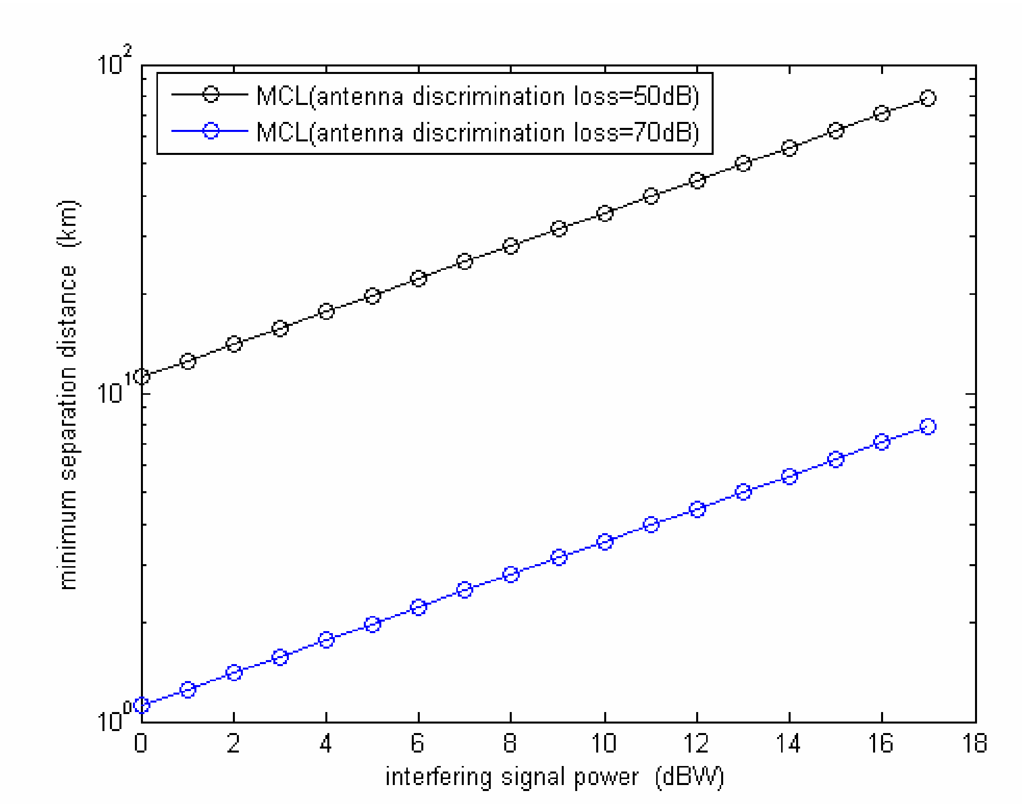

Fig. 2 Minimum Separation Distance (clutter loss=20dB)

The parameters used in the simulations are listed in the following table

Spectrum parameters of 802.16m system	
P_t	0~17dBW
P_s	(Pt/1024) W
R_s	10.24kHz
N	1024
Parameters for L_r Calculation	
f_c	2500 MHz
W_v	40 MHz
Parameters for $L_{\min}$ Calculation	
G_t	14.5dBi
G_r	42.5dBi
$I_{\max}$	-140.5 dBW/40MHz

Text Proposal for the 'Multi-Radio Coexistence'

===================*Start of Proposed Text*======================

17 Solutions for Co-deployment and Co-existence

17.x Determination of Minimum Separation Distance between Two Systems

17.x.1 System Spectrum Distribution and Interference Evaluation

In the evaluation of frequency sharing, it is based on the permitted interference level at the antenna terminal of the interfered or victim system. In order to ensure satisfactory co-existence of the 802.16m system and other system, it is important to be able to predict the interference level between these two systems to reasonable accuracy. Various prediction processes and models have been discussed, proposed and accepted by international communication organizations; and can be utilized in the prediction of interference between systems.

17.x.2 The Prediction of Minimum Separation Distance between Two Systems

From the predicted interfering signal power attenuation loss as derived in the above, the antennas gains of the interfering and the victim systems it can determine the minimum separation distance required between systems to ensure their co-existence with proper system performance.

===================*End of Proposed Text*======================

References

[1]. CEPT ERC Report 101: ‘A comparison of the minimum coupling loss method, enhanced minimum coupling loss method, and the Monte-Carlo simulation’, May 1999

[2]. ITU-R Recommendation P. 452–8: ‘Prediction procedure for the evaluation of microwave interference between stations on the surface of the earth at frequencies above about 0.7 GHz’

[3]. W.G Chung, et al,” Advanced MCL method for Sharing Analysis of IMT-advanced System”, *Electronic Letters*, 12th October, 2006, Vol. 42, No.21.