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Analysis on WiBro Interfering to WLAN under Co-channel in TV White Spaces

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Abstract

Co channel interference and adjacent channel interference of (WiBro) into Wireless LAN (WLAN) in TV White Spaces (TVWS) is evaluated through Spectrum Engineering Advanced Monte Carlo Analysis Tool (SEAMCAT) based on the Monte-Carlo simulation method. As a result, in the case of co channel interference, the minimum distance between WiBro Mobile Station (MS) and WLAN User Equipment (UE) should be 210 m to allow the maximum transmitter power of WiBro UE of 25 dBm. The transmit power of WiBro BS have to be reduced to -4.96 dBm.

Keywords: *WiBro, WLAN, TVWS, SEAMCAT, Guard band*

1. Introduction

An important benefit of the switch to all-digital broadcasting is that it freed up parts of the valuable broadcast spectrum for public safety communications (such as police, fire departments, and rescue squads) and applications on an unlicensed, such as Wi-Fi in TV White Spaces (TVWS). Also, some of the spectrum can now be auctioned to companies that will be able to provide consumers with more advanced wireless services [1]. WLAN is assumed to operate at 481 MHz. And WiBro is assumed to operate at co channel with WLAN or adjacent channel to WLAN. Based on previous assumptions, WLAN and WiBro potentially interfere with each other. This paper only analyzes WiBro interferers with WLAN, two scenarios will be analyzed as following: scenario1: WiBro mobile station (MS) interferes into WLAN user equipment (UE). scenario2: WiBro BS interferes into WLAN UE. Therefore, protection distance between WLAN UE and WiBro MS, the maximum allowable transmit power of WiBro MS and BS and guard band are respectively analyzed by using Spectrum Engineering Advanced Monte Carlo Analysis Tool (SEAMCAT)

2. System Descriptions

2.1 A. WLAN

A WLAN typically extends an existing wired local area network. WLANs are built by attaching a device called the access point (AP) to the edge of the wired network. Clients communicate with the AP using a wireless network adapter which is similar in function to a traditional Ethernet adapter.

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Table 1. Main parameters of WLAN

Parameter	Value	Units
Frequency	185/481 /687	MHz
Reception Bandwidth	22	MHz
Receiver Sensitivity	-55.33	dBm
Interference Criteria(C/I)	10	dB
Noise Floor	-90.41	dB
Antenna Height	Rx 1.5/Tx 2.5	m
Antenna Azimuth	0~360	Degree
Antenna Peak Gain	6	dBi
Antenna Pattern	Omni-directional	
Output Power	23	dBm

WLANs are built by attaching a device called the access point WLANs are being widely used in private home, business and hotspots (such as coffee shop, conference and airport,etc.). Main parameters of WLAN are summarized in Table 1 [3]. Blocking response of WLAN receiver is summarized in Table 2 [4].

Table 2. Blocking response

Frequency offset [MHz]	Attenuation [dBr]
±11	0
±25	38
±50	53
>50	63

2.2 B. WiBro

WiBro is the Korean service name for IEEE802.16e international standard. Comparing to WLAN, WiBro supports mobility up to walking speed and vehiclespeed and wider coverage. Main parameters of WiBro are assumed in Table 3.

Table 3. Main parameters of WiBro

Parameter	Value	Units
Frequency	Co/adjacent channel with WLAN	MHz
Bandwidth	10	MHz
Base station(BS)		
Transmit power	33	dBm
Antenna height	30	m
Mobile Stations (MS)		
Transmit power	25	dBm
Antenna height	1.5	m
Noise floor	-107	dBm/MHz
Noise Figure	7	dB
S/N	9.4	dB
Sensitivity	-90.6	dBm

Spectral mask for WiBro MS is summarized in Table 4 [5].

Table 4. WiBro MS spectral mask @Pout=25dBm

Frequency offset [MHz]	Attenuation [dBc]	Reference Bandwidth [kHz]
-5~+5	0	10000
±5.45	-36	100
±10.9	-42	100
±15.12	-48	100
±20.26	-52	100
±80 assumed	-82	100

Spectral mask for WiBro BS is summarized in Table 5 [6].

Table 5. WiBro BS spectral mask

Frequency offset from centre	Allowed emission level	Measurement bandwidth
5 ≤ Δf< 6 MHz	−13 dBm	100 kHz
6 ≤ Δf< 25 MHz	−13 dBm	1 MHz
25 ≤ Δf< 70MHz (assumed)	−28 dBm	1 MHz

3. Scenarios of WiBro Interfering with WLAN and Methodology

Indoor deployment environment in urban is chosen and two scenarios will be assumed subsequently:

Scenario 1: WiBro MS interferes with WLAN UE. This scenario is further divided into two scenarios which are illustrated in Figure 1 and Figure 2, respectively.

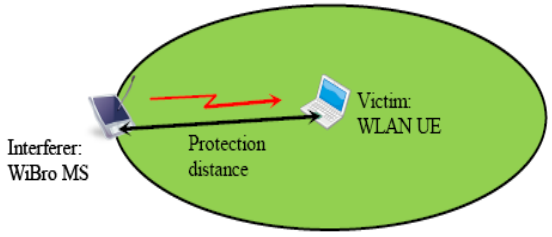

Figure 1. Scenario of single WiBro MS interferences with WLAN UE

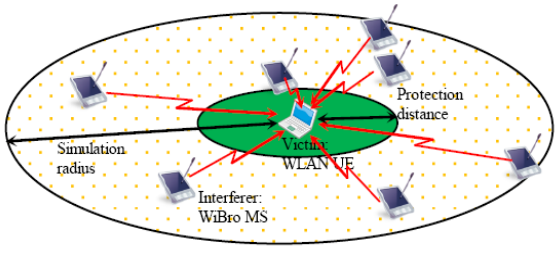

Figure 2. Scenario of multiple WiBro MSs interfere with WLAN UE

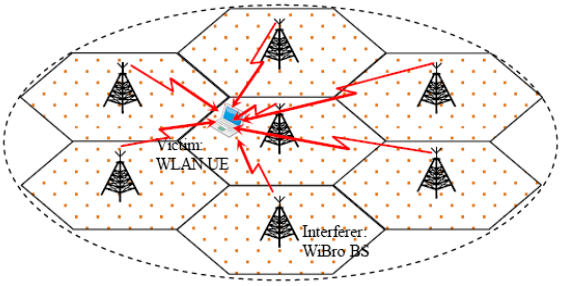

Figure 3. Scenario of multiple WiBro BS interfere with WLAN UE

SEAMCAT based on the Monte-Carlo simulation method permits statistical modeling of different radio interference scenarios for performing sharing and compatibility studies between radio communications systems in the same or adjacent frequency bands. Basic methodology of SEAMCAT is briefly explained as following [7]:

The criterion for interference to occur is for the victim receiver (Vr) to have a carrier to interference ratio (C/I) less than the minimum allowable value. In order to calculate the victim's C/I, it is necessary to establish the victim's wanted signal strength/dRSS corresponding to the C, as well as the interfering received signal strength (iRSS) corresponding to the I. Figure 4 illustrates the various signal levels. Figure 4 (a) represents the situation when there is no interference and the victim is receiving the desired signal with wanted signal margin.

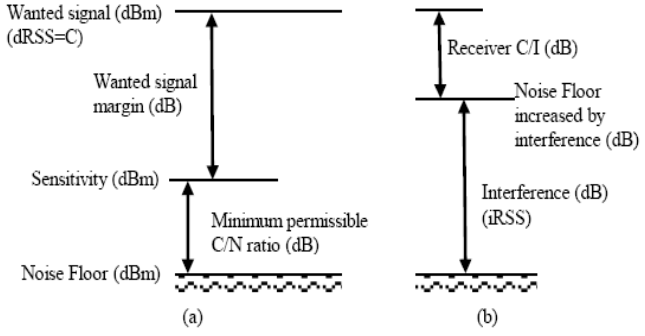

Figure 4. The signal levels used to determine whether or not interference is occurring

Figure 4 (b) illustrates what happens when interference occurs. The interference adds to the noise floor. The difference between the wanted signal strength and the interference signal is measured in dB, which is defined as the Signal to Interference ratio. This ratio must be more than the required C/I threshold if interference is to be avoided. The Monte Carlo simulation methodology is used to check for this condition and records whether or not interference is occurring.

4. Simulation Results and Analysis

Propagation model for different links are separately assumed as follows: Extended Hata SRD model for victim link WLAN (Wt: Wanted transmitter ->Vr: Victim receiver), Extended Hata is for interfering link WiBro (It: Interfering transmitter ->Wr: Wanted receiver) and Extended Hata SRD model for interference link （It: Interfering transmitter ->Vr: Victim receiver）. On the basis of previously introduced system parameters, interference scenarios and interference probability of 5% blow is chosen as an acceptable level for performance requirement of WLAN, co channel and adjacent channel interferences from WiBro to WLAN UE will be evaluated in SEAMCAT, respectively.

-Co channel interference

In the scenario of co channel interference from WiBro to WLAN UE, WiBro and WLAN operating at the same frequency of 481 MHz is assumed. And then, the protection distance between WiBro MS and WLAN UE and the maximum allowable transmit power of WiBro MS and BS will be evaluated.
In case of single WiBro MS interfering into WLAN UE, according to the specified transmits power of WiBro MS of 25 dBm, the protection distance between WiBro MS and WLAN UE is evaluated to meet the acceptable interference probability of 5%. The relationship between interference probability of WiBro MS interfering with WLAN UE and the protection distance between WiBro MS and WLAN UE is obtained in Figure 5.

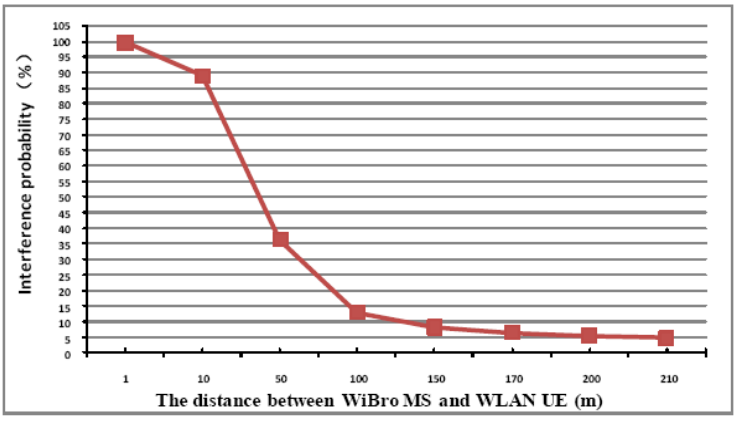

Figure 5. Interference probability vs. the distance between WiBro MS and WLAN UE

Figure 5 shows if the specified WiBro MS transmit power of 25 dBm is used, the protection distances between WiBro MS and WLAN UE is supposed to be more than 210 m corresponding to 481 MHz.

In addition, according to different required protection distances between WiBro MS and WLAN UE, the corresponding maximum allowable transmit power of WiBro MS can be figured out through simulation.

5. Conclusion

The interference situation from WiBro to WLAN in TVWS was taken into account in this study. In co-channel interference case, the minimum distance between WiBro ME and WLAN UE should be 210 m if the maximum transmitter power of WiBro UE of 25 dBm is specified. However, the transmit power of WiBro BS is reduced to -4.96 dBm. In the case of adjacent channel interference, the guard band should be at least 20 MHz if WiBro adopts TDD (Time Division Duplexing) for duplexing. If WiBro uses FDD (Frequency Division Duplexing) for duplexing, the guard band between WiBro Up link and WLAN should be at least 4 MHz, and the guard band between WiBro Down link and WLAN should be at least 20 MHz. Analysis results of this paper can provide reference and guideline to make spectrum plan for deploying WiBro and WLAN in TVWS.

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