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통신 시스템간 채널 공유를 위한 특성 분석

Analysis on Characteristics for Sharing Co-channel between Communication Systems

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요 약 본 논문은 채널 공유를 위한 기준 간섭확률 대비 두 시스템인 WiBro 와 WLAN간의 이격거리를 분석하여 상용화의 기준 자료가 되도록 하였다. Monte-Carlo 방법에 기초한 Spectrum Engineering Advanced Monte Carlo Analysis Tool(SEAMCAT)을 이용하여 TV White Spaces(TVWS) 대역의 동일 및 인접채널에서 WiBro가 무선랜에 미치는 간섭확률 및 그 영향을 분석하였다. 분석 결과, 동일채널에서 WiBro Mobile Station(MS)의 최대 송신파워(25 dBm)를 허용하기 위해 WiBro MS와 무선랜 User Equipment(UE) 사이에 210 m의 이격거리가 요구된다. 또한, WiBro Base Station(BS)의 송신파워는 -4.96 dBm으로 감소되어야 한다.

Abstract In this paper, we analyze the distance between two systems, WiBro and WLAN, compared to standard interference probability for channel co-use in order to be used as a criteria in realization. Co-channel and adjacent channel interference probability and its effect 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.

Key Words : WiBro, WLAN, TVWS, SEAMCAT, Guard band

Ⅰ. 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 potentically interfere 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,

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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).

II. System Descriptions

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.

표 1. WLAN의 주요 변수
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 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].

표 2. 블록 응답
Table 2. Blocking response

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

B. WiBro

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

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

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

표 3. 와이브로의 주요 변수
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 hight	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

표 4. 와이브로 단말 스펙트럼 마스크(출력=25dBm)
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

표 5. 와이브로 기지국 스펙트럼 마스크
Table 5. WiBro BS spectral mask

Frequency offset from centre	Allowed emission level	Measurement bandwidth
$5 \leq \Delta f < 6$ MHz	−13 dBm	100 kHz
$6 \leq \Delta f < 25$ MHz	−13 dBm	1 MHz
$25 \leq \Delta f <$ 70MHz (assumed)	−28 dBm	1 MHz

Ⅲ. 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.

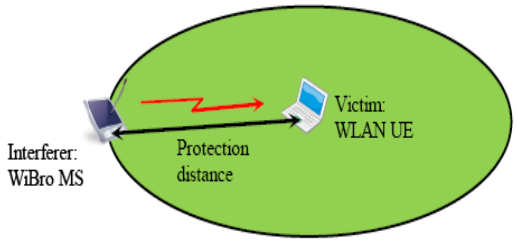

그림 1. WLAN 단말과 단일 와이브로 단말간 간섭 시나리오
Fig. 1. Scenario of single WiBro MS interferences with WLAN UE

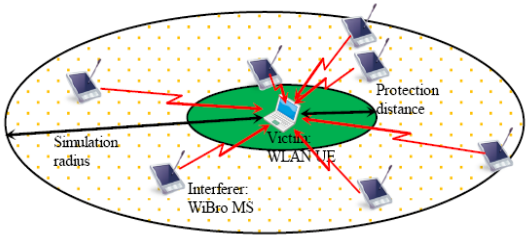

그림 2. WLAN 단말과 다중 와이브로 단말간 간섭 시나리오
Fig. 2. Scenario of multiple WiBro MSs interfere with WLAN UE

Scenario 2: Closest Seven WiBro BSs interfere with WLAN is considered in Figure 3.

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.

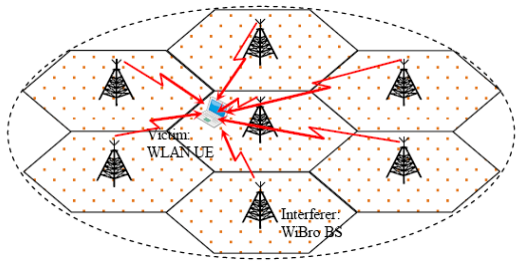

그림 3. WLAN 단말과 다중 와이브로 기지국간 간섭 시나리오
Fig. 3. Scenario of multiple WiBro BS interfere with WLAN UE

Figure 4 (a) represents the situation when there is no interference and the victim is receiving the desired signal with wanted signal margin.

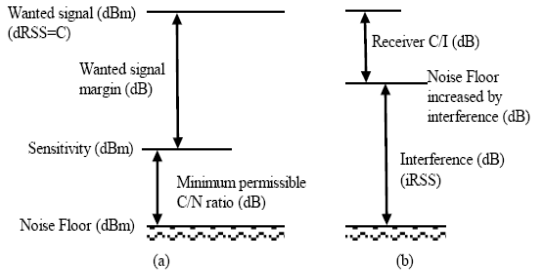

그림 4. 간섭 발생여부를 결정하기 위한 신호레벨
Fig. 4. The signal levels used to determine whether or not interference is occurring

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.

Ⅳ. 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.

A. 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 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.

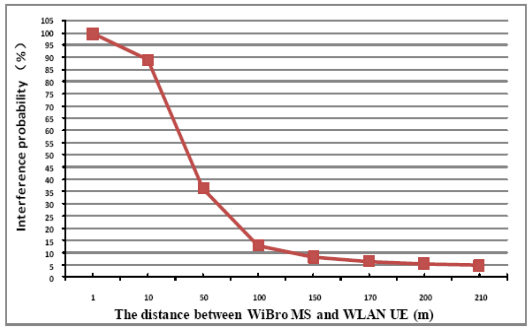

그림 5. WLAN 단말과 와이브로 단말간 거리에 따른 간섭 확률

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

B. Adjacent channel interference

In scenario of adjacent channel interference from WiBro to WLAN, the case of multiple WiBro MSs interfering with WLAN UE is taken into account, Density of interferes/km^2 of 50, 100, 150 and 200 and the protection distance of 1 m are assumed. And then, according to different required guard bands, the maximum allowable transmit power of WiBro MS is evaluated through simulation. The results are summarized in Table 6.

표 6. 지정 보호대역 대 허용 가능한 최대 와이브로 단말 전송 출력

Table 6. The maximum allowable WiBro MS transmit power vs. the appointed guard band

Appointed guard band (MHz)	Maximum allowable transmit power of WiBro MS (dBm)			
	WLAN: 481 MHz WiBro: 497MHz + guard band			
	Density of interferers/km^2			
	50	100	150	200
0	27.0	22.5	19.35	17.7
2	32.7	28.2	25.8	23.4
4	34	29.8	27.2	25.2

Table 6 shows that when density of interferers equals to 200, interference situation of WiBro MS interfering with WLAN UE is the worst case. Therefore, the guard bands should be more than 4 MHz

corresponding to 481 MHz for meeting the specified transmit power of WiBro MS of 25 dBm.

In the case of multiple WiBro BSs interfering with WLAN UE, according to different required guard bands, the maximum allowable transmit power of WiBro BS is evaluated through simulation. The results are summarized in Table 7. Table 7 shows that the guard band of 20 MHz at 481 MHz is able to meet the specified transmit power of WiBro BS of 33 dBm.

표 7. 지정 보호대역 대 최대 허용 가능한 와이브로 기지국 전송출력

Table 7. The maximum allowable WiBro BS transmit power vs. the appointed guard band

Appointed guard band (MHz)	Maximum allowable transmit power of WiBro BS (dBm)
	WLAN: 481 MHz WiBro: 497MHz + guard band
0	16.8
5	19.5
10	21.12
15	23.46
20	33.0

V. 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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