Analysis of radio interference through ducting for 2.5GHz WiMAX service

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Abstract

In this paper, we have analyzed the interference effect of 2.5GHz WiMAX services between Korea and Japan by ducting. We focus on especially interference scenario of base station to base station and the APM model being verified by measurement is used to calculate the propagation loss in ducts.

Keywords: Ducting, Interference effect, WiMAX

1. Introduction

As sharing of many frequency bands between different radio services, and the different operators of similar radio service, it is important to be able to predict with reasonable accuracy the potential interference between them. Also there are radio interference problems with neighboring countries. Radio interference has been occurred in Trunked Radio Service (TRS) frequency band in the south coastal area of Korea [1] and similar interference has been observed in the mobile communication frequency band [2]. After monitoring the radio interference, it is found that the main reasons of radio interference are due to the radio signal through ducting from the seaside of Japan.

In recent years, UQ communication of Japan starts the WiMAX service using 2595MHz ~ 2625MHz frequency band. In Korea, a new operator is under the procedures to start the WiMAX service using 2580MHz ~ 2620MHz frequency band. So it needs to look at interference effects between two countries in advance.

In this paper, we have analyzed the effect of interference between WiMAX services of two country using 2.5GHz frequency band. In order to analyze the interference, we focus on especially interference scenario for Base station to Base station because it would produce more serious interference than any other interference scenarios. The Minimum Coupling Loss (MCL) method is used for the interference analysis between BSs. Also we employ the Advanced Propagation Model (APM) for calculating the propagation loss in ducts. The APM model was verified by comparing with the interference experimental data fulfilled in between Korea and Japan [3].

2. Interference Scenarios

The interference analysis between the mobile WiMAX TDD systems is carried out according to the different interference scenarios. Six interference scenarios can be considered as shown in Table 1.

Interference scenario of base station to base station would produce more serious interference than interference scenario of base station to mobile station and interference scenario of mobile station to mobile station. So it seems to have no interference problem between WiMAX systems if the system timing of base station between two countries is synchronous.

But we have to consider a mechanism of interference occurrence shown in Figure 1. The separate distance between Korean and Japan is about 240km ~ 300km. So the transmitting signals from Japan's WiMAX base station arrive at Korean with having the delay of 0.8ms~1ms. The delayed signals from Japan receive at WiMAX base station of Korean and it can induce the interference. The effect of interference depends on the level of received interference signal.

Table 1: Interference scenarios between WiMAX systems

Scenario		Interferer	Victim
Synchronous case	Case1	WiMAX BS	WiMAX MS
	Case2	WiMAX MS	WiMAX BS
Asynchronous case	Case3	WiMAX BS	WiMAX BS
	Case4	WiMAX BS	WiMAX MS
	Case5	WiMAX MS	WiMAX BS
	Case6	WiMAX MS	WiMAX MS

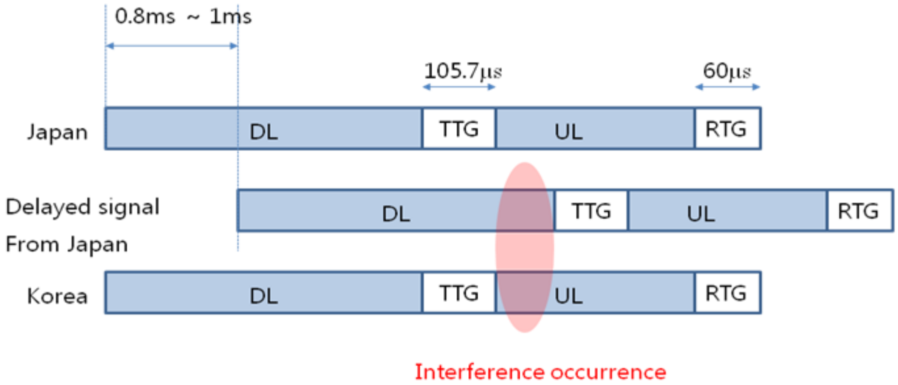

Figure 1: A mechanism of interference occurrence.

3. Interference Analysis Method between WiMAX services

3.1 **APM**

The Parabolic Equation (PE) method was mainly used to calculate the propagation loss in ducts [4]. This method has ability to compute propagation effect within the horizon as well as beyond the horizon, however, it requires extensive computation. A hybrid propagation model called APM to overcome the high computational burden of split-step PE method. The APM is much faster than split-step Parabolic Equation (PE) method, yet it requires far less memory, and can be used to wider application.

APM considers four regions and at ranges less than 2.5km and for all elevation angles above 5°, APM uses a flat earth (FE) model region. For the region beyond the FE region where the grazing angles of reflected rays from the transmitter are above a small limiting value, a Ray Optics (RO) model is used. The PE model is used for ranges beyond the RO region, but only for altitudes below a maximum PE altitude determined by the maximum 1024-point Fast-Fourier transform (FFT) allowed. For ranges beyond the RO region and heights above the PE region, an extended optics (XO) method allowed. For ranges beyond the RO region and heights above the PE region, an extended optics (XO) method at the maximum PE altitude, and uses ray-optics methods to propagate the signal to higher altitudes[4]. In the PE region, the split-step PE model proposed by Dockery [5] is used.

3.2 **Basic equation for interference analysis**

The interference level at the receiver is a function of the gains and losses the interference signal will incur between the interferer transmitter and the victim receiver and is expressed by [6]

$$I = P_t + G_t + G_r - L_b(d) - FDR(\Delta f) \quad (1)$$

Where I is an interference power level in dBm, P_t is an interferer transmitter power in dBm, G_t is a gain of interferer antenna in direction of receiver in dBi, G_r is a gain of victim receiver antenna in direction of interferer in dBi, $L_b(d)$ is a basic transmission loss for a separation distance d between interferer and receiver in dB, $FDR(\Delta f)$ is a measure of the rejection produced by the receiver selectivity curve on an unwanted transmitter emission spectrum in dB.

After calculating the interference power level at victim receiver by using equation (1), the interference power-to-noise power ratio (I/N) is compared with the interference criterion. And then we determine whether the interference occurs or not.

4. Simulation Results

As depicted in Table 1 and Figure 1, BS to BS interference scenario is considered where WiMAX networks are deployed at the shore of Korea and Japan. The table 1 presents the simulation parameters for interference analysis. The propagation loss is predicted using the APM model and the modified refractivity value of Pohang and Fukuoka providing from the WMO station is used.

Table 1: Parameter value for simulation

Parameter	Value
Operating frequency	2600MHz
Noise-equivalent bandwidth, B	10MHz
Transmitting Power	43dBm
Transmitter antenna height	30m
Receiver antenna height	30m
Transmitter antenna Gain	15dBi
Receiver antenna Gain	15dBi
Base station noise figure	5dB
Desensitization	1dB
modified refractivity	WMO data

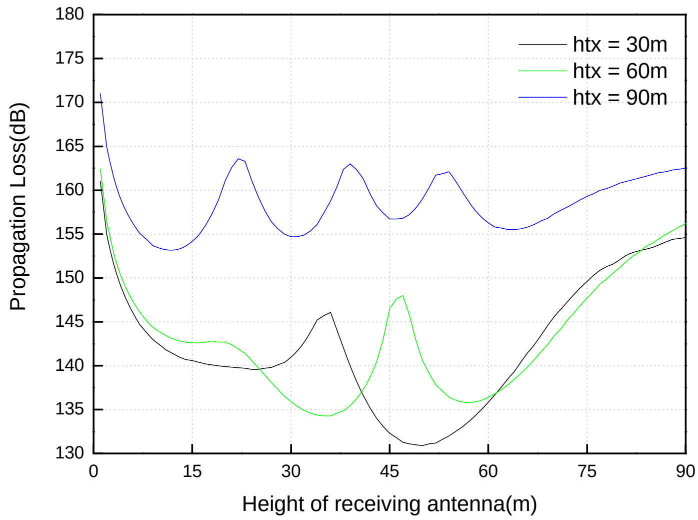

Figure 3: Propagation Loss for variation of antenna height.

Figure 3 shows the propagation loss for variation of antenna height using the APM. The propagation loss is calculated by applying WMO data of the surface-based duct and the elevated ducts in June.

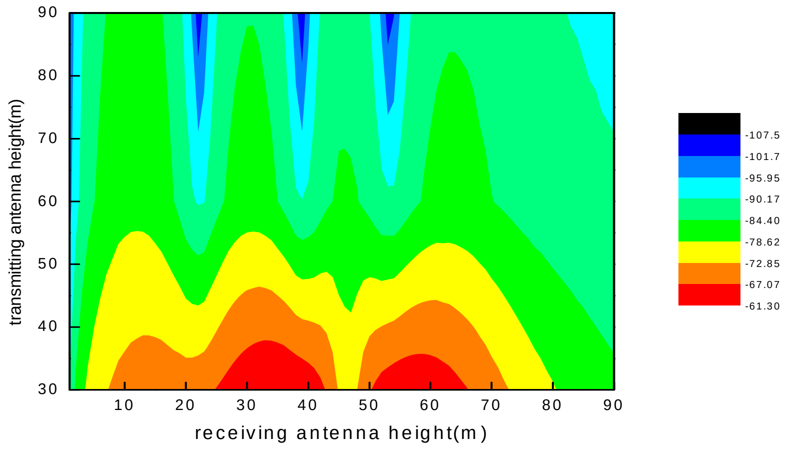

Figure 4: Received interfered signal strength for antenna height.

Figure 4 shows the received interfered signal strength at victim receiver being calculated by equation (1) and the parameter of Table 1. Assuming the height of transmitting antenna and receiving antenna is 30m, the received interfered signal strength from WiMAX base station of Japan is about −67dBm/10MHz. This signal strength don't agree with the permissible interference level, −105dBm/10MHz. From the result, the received interfered signal strength depends on the antenna height and it may agree with the permissible interference level according to the height. Also it can be varied by the modified refractivity value of duct.

5. Conclusion

In this paper, the effect of interference for 2.5GHz WiMAX services between Japan and Korea by ducting is analyzed. The MCL method is used for the interference analysis focusing on for BS to BS interference scenario. Also the APM model is used to calculate the propagation loss in ducts and WMO data of the surface-based duct and the elevated ducts is applied. We confirm that the received interfered signal strength depends on the antenna height and it doesn't satisfy the permissible interference level according to the height. We need to find the solution for share the frequency with an acceptable interference.

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Acknowledgments

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