International Journal of Future Generation Communication and Networking
Vol.10, No.6 (2017), pp.45-54
http://dx.doi.org/10.14257/ijfgcn.2017.10.6.05

A Study on Finding Optimal Propagation Model Using the Real Radio Spectrum Data in High-Land Area

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Abstract

The path loss in wireless communications is influenced by frequency, distance, geographical features, antenna height of transmitting station and the receiving station and artificial environment. The received signal measurement in wireless environment and the path loss prediction model are widely used, because the RF environment is different from region to region and the frequency band is also wide. There is too much cases using RF field measurement to derive the RF model that is costly and time-consuming. Also, theoretical predict models to derive the RF Model and actual frequency environments is often different. Thus, both the field measurement and the theoretical prediction models are complementary to each other. In this paper, we derived the optimal RF model for mountainous region using actual measured data and variety RF model of coverage simulation results. Also we analyzed the correlation of the field measured data with simulation data.

Keywords*: Path loss, Propagation Model, Coverage Simulation*

1. Introduction

In accordance with growing needs of wireless communication technology, various research projects related coverage simulation are being carried out for planning optimized service. However, there are some limitations in surveying and analyzing propagation in high-land areas. In order to provide better communication service, various radio environment conditions which are based on wide radio bandwidth (selection of propagation model, correction of value in accordance with radio bandwidth, *etc.*) should be considered. In an attempt to predict reliable propagation coverage, this paper examines limited propagation data with HTZ Warfare which were collected from high land sites in Korea.

Furthermore, through testing simulations it analyzes comparative performance evaluation for optimized propagation model [1-2].

2. Radio Measurement Environment

The measurement was conducted on the basis of the measured high-land Hwacheon site primarily for this study and secondary candidate site (Daebudo, Wonju, Yesan, Hongsung) which performed measurement of radio environment [3], [6-8].

Figure 1 is shown a conFigureuration of transmitting system. Table 1 is shown as a radio measurement information, and the range. The measurement frequency is HF, VHF, UHF band was collected to measure the radio waves from four highlands. Spread form and output was used for the non-modulation (Continuous Wave) CW wave.

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ISSN: 2233-7857

Receiving the operating system was mounted on the vehicle, is the main component composed of a spectrum analyzer, receive antenna, LNA (Low Noise Amp.), GPS (Global Positioning System), a laptop *etc*.

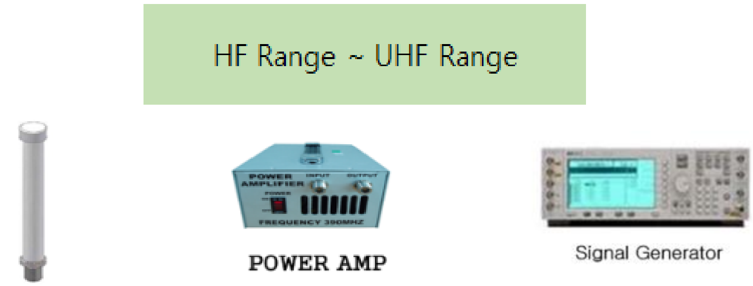

Figure 1. Diagram of Transmitting System

Table 1. Radio Measurement Specification and Coverage

Category	Contents
Frequency	HF (28.7 MHz) VHF (110 MHz) UHF (415MHz , 850MHz , 1.8GHz, 2.1GHz)
Location	- 1st : Whacheon - 2nd : Daebudo, Yesan, Hongsung, Wonju
Type	Non-modulation CW Frequency

Figure 2 is a structural view for receiving a radio wave signal for measuring the radio wave, and serves to measure and store the received electric field strength according to the moving distance of the vehicle [4-5].

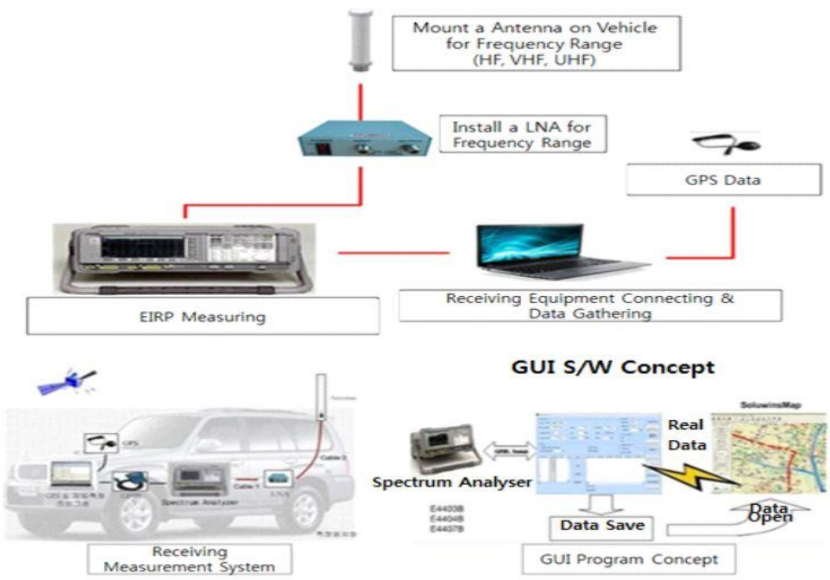

Figure 2. Diagram of Receiving System

3. Electric Field Strength Simulation and Correlation Analysis

Measuring program performs a storing function for the received electric field strength measurement data from the spectrum analyzer and processing the latitude & longitude data, measurement time through the GPS receiver.

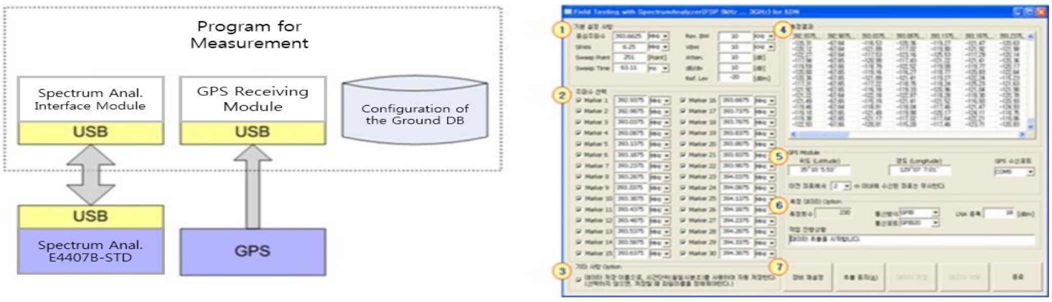

Figure 3. Concept of Measurement Program and Main View Feature

Figure 3 is the information on the GUI screen and the conFigureuration information for a measurement program.

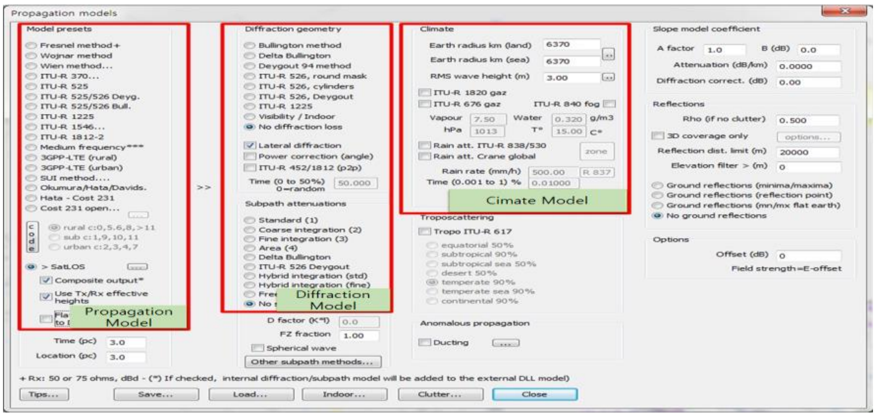

Figure 4. HTZ Warfare Propagation Model Program Feature

Measuring program is transmitted and received and a spectrum analyzer data through the USB interface, and receives the GPS information from the external location information showing that driven by the program.

Figure 4 is information about each of the free space loss model (applied in accordance with the propagation distance attenuation), the diffraction loss model (Non LoS obstructions environment applicable), part path loss attenuation model (Near LoS obstructions environment applicable).

In consideration of the propagation environment of radio waves that target only the broadband measurements and characteristics it may be applied to terrestrial propagation model as described above [9].

4. Actual Results of Radio Environment

4.1. Hwacheon High-Land Area Fixed Radio Measurement Result

Table 2 shows a fixed radio measurement results are: 8.7MHz, 110MHz, 415MHz, 850MHz, 1.8GHz, and 2.1GHz, respectively, were calculated correlation coefficients of the predicted value and the measured value of the 4 sites. The results are respectively 0.26065, 0.75378, 0.862702, 0.118924, 0.797126, and the value of 0.500775.

The correlation coefficient is related to the contrary case of the perfect match relationship, -1 if the value of I of the range of -1 to + 1, 1, indicates that there is a correlation of 0.

28.7MHz and 2850MHz portion of the difference between the predicted and measured values were the result of the biggest bands.

This portion is determined by the correction is necessary by all means part. Figure 5 represents the dB difference between the predicted value and the measured value

Table 2. Radio Measurement Specification and Coverage

Transmittion	Receive	Distance(m)	Prediciton(dB)	Measured(dB)
Hwacheon_28.7	1	17429.79	-59.78	-44.1
Hwacheon_28.7	2	11538.31	-73.3	-60.96
Hwacheon_28.7	4	15910.13	-57.29	-61.26
Hwacheon_28.7	8	4686.15	-31.28	-53.33
Hwacheon_110	1	17429.79	-57.83	-66.4
Hwacheon_110	2	11538.31	-72.36	-73.3
Hwacheon_110	4	15910.13	-54.34	-76.29
Hwacheon_110	8	4686.15	-38.7	-54.77
Hwacheon_415	1	17429.79	-68.49	-58.49
Hwacheon_415	2	11538.31	-82.94	-82.19
Hwacheon_415	4	15910.13	-62.8	-66.15
Hwacheon_415	8	4686.15	-48.5	-55.16
Hwacheon_850	1	17429.79	-75.57	-48.85
Hwacheon_850	2	11538.31	-91.74	-66.16
Hwacheon_850	4	15910.13	-68.19	-77.7
Hwacheon_850	8	4686.15	-54.69	-56.57
Hwacheon_1.8	1	17429.79	-83.38	-78.45
Hwacheon_1.8	2	11538.31	-101.08	-90.66
Hwacheon_1.8	4	15910.13	-73.5	-83.72
Hwacheon_1.8	8	4686.15	-61.08	-77.65
Hwacheon_2.1	1	17429.79	-85.05	-83.69
Hwacheon_2.1	2	11538.31	-103.05	-85.29
Hwacheon_2.1	4	15910.13	-74.54	-89.02
Hwacheon_2.1	8	4686.15	-62.41	-76.33

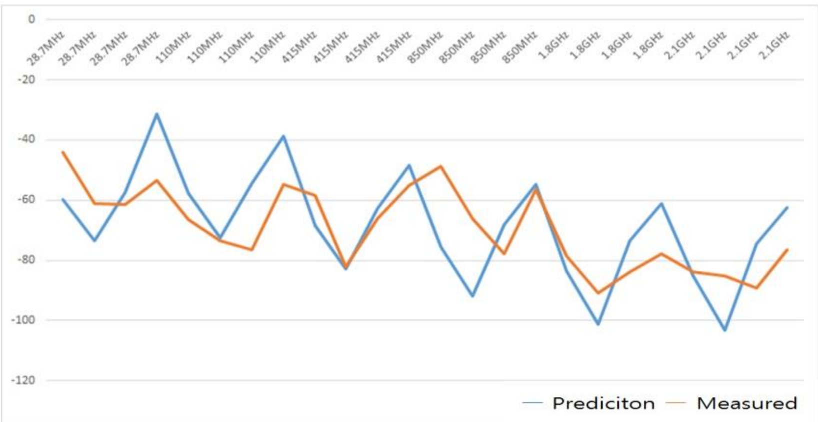

Figure 5. Comparison dB of Prediction and Measurement Value

4.2. Frequency-Dependent Correlation Analysis Result

Table 3. Analysis Result of Each Other Frequencies

Category		Hwa cheon	Daebu do	Wonju	Yesan	Hong sung
MHz	Frequency Model	%<±6 dB	%<±6 dB	%<±6 dB	%<±6 dB	%<±6 dB
28.7	525-526-526	54.51	68.44	57.04	66.73	68.27
	525-deygout94-Standard	18.66	10.33	3	5.32	9.02
	525-deygout94-NoSubpath	81.86	20.79	37.99	27.73	51.99
	525-deygout94-coarse	73	69.02	57.1	75.2	60.21
110	525-526-526	-	85.02	38.39	82.09	58.68
	525-deygout94-Standard	-	27.93	5.6	10.12	10.28
	525-deygout94-NoSubpath	-	8.79	62.41	43.1	72.49
	525-deygout94-coarse	-	81.96	46.54	86.22	37.41
380	525-526-526	65.28	61.43	17.74	56.33	9.99
	525-deygout94-Standard	83.8	54.85	15.19	14.06	6.81
	525-deygout94-NoSubpath	72.36	64.16	76.61	79.77	73.67
	525-deygout94-coarse	87.41	71.08	37.76	35.69	17.54
850	525-526-526	28.37	39.34	9.28	28.19	10.43
	525-deygout94-Standard	54.13	62.67	24.97	22.92	8.33
	525-deygout94-NoSubpath	74.61	72.62	90.19	79.84	60.56
	525-deygout94-coarse	69.96	58.7	24.78	24.9	7.13
1800	525-526-526	48.04	46.26	21.34	45.82	5.2
	525-deygout94-Standard	85.61	74.73	73.93	67.99	62.31
	525-deygout94-NoSubpath	89.63	66.82	75.11	77.24	93.03
	525-deygout94-coarse	86.96	73.32	45.19	45.82	19.53
2100	525-526-526	44.01	49.72	22.91	57.97	5.77
	525-deygout94-Standard	83.86	72.83	72.5	76.66	65.59
	525-deygout94-NoSubpath	89.5	65.9	69.13	68.54	92.07
	525-deygout94-coarse	84.83	76.08	45.07	57.4	23.4

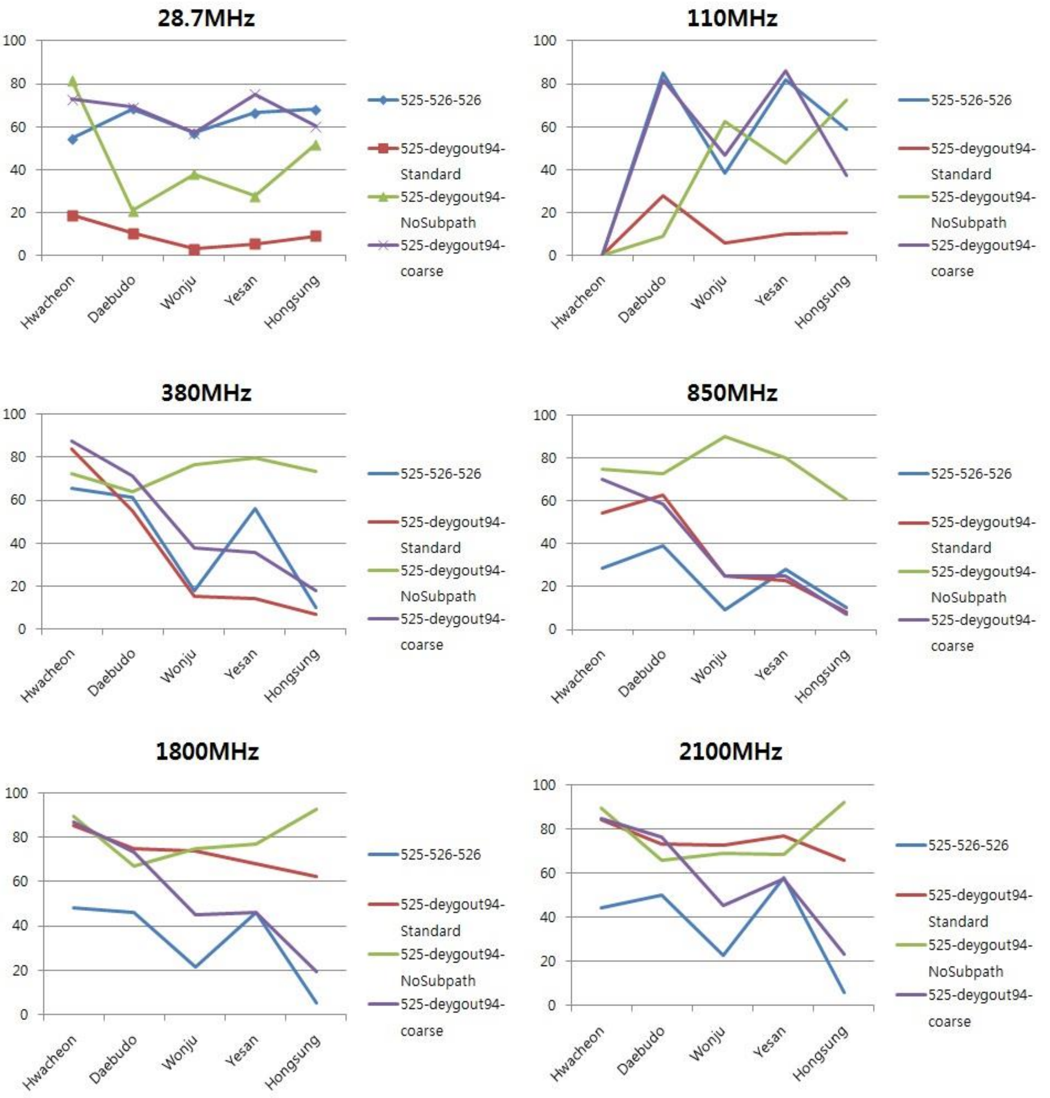

Figure 6. Analysis Result Graph of Each Other Propagation Models

For the frequency base analysis of correlation value, we analyzed radio strength measurement data of each location.

Analysis carried out by propagation model based on the measurement position was recorded to measure targeted at % <± 6dB the data of the comparison result.

As shown in Table 3, 525/526/526 and 525/Deygout94/Coarse model showed a relatively high correlation in 28.7MHz and 110MHz bands. 380MHz, 850MHz, 1800MHz, and 2100MHz was generally in 525/Deygout 94/NoSub path model also shows that the correlation appears high. In the case of 1800MHz and 2100MHz, is effect has been analyzed in 525 / Deygout 94 / Standard Model. Figure 6 shows the data on Table 3 in a graph.

4.3. Propagation Model-Dependent Correlation Analysis Result

Table 4. Analysis Result of Each Other Propagation Models

Category		Hwacheon	Daebudo	Wonju	Yesan	Hongsung
Model	MHz	%<±6dB	%<±6dB	%<±6dB	%<±6dB	%<±6dB
525-526-526	28.7	54.51	68.44	57.04	66.73	68.27
	110	-	85.02	38.39	82.09	58.68
	380	65.28	61.43	17.74	56.33	9.99
	850	28.37	39.34	9.28	28.19	10.43
	1800	48.04	46.26	21.34	45.82	5.2
	2100	44.01	49.72	22.91	57.97	5.77
525-deygout 94-Standard	28.7	18.66	10.33	3	5.32	9.02
	110	-	27.93	5.6	10.12	10.28
	380	83.8	54.85	15.19	14.06	6.81
	850	54.13	62.67	24.97	22.92	8.33
	1800	85.61	74.73	73.93	67.99	62.31
	2100	83.86	72.83	72.5	76.66	65.59
525-deygout 94-NoSubpath	28.7	81.86	20.79	37.99	27.73	51.99
	110	-	8.79	62.41	43.1	72.49
	380	72.36	64.16	76.61	79.77	73.67
	850	74.61	72.62	90.19	79.84	60.56
	1800	89.63	66.82	75.11	77.24	93.03
	2100	89.5	65.9	69.13	68.54	92.07
525-deygout 94-coarse	28.7	73	69.02	57.1	75.2	60.21
	110	-	81.96	46.54	86.22	37.41
	380	87.41	71.08	37.76	35.69	17.54
	850	69.96	58.7	24.78	24.9	7.13
	1800	86.96	73.32	45.19	45.82	19.53
	2100	84.83	76.08	45.07	57.4	23.4

The results relatively low frequency band of Table 4 were 525/526/526, 525 / Deygout94 / Coarse model correlation percentage is high, the high frequency 525 / Deygout94 / Standard., 525 / Deygout94 / NoSubpath correlation model showed that high. Figure 7 shows the data on Table 4 in a graph.

On the other hand, given the wide variety of regional and frequency, is expected to be relatively good for selecting the 525 / Deygout 94 / NoSubpath model.

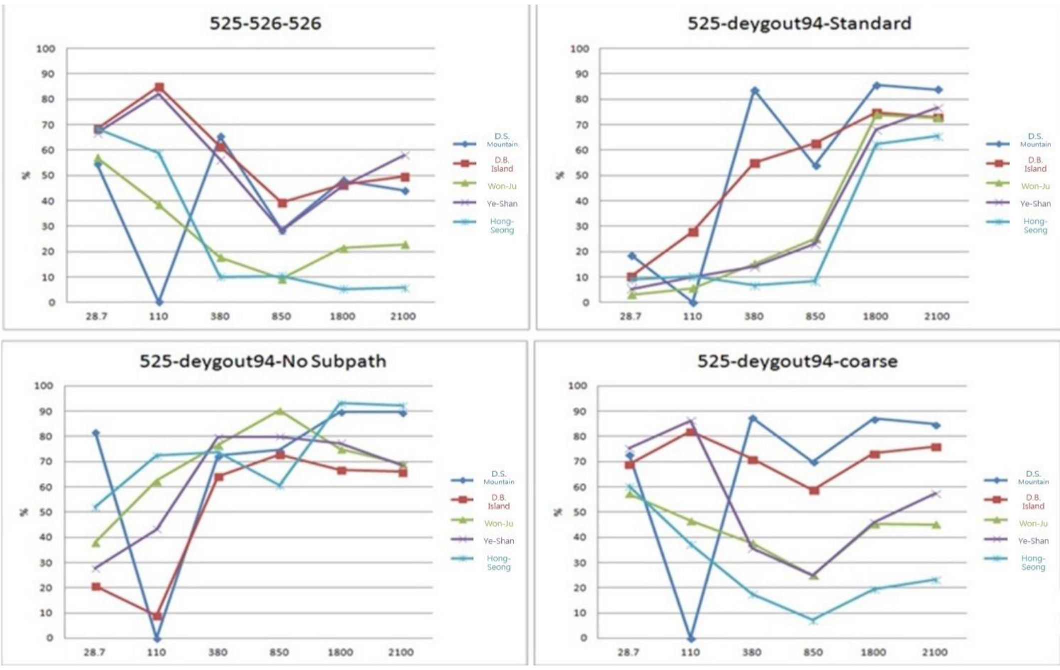

Figure 7. Analysis Result Graph of Each Propagation Models

5. Conclusion

Measuring a radio wave environment, the service provider through the survey serves as leading in continuing to provide a good quality of service. Also it can promptly cope with the problems that may occur in detection of new services expected by ensuring the radio environment data on the frequency bands to secure the data required for the allocation of a new service frequency band to the communications network deployment early. This makes it possible to maintain the competitive advantage of network management.

In this paper, we measured the radio spectrum in each High-mountain regions in South Korea. In addition, it can easily and conveniently measure stations during the performance measurement. Also proposed optimized radio wave propagation model through the simulation with HTZ Warfare and analyzed correlation between actual measured data and predicted data.

Based on this study, the sampling data accumulated through continuous spectrum measured will be able to present a reliable optimization model in each region.

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