RESEARCH ARTICLE OPEN ACCESS

Path Loss Study of Lee Propagation Model

S.Karthika
1(Department of Electronics, Madras Institute of Technology, Anna University, and Chennai)

Abstract:

Channel properties has high impact on the development of wireless communication systems. Unlike wired channels are stationary and predictable, radio channels are extremely random and don't offer easy analysis. A Radio Propagation Model (RPM), is an empirical mathematical formulation for the characterization of radio wave propagation as a function of frequency. In wireless communication, path loss propagation models are mandatory for proper planning, interference estimations, frequency assignments and cell parameters which are the basic for network planning process. Propagation models that predict the mean signal strength for an arbitrary transmitter-receiver (T-R) separation distance which is useful in estimating the radio coverage area of a transmitter are called large-scale propagation models, since they characterize signal strength over large T-R separation distances. In this paper, the large-scale propagation performance of Urban, Suburban and Open Area has been compared using Lee Model by varying Mobile Station (MS) antenna height, Transmitter-Receiver distance and Base Station (BS) antenna height, considering the system to operate at 900 MHz. Through the MATLAB simulation it is turned out that the Open Area shows the better performance than that of the other areas.

***Keywords* — Propagation Model, Antenna Height, Distance, Lee Model, Path Loss.**

I. INTRODUCTION

Propagation models have traditionally concentrated on predicting the received signal strength from the transmitter at a given distance, as well as the changeability of the signal strength in a close spatial proximity to a particular location. Propagation models for wireless communication that envision the signal strength for an arbitrary transmitter receiver (T-R) separation distance are useful in estimating the radio coverage area of a transmitter and it is used to predict the signal attenuation. Conversely, propagation models that characterize the rapid fluctuations of the received signal strength over very short travel distances are called small-scale or fading models. The information of path loss models can be used as a controlling factor for an improvement of system performance to achieve perfect reception.

It is valuable to examine the three main propagation mechanisms that determine and describe path loss: Reflection occurs when a radio wave collides with an object which has very large dimensions compared to the wavelength of the propagating wave. Reflections are very commonly caused by the surface of the earth and from buildings, walls, and other such obstructions. Diffraction occurs when the radio path between the transmitter/receiver pair is obstructed by a surface with sharp edges. This causes secondary waves to arise from the obstructing surface. There is a possibility that the secondary waves can bend around the obstacle and provide an almost artificial LOS between transmitter and receiver. Scattering occurs when the propagating wave touches the surface whose area is lesser than the signal wavelength.

Lee's path loss model is used to model a flat terrain. The model is used to analyze the path loss of various terrains like urban, suburban and open areas and a comparison is made between them.

The work is organized as follows. Section II describes the path loss models. Section III deals with the expressions for path loss of the model. Section IV discusses the model and the results. Section V concludes with the analysis of the result.

II. RELATED WORKS

Path loss is the reduction in power (in dB) of an electromagnetic wave when it propagates through space and signal level attenuation caused by scattering, reflection, diffraction and it is used to calculate link budget. Macro cells are generally large, providing a coverage range in kilometers and used for outdoor communication. Several empirical path loss models have been determined for macro cells. Among numerous propagation models, the following are the most significant ones,

A) Hata Okumura model
B) COST 231 model
C) ECC 33 model
D) Lee model

The Hata-Okumura model is the most important popular model and an empirical formula for manipulating the graphical path loss data provided by Yoshihisa Okumura, and is valid from 150 MHz to 1500 MHz. The Hata model is a set of equations based on measurements and extrapolations from curves derived by Okumura. Hata granted the urban area propagation loss as a definitive formula, along with additional correction factors such as suburban, rural among others. However, the model neglects terrain profile between transmitter and receiver if hills or other obstacles between transmitter and receiver.

The European Co-operative for Scientific and Technical Research (COST) introduced the COST-231 model for an extension Hata-Okumura Model for operating frequency 1800 to 2000 MHz. This model is derived from Hata model and depends upon four parameters for prediction of propagation loss: frequency, height of received antenna, height of base station and distance between base station and received antenna

Electronic Communication Committee (ECC) is developed ECC 33 path loss model, is extrapolated from original measurements by Okumura and modified its assumptions so that it more closely represents a fixed wireless access (FWA) system.

The Lee propagation prediction model has been well recognized by the wireless industry as one of the most accurate propagation prediction models. In general, the Lee model is composed of two parts, the impact of man-made structures and the impact of the natural terrain variation which contribute to path loss. This makes the model more accurate.

III. PROPOSED WORK

The Lee propagation model is used to predict signal strength over an area. The inputs to the model are the distance, antenna height, and the transmit power and frequency values. Lee's path loss model is based on empirical data chosen so as to model a flat terrain. Errors may arise when the model is applied to a non-terrain. The operating frequency of the model is 900 MHz, the model includes a frequency adjustment factor that can be used to increase the frequency range analytically

The predicted signal strength value for an area is the average signal strength representative of the region. The Lee model allows a user entered rate of signal decay over distance from an intercept reference point, typically 1 km or 1 mile.

The rate at which the RF signal decays over distance is referred to as the slope. The intercept is the mean signal strength (for reference conditions) at a distance from the transmitter from which the model's predictions are considered to be valid. Signal predictions at a distance less than the intercept reference point are not considered valid since the radio signal is affected by factors other than terrain.

The received signal power in dBm is expressed as

$$\mu_{\Omega} = 10\log_{10}\left(\mu_{\Omega 0}\left(\frac{d_0}{d}\right)^{\beta}\left(\frac{f_c}{f}\right)^{n}\alpha_0\right) \quad (1)$$

$$n = \begin{cases} 2 \ for \ f_c < 450MHZ \\ 3 \ for \ f_c > 450MHZ \end{cases} \quad (2)$$

TABLE I
PARAMETERS FOR TERRAIN MODEL

Terrain	$\mu_{\Omega o}$	β
Free Space	-45	2
Open Area	-49	4.35
North American Suburban	-61.7	3.84
North American Urban	-70	3.68
Japanese Urban	-84	3.05

Two parameters are initially required to characterize the model: $\mu_{\Omega 0}$ (the power at a 1.6 Km point of interception) and the path loss exponent β. These two parameters are determined from empirical measurements and listed in Table I.

The following nominal conditions are set when employing Lee's model:
fc = 900 MHz
do = 1.6 Km
Base Station Antenna Height = 30.48 m
Mobile Station Antenna Height = 3.0 m Base Station Transmit Power = 10 W
Base Station Antenna Gain = 6 dB above dipole gain
Mobile Station Antenna Gain = 0 dB above dipole gain
The following parameters must also be set:
f- the actual carrier frequency
d- distance between mobile station and base station antennas
α_o- is a correction factor

The parameter α_o is basically used to account for different BS and MS antenna heights, transmit powers, and antenna gains.
For instance, if the actual conditions differ from the nominal ones, then α_o is computed by $\alpha_0=\alpha_1\alpha_2\alpha_3\alpha_4\alpha_5$
Where

$$\alpha_1 = \left(\frac{\text{new BS Antenna Height(m)}}{30.48\text{m}}\right)^2 \quad (3)$$

$$\alpha_2 = \left(\frac{\text{new MS Antenna Height(m)}}{3\text{m}}\right)^{\varepsilon} \quad (4)$$

$$\xi = \begin{cases} 2 \text{ for MS Antenna Height} > 10\text{m} \\ 3 \text{ for MS Antenna Height} > 3\text{m} \end{cases} \quad (5)$$

$$\alpha_3 = \left(\frac{\text{new Transmit Power}}{10\text{W}}\right)^2 \quad (6)$$

$$\alpha_4 = \left(\frac{\text{new BS Antenna Gain}}{4}\right) \quad (7)$$

α_5=different antenna gain correction factor at MS.

IV. RESULTS AND DISCUSSION

The path losses for different regions like urban, suburban and open areas are compared along with the parameters such as TR separation, MS antenna height and BS antenna height.

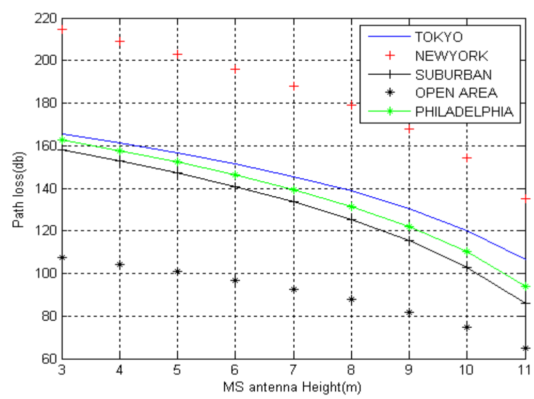

Fig. 1 Propagation Path Loss due to the change in MS antenna height

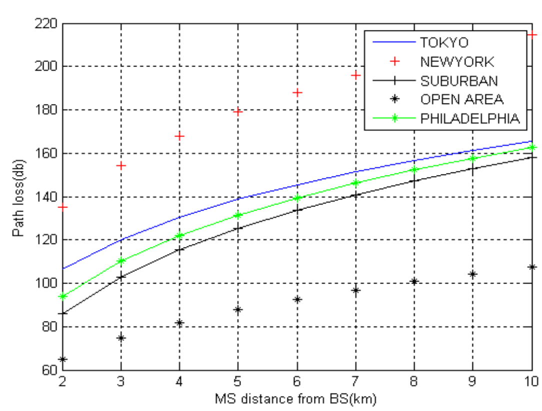

Fig.2 Propagation Path Loss due to the TR separation for Lee Model

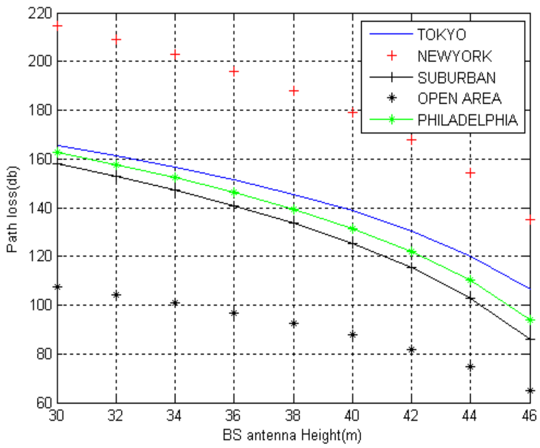

Fig. 3 Propagation Path Loss due to the change in BTS antenna height

V. CONCLUSIONS

In this paper performance of path loss for various regions were studied and analyzed. The simulation was done to find out the path loss by varying the parameter BS antenna height, MS antenna height and the T-R separation. The result of this analysis shows that the open area has lesser path loss than other areas.

ACKNOWLEDGMENT

I have taken Mr.M.A.Alim paper has our reference. Through this acknowledgment, we express our sincere gratitude to him.

REFERENCES

1. *Lee WC. Mobile communications design fundamentals. John Wiley & Sons; 2010 Jul 15.*

2. *Seybold JS. Introduction to RF propagation. John Wiley & Sons; 2005 Oct 3.*

3. *Ali AA, Alhaider MA. Millimeter wave propagation in arid land-a field study in Riyadh. IEEE transactions on antennas and propagation, vol. 40, no. 5, 492496, May 1992.*

4. *Hernando JM, Perez-Fontain F, "Introduction to mobile communicstion engineering"', Artech House, 1999. R. E. Sorace, V. S. Reinhardt, and S. A. Vaughn, "High-speed digital-to-RF converter," U.S. Patent 5 668 842, Sept. 16, 1997.*

5. *Alotaibi FD, Ali AA, "TETRA Outdoor large – scale received signal prediction model in Riyadh city-saudi Arabia" , Wireless and Microwave Technology Conferernce , 1-5, Dec 2006.*