INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Analysis of Wimax Connectivity in Rural and Urban Area Using Okumura-Hata Propagation Model

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Abstract:
Worldwide Interoperability of Microwave Access (WiMAX) technology becomes popular and receives growing acceptance as a Broadband Wireless Access (BWA) system. It is capable of delivering broadband Internet service and extending services like Internet telephony throughout India without major disruption to transportation and other services. Predicting path loss and finding coverage area are important factors in wimax wireless system for proper planning, interference estimations and frequency assignments. We use the Okumura –Hata model for computing a transmission coverage area and propagation loss in any outdoor environment such as rural, urban, and suburban. The system was developed by using Matlab software in that on rural or urban map image, we place the transmitter point on the map and inputs such as Frequency ,Transmitter Power ,Gain, Height ,System Loss ,Distance are for a that particular image and compute coverage area and propagation loss. A coverage area and propagation loss for different area is observed. By varying frequency and distance we compare a coverage area and propagation path loss for different geographical areas.

Key words: *Coverage area, propagation model, Path Loss, Okumura- Hata model*

1. Introduction

WiMAX stands for Worldwide Interoperability for Microwave Access .It is based on IEEE 802.16 standards. In this technological world, we have so many technologies that help us in every aspect of our daily life such as transportation, communication. . WiMAX base station can provide broadband wireless access in a range up to 30 miles (50kms) for fixed stations and 3 to 10 miles (5 to 15 kms) for mobile stations with a maximum data rate of up to 70 Mbps.There is no need for line of sight connection between subscriber terminals and the base station in WiMAX technology and it can support hundreds if not thousands of subscribers from a single base station. The Institute of Electrical and Electronics Engineers (IEEE) 802 committee, which sets networking standards such as Ethernet (802.3) and Wi-Fi (802.11), has published a set of standards that define WiMAX..

2. Propagation Model

Propagation models are used for calculation of electromagnetic field strength for the purpose of wireless network planning during preliminary deployment. It describes the signal attenuation from transmitter to receiver antenna as a function of distance, carrier frequency, antenna heights and other significant parameters like terrain profile (e.g. urban, suburban and rural). For wireless communication system, the system should have the ability to predict the accurateness of the radio propagation behavior. Thus it has become pivotal for such system design. The site measurements are expensive and costly. Propagation models have been developed at low cost, convenient alternative and suitable way. Models such as the Harald.T. Friis free space model are used to predict the signal power at the receiver end when transmitter and receiver have line-of-sight condition. The classical Okumura model is used in urban, suburban and rural areas for the frequency range 200 MHz to 1920 MHz for initial coverage deployment. A developed version of Okumura model is a Hata-Okumura model known as Hata model which is also extensively used for the frequency range 150 MHz to 2000 MHz**.**

3. Okumura-Hata Propagation Model

It is used to calculate path loss in three different environments like urban, suburban and rural.
Path loss in db for Okumura –Hata prediction model is

$PL=46.3+33.9\log_{10}(f)-13.82\log10(h_b)-ah_m+(44.9-6.55\log_{10}(h_b))\log_{10}d+c_m$

Where:

- *d:* Distance between transmitter and receiver antenna [km]
- *f:* Frequency [MHz]
- *hb:* Transmitter antenna height [m]

The parameter *cm* has different values for different environments like 0 dB for suburban and 3 dB for urban areas and the remaining parameter *ahm* is defined in urban areas as

$ah_m = 3.20(\log_{10}(11.75hr))^2 - 4.79$, for $f > 400$ MHz

The value for ah_m in suburban and rural (flat) areas is given as:

$ah_m = (1.11\log_{10} f - 0.7)\,h_r - (1.5\log_{10} f - 0.8)$

Where the h_r is the receiver antenna height in meter.

4. Block Diagram for Coverage and Path Loss Calculation

By using the wireless model and propagation loss details, we try to cover the geographical area by simulation method. In this method, we use a geographical area map and select system parameters so that we will get coverage area map and loss details.

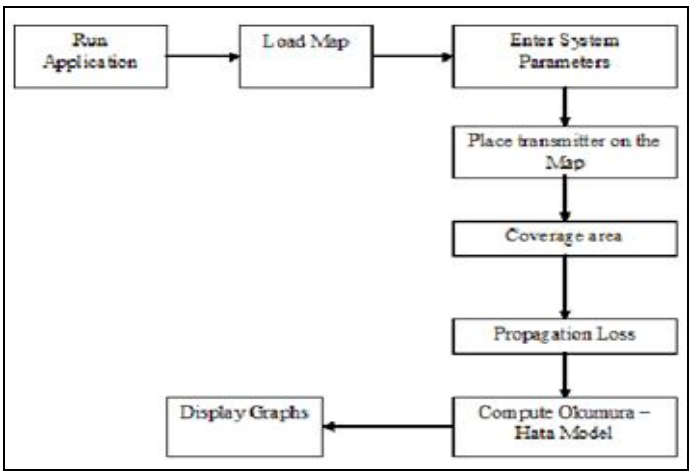

Figure 1: Block Diagram of coverage and path loss Calculation

4.1. Selecting map: select a map of format .jpeg or .bmp of an area taken from satellite or any readily available images from internet.
4.2. Entering system parameters shown below.
Parameters for planned network:

- Frequency [MHz]
- Transmitter Power [dBm]
- Transmitter Gain [dBi]
- Receiver Gain [dBi]
- System Loss [dB]
- Transmitter Height [m]
- Receiver Height [m]
- Distance [km]

4.3. Wimax device (Transmitter) placement and coverage prediction: we can place a wimax transmitter on the map area. And after this coverage area is covered by using Okumura-Hata model
4.4. Results: Okumura-Hata, Free Space Propagation path loss and received power.

5. Inputs and Outputs of System

5.1. Inputs

- Map in proper image format in jpg
- System parameters
- Clicking of mouse point on the map (means placing transmitter)

5.2. Output

- Predictive coverage area by the transmitter
- Graphs showing free space and Okumura- Hata model
- Received power.

6. GUI Output Window

This is main GUI output window, which consists of different push buttons to upload map, clear map and exit by using these push buttons map of urban, rural or suburban area is uploaded by clicking on push button of upload map. After completion of coverage and path loss calculation a map is clear by clear map pushbutton and exit from main GUI by exit push button. It consists of a panel named as system parameters which consists of different input parameters such as frequency, transmitter power, transmitter gain, receiver gain, system loss, transmitter height and distance. After giving different input parameters transmitter point is selected on map and by clicking predict coverage push button a coverage area on map with respect to that transmitter is observed. the output graphs of free space loss and Hata models is observed .And outputs free space path loss and Okumura Hata model is in output panels in this main GUI. Results of coverage area for urban, suburban and rural areas with following input parameters:

Input Parameters	Values
Frequency	1500 MHz
Transmitter power	46 dBm
Transmitter gain	16 dBi
Receiver gain	0 dBi
System loss	3 Db
Transmitter height	30 m
Receiver height	1.5 m
Distance	15 km

Table 1

6.1. Coverage Area of Different Urban Areas

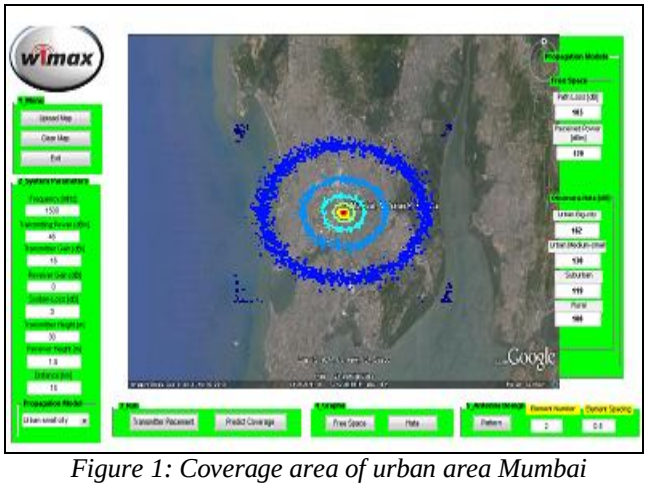

Figure 1: Coverage area of urban area Mumbai

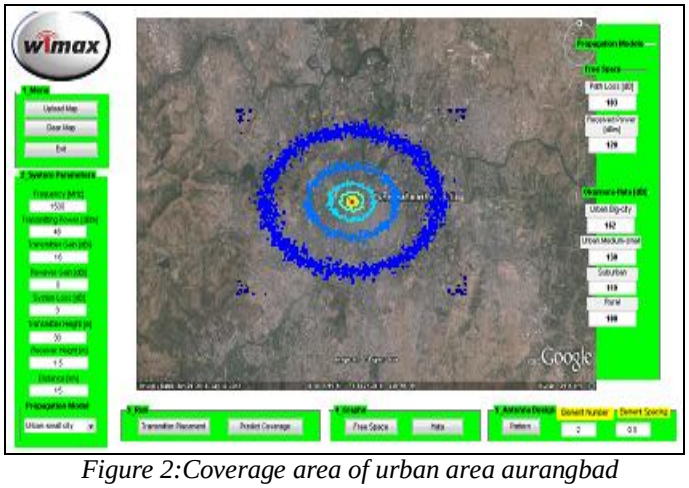

Figure 2:Coverage area of urban area aurangbad

6.2. Observations for Path Loss in Different Propagation Environment

Sr. No.	Propagation Environment	Path loss Model	Path loss value in dB
1	Urban big city	Okumura Hata Model	150
2	Urban Small city		111
3	Suburban		98
4	Rural		78

Table 2

From the reference of above table which shows the value of path loss in db for different propagation environment .Path loss is defined as" the signal attenuation from transmitter to receiver antenna as a function of distance, carrier frequency, antenna heights and other significant parameters like terrain profile (e.g. urban, suburban and rural)".

- Path loss value in urban big city is 150 db.
- Urban small city has 26% less path loss in db as compared to urban big city.
- Suburban small city has 34.67% less path loss in db as compared to urban big city.
- Rural has 48% less path loss in db as compared to urban big city.

7. Conclusion

WiMAX Technology is one of the emerging wireless technologies that provide us high speed mobile data and telecommunication services. It is capable of delivering broadband Internet service and extending services like Internet telephony throughout India without major disruption to transportation and other services. The rural area coverage via technology is very difficult, by using wireless feature; we can try to cover the geographical area.

Predicting path loss and finding coverage area are important factors in wimax wireless system for proper planning, interference estimations and frequency assignments. By using Okumura –Hata model we predict path loss and coverage area in outdoor environment such as rural, urban and sub urban. Application also compares a coverage area, propagation path loss and received power in different environment. Since site measurements are costly, propagation models are convenient alternative for predicting path loss in outdoor environments.

8. References

1. M. A. Alim, M. M. Rahman, M. M. Hossain, A. Al-Nahid, "Analysis of Large-Scale Propagation Models for Mobile Communications in Urban Area" (IJCSIS) International Journal of Computer Science and Information Security, Vol. 7, No. 1, 2010.
2. Jim Martin, Bo Li, Will Pressly, James Westall, "WiMAX Performance at 4.9 GHz" 978-1-4244-3888-4/10/©2010 IEEE.
3. Md. Didarul Alam1 and Md. Rezaul Huque Khan, "Comparative Study of Path Loss Models of WiMAX at 2.5 GHz Frequency Band" International Journal of Future Generation Communication and Networking Vol. 6, No. 2, April, 2013.
4. Bo Li, Yang Qin , Chor Ping Low and Choon Lim "A Survey on Mobile WiMAX" IEEE Communications Magazine • December 2007
5. WiMAX Forum, "Mobile WiMAX — Part II: A Comparative Analysis", May 2006; http://www.wimaxforum.org/
6. Mrs. Kalpana Chaudhari, Dr Mrs. Upena D Dalal and Mr. Rakesh Jha, "Mobile Governance based on WiMAX Connectivity for Rural Development in India", I. J. Computer Network and Information Security, volume 4,(49-55).2012.
7. Mohammed Alshami, Tughrul Arslan, John Thompson and Ahmet Erdogan, "Evaluation of Path Loss Models at WiMAX Cell edge" 978-1-4244-8704-2/11/ ©2011 IEEE.
8. Josip Milanovic, Snjezana Rimac-Drlje, Krunoslav Bejuk, "Comparison of Propagation Models Accuracy for WiMAX on 3.5 GHz" 1-4244-1378-8/07/ ©2007 IEEE.
9. Magdy F. Iskander, and Zhengqing Yun ,"Propagation Prediction Models for Wireless Communication Systems" IEEE transactions on microwave theory and techniques, vol. 50, no. 3, march 2002 ,0018–9480/02 © 2002 IEEE
10. Y.-H. Lee, H. -W. Tseng, , W.-C. Lee, J.-Y. Lin, Y.-G. Jan and H.-W. Tsao , "The measurement and analysis of wimax Base station signal coverage" Progress In Electromagnetics Research C, Vol. 25, 223 -232, 2012.
11. René Wahl, Oliver Stäbler, Gerd Wölfle "Propagation Model and Network Simulator for Stationary and Nomadic WiMAX Networks" 1-4244-0264-6/07/ ©2007 IEEE.
12. Chhaya Dalela, "Propagation Path Loss Modeling forDeployed WiMAX Network" International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, Volume 2, Issue 8, August 2012).
13. Magdy F. Iskander, and Zhengqing Yun ,"Propagation Prediction Models for Wireless Communication Systems" IEEE transactions on microwave theory and techniques, vol. 50, no. 3, march 2002 ,0018–9480/02 © 2002 IEEE
14. Z. Nadir, N. Elfadhil, F. Touati ,"Pathloss Determination Using Okumura-Hata Model And Spline Interpolation For Missing Data For Oman" Proceedings of the World Congress on Engineering 2008 Vol I ,WCE 2008, July 2 - 4, 2008, London, U.K.