International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 04 | Apr-2018 www.irjet.net p-ISSN: 2395-0072

Optimized Path loss model for the effects of Environmental Factors on Mobile Signal Strength

Pooja.N[1], Anitha.R[2], C.S Hanchinal[3]

[1]*Dept.of Computer Science & Engineering, NIE College, Mysore, Karnataka, India*
[2] *Associate Professor, NIE College, Mysore, Karnataka, India*
[3] *Sub-Divisional Engineer, RTTC, BSNL, Mysore, Karnataka, India*

***

Abstract - *Mobile communication is the fastest growing segment of the wireless industry. Radio Path Loss is defined as the decrease in power density when a signal is transmitted from transmitter to receiver.*

Accurate characterization of radio channel through key parameters and a mathematical model is important for: Predicting signal, coverage, achievable data rates, network planning, Quality of service, hand over performance, etc.

The efficiency of Okumara-Hata Model and Walfish-Ikegami Path loss model suffers when the varying Environmental factors are considered.

This paper mainly aims to a provide an analysis of Signal Strength correlated with Environmental parameters such as Humidity, Pressure, Temperature, in urban areas. The Walfisch Ikegami Model is taken into consideration and a new optimized model comprising of the effects of atmosphere, for the same is suggested to improve its efficiency. A Graph for Signal strength vs. different environmental parameters is plotted.

Key Words: **Radio Pathloss, Network Planning, Quality of Service, Environmental Parameters, Okumara-Hata, Walfisch-Ikegami, Signal Strength**

1.INTRODUCTION

The advancement in wireless communication systems with exponential growth in number of subscribers, motivated to a great journey from 1G to 4G.

The wireless channel environment is mainly governed by the performance of wireless communication systems. Channel environment plays main role in wireless communication. So, the foundation for the development of high performance and bandwidth-efficient wireless transmission technology is very important. Antennas are known to be one of the major components in mobile system communication. One of the most important application of Mobile Radio Engineering is that it involves long distance communication by means of electromagnetic waves.

The wave propagation characteristics between transmitter & Receiver are controlled by the transmitting antenna, operating frequencies and media between them. [1] Mobile communication is the fastest growing segment of the wireless industry.

The last decade, motivated a great development in field of telecommunications which has shrink the globe into a small village. The mobile communication had a key breakthrough from analog to digital communication. [2]

This paper aims to provide a model which consists of signal strength correlated with the environmental parameters. A new model considering all the environmental Factors in urban areas such as Temperature, Humidity, Pressure, Wind speed are co-related with Received mobile signal strength from a constant Base Terminal Station using a drive test tool. Performance Evaluation is done on the signal strength received for different weather parameters such as temperature, humidity and pressure.

1.1 Cellular Concept

The key idea of modern cellular systems is that it is possible to serve the unlimited number of subscribers, distributed over an unlimited area, using only a limited number of channels, by efficient channel reuse. The area serviced by a transmitter is called a cell. [2]. The power loss involved in transmission between the base station (BTS) and Mobile Station (MS) is known as the path loss and depends particularly on the antenna height, carrier frequency and distance.

There are basically three types of cells:

Macro Cell - They are the main means of providing initial network coverage over a wide area. However, the propagation models are also applicable to broadcasting, private mobile radio and fixed wireless access applications including WiMAX.

Micro Cell - The deployment of Micro cells is motivated by a desire to reduce cell sizes in areas where large number of users require access to the system. Serving these users with limited radio spectrum requires frequencies to be reused over very short distances, with each cell containing very limited number of users.

Pico Cells – When a base station antenna is located inside a building, a picocell is formed. Picocells are used in cellular telephony for high traffic areas.

1.2 Radio Path Loss

Path Loss is the decrease in the power density of an electromagnetic wave between the transmitter and the receiver [3].

It depends on several factors such as distance between the transmitter and the receiver, Environmental factors, type of wave propagation, height and location of the antennas, reflection, diffraction etc.

For the growth and betterment of Mobile Communication, Path loss is highly inevitable for the evaluation of network services.

Fig -1: Radio Path Loss

1.3 Atmospheric Effects

The earth's atmosphere has characteristics that affect the propagation of radio waves. These effects happen at different points in the atmosphere. The most important atmospheric effects on radio wave propagation are refraction and reflection. Refraction can occur in the troposphere or the ionosphere. Tropospheric refraction occurs because the refractive index of the atmosphere decreases as altitude increases, leading to a bending of waves back toward the earth.

Atmospheric Refraction

Refraction in the troposphere produces rays, initially launched horizontally bending along with the curvature of the earth [4]. To understand this process, we first examine the refractive index of the atmosphere as a function of altitude.

The refractivity of the atmosphere is a function of many things, including the air pressure (p), the absolute temperate (T), and the humidity (e). A commonly used expression is

$$N = \frac{77.6}{T}\left(p + \frac{4810e}{T}\right)$$

where p is in millibars, T is in Kelvin, and e is expressed as the partial pressure of water vapor,

in millibars. The most important thing to note is that refractivity is inversely proportional to temperature and directly proportional to pressure and humidity. Hence, as we go higher into the atmosphere, the refractivity tends to drop, the pressure is less, and the air is drier.

Temperature plays a role as well, and, temperature gradients can cause the refractivity profile to be non-monotonic.

The refractivity of the atmosphere decreases as you get higher into the atmosphere. This leads to a curved propagation path for rays that are incident to the atmosphere at an angle.

1.4 LOS and NLOS

LOS (Line of Sight) deployment is possible when there is no obstruction between base station (BS) and mobile/fixed subscriber stations (SSs). In other words, LOS communication is possible when there is no obstruction between transmitter and receiver.

NLOS (Non-Line of Sight) communication is possible even when there is obstruction between transmitter and receiver. The signal arrives to the receiver after going through many obstructions in between. On the path, signal goes through attenuations as well as reflection, diffraction as well as penetrations [9].

2. EXISTING MODEL

The two basic propagation models (free space loss and plane earth loss) would require detailed knowledge of the location, dimension and constitutive parameters of every tree, building and terrain feature in the area to be covered. One appropriate way of accounting for these complex effects is via an empirical prediction models among them are: Okumara-Hata model, Cost 231-Hata model, Cost 231 Walfisch-Ikegami model. These models depend on location, frequency range and clutter type such as urban, sub-urban and country side [8].

2.1 Existing COST-231 Walfisch-Ikegami Model

It is based on considerations of reflection and scattering above and between buildings in urban environments. It considers both line of sight (LOS) and non-line of sight (NLOS) situations. It is designed for 800 MHz to 2 GHz, base station heights of 4 to 50 m, and cell sizes up to 5 km, and is especially convenient for predictions in urban corridors.

The case of line of sight is approximated by a model using free space approximation up to 20 m and the following beyond:

$L_{LOS} = 42.6 + 26 \log (d/ 1km) + 20 \log (f/1 MHz)$ for d>=20m
The models for non-line of sight considers various scattering and diffraction properties of the surrounding buildings:

$$L_{NLOS} = L_0 + \max \{0, L_{rts} + L_{msd}\}$$

where L0 represents free space loss, Lrts is a correction factor representing diffraction and scatter from rooftop to street, and Lmsd represents multiscreen diffraction due to urban rows of buildings [1].

2.2 Problem Statement

Wallfish Ikegami model fails in its efficiency when the varying environmental factors are considered. The major drawback of this model is, it focuses more on roof to street diffraction effects and neglects the losses because of changes in atmospheric factors such as Temperature, Pressure and Humidity. Signal strength significantly varies with the changes in atmospheric factors. There is a need for considering the atmospheric factor in propagation prediction models, to achieve optimum design of next generation communication systems.

2.3 Proposed System

The existing system of COST-231 Walfisch-Ikegami Model does not consider the effects of Environmental Factors on Signal Strength. The revised version of this model encorporates the concept of Atmospheric Refraction(which is dependent on Atmospheric Temperatue, Pressure and Humidity). Thus the Atmospheric Refractivity 'N' is integrated with the existing model for the accurate result of the path loss.

For both LOS and NLOS models, initially signal strength is measured along with the corresponding values of Temperature, pressure and humidity. Refractivity 'N' is computed and finally 'N' is combined with the existing COST-231 Walfisch-Ikegami model to obtain accurate results.

3. METHODOLOGY

Drive testing is performed for a specific network (2G,3G,4G) to measure the Signal Strength with a constant Base station. Drive testing is a method of accessing and measuring the coverage and capacity of a mobile radio network [5].

Drive tests are most common measurement tool used by operators to probe the quality status and solve network problem. Then, Received Signal Strength(RSS) is recorded and corelated with corresponding environmental factors such as Temperature, Pressure and Humidity.

For Urban areas, an existing path loss model, COST-231 Walfisch-Ikegami Model which does not consider the environmental effects on signal strength is considered for further analysis. Refractive Index of Atmosphere(N), which is a function of Temperature, Pressure and Humidtiy is computed. A revised-model is suggested by combining the computed value of the Atmospheric Refractive Index 'N' to the existing model to obtain the accurate path loss.

The effects of Temperature, Pressure and Humidity on the Received Signal strength is as shown in the graph.

The case of line of sight. Loss is calculated as;

LLOS =42.6+26 log (d/ 1km) + 20 log (f/1 MHz) + N
and in case of Non-Line of sight;

LNLOS = L0 + max {0, L rts + L msd + N}

Where 'N' is refractivity and it is given by,

N=77.6/T(P+4810H/T) (Refractivity is a function of Temperature, Humidity and Pressure) [7].

4. OBSERVATIONS

The received signal strength recorded with the help of drive test tool with a constant base station at different timings along with corresponding Atmospheric factors values as taken from a Weather Mobile application is as shown below:

Table-1: Signal Strength(2G,3G,4G) corelated with Atmospheric Factors

Sl.No	Signal Strength in dBm	Temperature in Centigrade	Pressure in KPa	Humidity in %
1	-55.8583	21	101.14	11
2	-56.2713	22	101.14	12
3	-57.3714	23	101.11	12
4	-58.2308	24	101.12	15
5	-58.2047	25	101.25	27
6	-58.3273	27	101.35	40
7	-59.6077	28	101.42	48
8	-62.3269	30	102.00	57
9	-67.8578	31	102.02	62
10	-71.6475	32	102.10	69
11	-73.5557	33	102.12	76
12	-75.2345	34	102.13	80
13	-79.0914	35	100.99	82
14	-81.2528	36	101.12	85
15	-82.077	37	101.76	86

From the above readings, we can conclude that changes in atmosphere at different time has an impact on the received signal strength of mobile communication system.

1. As the Temperature increases, Signal strength decreases. Signal Strength is inversely proportional to the Atmospheric Temperature.

2. Atmospheric Pressure also has a negative effect on the mobile signal strength.

3. Higher the Humidity, Lower the Signal strength.

4.1 Graph

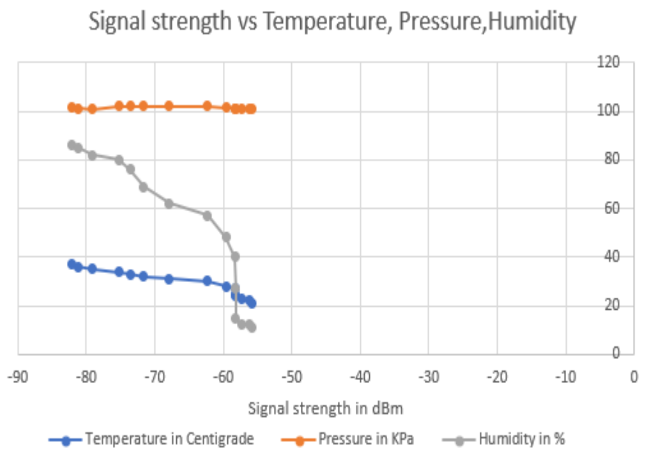

Fig -2:Graph of Signal strength vs Environmental Factors

5. CONCLUSIONS

After a brief analysis of signal strength corelated with the environmental factors, we can conclude that Environmental factors greatly affect the mobile Signal Strength. There is a need for considering the atmospheric factor in propagation prediction models, to achieve optimum design of next generation communication systems. The Revised Walfisch-Ikegami model gives an accurate prediction of path loss by incorporating the environmental parameters to achieve the required cell coverage and Quality of Service. The new model suggested can be widely used by the network administrators for proper planning of the mobile network.

Advantages of Proposed model are; Optimization of the Network, to check deployments of new Network sites to meet coverage and Quality of service, trouble Shooting, benchmarking of performance and to verify performance after upgradation or reconfiguration of the Network.

REFERENCES

[1] C.S.Hanchinal, Dr. K.N. Muralidhara "A Survey on the Atmospheric Effects on Radio Path Loss in Cellular Mobile Communication System" International Journal for Computer Science & Technology.IJCST-2016

[2] Prof. Sean Victor Hum "Radio and Microwave Wireless Systems"

[3] Steve Worgu, Samuel Godwin Ajumo, Njumoke N. Odu "Comparative Evaluation of the Pathloss Prediction Performance Hata-Okumura Pathloss Model for Urban, Suburban and Rural Areas". IJSSAM 2017

[4] "Path Loss model using Geographical Information System". Research Gate-2013

[5] M. Rahnema "Overview of the GSM system and protocol architecture" IEEE-2012

[6] Isabona Joseph, Konyeha. C.C "Urban Area Path loss Propagation Prediction and Optimisation Using Hata Model at 800MHz" IOSR Journal of Applied Physics-2013

[7]Edilbrito.O.Rosal,Evaldo.G.Pelase "Statistical adjustment of Walfisch-Ikegami model based in urban propagation measurements" IEEE-2007

[8] JDSU "Drive Testing Lte White paper" JDSU

[9] "Performance Analysis of Pathloss Prediction Models in Wireless Mobile Networks in Different Propagation Environments". (EECSS 2017)