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PROPAGATION PATH LOSS IN URBAN AND SUBURBAN AREA

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ABSTRACT

In this paper, we would discuss the influence of propagation environment in a GSM mobile network. Here we discuss the path loss in urban and suburban areas. The objective of this paper is to develop and optimize a path loss model based on the existing Hata path loss model and outdoor measurement using frequency range from 400MHz to 1800 MHz. The Hata and many other path loss propagation models are compared with the measured data taken in the drive test. The result shows that the measured data and the Hata model are close while the other models undervalue the path loss phenomena. The values for modified empirical parameters of Hata model were developed and presented in this paper. The modification of hata model is given by considering building effects and dust storm effects in the above mentioned area.

Keywords— Propagation path loss, Hata model, Received signal strength, Measured data.

I INTRODUCTION

GSM is one of the most widely used technologies in the world of wireless communication. Wireless communication works highly to provide mobility for customers and try to satisfy all the general demands of the subscribers at any location covered by the wireless network. We are facing degradation of the mobile phone signal due to various obstacles between base station and mobile stations in urban and suburban area. Without radio wave propagation we cannot imagine the wireless communication. It is one of the most important phenomenons in our daily life. When a radio signal travels from transmitter station to receiver station in mobile communication passes through the earth's environment and this can introduce certain impairments. This transmission process at higher frequencies is usually changed by surrounding conditions and climatic conditions such as rain, vapour, dust, snow, cloud, fog and mist. Path loss models are important for predicting coverage area, interference analysis, frequency assignments and cell parameters which are basic elements for network planning process in mobile radio systems.

The propagation models can be divided into three types of models namely the empirical models, semi-deterministic models and deterministic models. Empirical models are based on measurement data, statistical properties and few parameters. Examples of this model category will be Okumura model and Hata model.

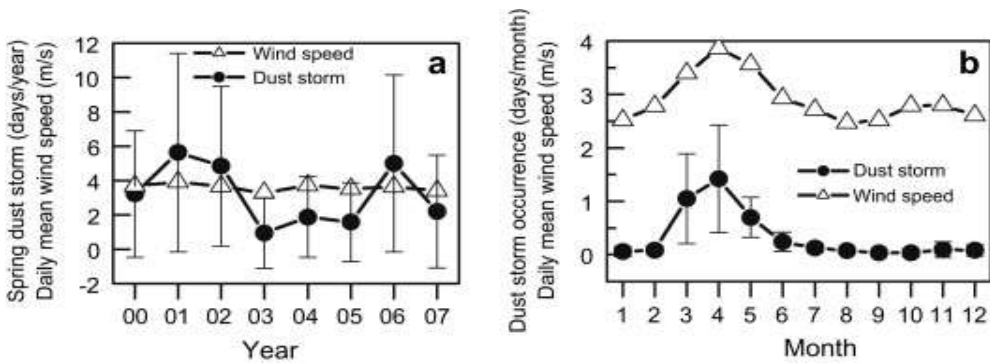

Fig.1 Average Dust Storms And Wind Speed (M/S)

II PROPAGATION PATH LOSS

Path loss refers to electromagnetic wave attenuation between transmitter and receiver in the communication system. Path loss might be due to effects such as diffraction, refraction, reflection, free space loss, coupling loss and absorption loss. Path loss is a major component in the analysis and design of the link budget of a telecommunication system. The term path loss is commonly used in wireless communications and signal propagation. The average large-scale path loss for an arbitrary transmitter to receiver separation is expressed as a function of distance as:

$$\mathbf{P_L(db) = P_L(do) + 10n\log_{10}(d/d_o)}$$

Where, n = path loss exponent
d = measured distance
d_o = reference distance

The following are some of the major elements causing signal path loss for any radio wave system.

2.1 Free space loss: In free space there are no obstacles. The propagated wave radiates freely to an infinite distance without being absorbed or reflected. This is the ideal case scenario and not very possible in real life situations. The calculation of free space path loss is done by following equation.

$$PL(db) = Gt - Gr + 32.44 + 20\log(d) + 20\log(f)$$

Where, Gt= transmitted antenna gain in dBm

Gr= received antenna gain in dBm

d =T-R separation in Km.

f = frequency in (MHz)

2.2 Multipath: In a real global environment, signals will be reflected and they will reach the receiver via a number of different paths. These signals may add or subtract from each other depending upon the relative phases of the signals. This entire process leads to a loss which is multipath loss. Mobile receivers (e.g. Mobile phones) are subject to this effect which is known as Rayleigh fading.

2.3 Atmosphere: It affects at low frequencies, especially below 30-50MHz, the ionosphere has a major effect, reflecting them back to Earth.

III HATA MODEL

To measure path loss we have many more models. In all those models Hata model is giving more reliable results which are near to the data taken after comparing with the practical drive test. The model developed by Y. Okumura and M.Hata and is based on measurements in urban and suburban areas. The Hata model is an empirical formulation of the graphical path-loss data provided by the Okumura and is valid over roughly the same range of frequencies, 150-1500MHz. This empirical model simplifies calculation of path loss since it is a closed-form formula and is not based on empirical curves for the different parameters.

3.1 Urban area: Built up city or large town with large building and houses.

$$L\,(dB) = 69.55+26.16 \log_{10} (f_C)-13.82 \log_{10}(h_{te})-a(h_{re})+(44.9-6.55 \log_{10}(h_{te})) \log_{10}(d)$$

a (*hre*) = correction factor for the mobile antenna height based on the size of the coverage area.

$a\,(h_r)= 3.2(\log (11.75h_r)^2 - 4.97dB$

hte= base station antenna height above local terrain height(m)

r=great circle distance between base station and mobile (m)

f= carrier frequency (Hz)

$fc = f * 10^{-6}$ carrier frequency(MHz)

3.2 Suburban area: Village highway scattered with trees and house with some obstacles near the mobile but not very congested. Suburban areas path loss:

$$L\,(db) = 69.55+26.16 \log fc-13.82\log h_{te}+(44.9-6.55 \log h_{te}) \log R-2[(\log(f_c/28))^2+5.4]$$

Hata's model does not provide for any path specific correction factors, as is available in the Okumura model. The Hata model well-approximates the Okumura model for distances *d* > 1 Km. Thus, it is a good model for first generation cellular systems, but does not model propagation well in current cellular systems with smaller cell sizes and higher frequencies.

IV RECEIVED SIGNAL STRENGTH

Received signal strength is a strength which is used to measure the power between the received radio signals. For each base station there is a threshold point below which connection break with active base station. Therefore the signal strength must be greater than threshold point to maintain the connection with active BS. The signal gets weaker as mobile moves far away from active base station and gets stronger signal towards new base station as it move closer. The received signal strength for Okumara Hata model is calculated as:

$$P_r = P_t + G_t + G_r - PL - A$$

Where, Pr= received signal strength in dBm

Pt =transmitted power in dBm

Gt=transmitted antenna gain in dBm

Gr=received antenna gain in dBm

PL=total path loss in dBm

A=connector and cable loss in dBm

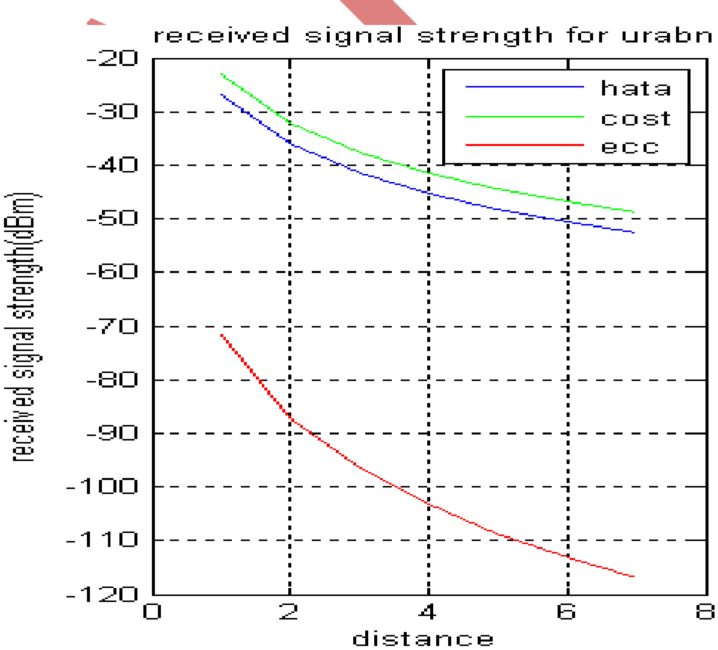

Fig.2 Received Signal Strength for Urban Areas

V COMPARISON WITH MEASURED DATA

Field measurement data was taken in the urban, suburban and rural using spectrum analyzer. The power from the transmitter taken is 5KW.The close-in reference distance taken is1KW. Measurements were taken in regular intervals between 1KW and 5KW. By observing the practical received power strength we got a conclusion that the path loss is less in the rural areas than in sub urban and urban areas. That means the path loss is more in the case of urban environment.

By observing the practical received power strength we got a conclusion that the path loss from the field data is near to the Hata model as shown in the figures. The accuracy of the any existing model is going to suffer when they are used in the surroundings or the fields other than they were designed so the original Hata model needs some correction to get the accurate results in the mentioned environment at which we have taken the field measured data. In this congested urban environment on calculating the path loss first we are considering the large buildings and secondly the regular dust storms occurring during summer. Addition of building and dust storm effects in the original Hata model we are getting better results which are shown in figure. At lower values of visibility we found more path loss as comparison with the higher values of visibility.

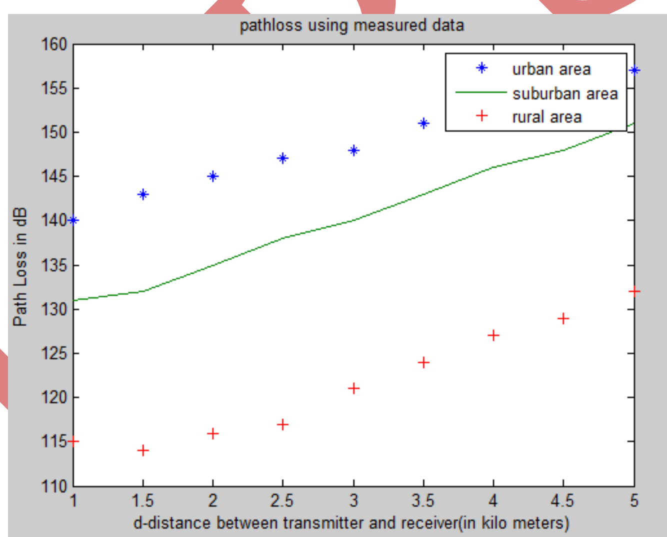

Fig.3 Measured path loss in different enviroment

VI CONCLUSION

Here we discussed different models and calculated path loss in two different environments (urban and suburban) using MATLAB Software and those results are compared with the field measurement data. Presented here are the statistically derived path loss models for wireless communications systems for both urban and suburban area. The comparison between the measured model and the Hata model, showed a difference that was used to modify the Hata model. The work in this paper reveals a considerable advance in our understanding the role of buildings and dust storms in the signal attenuation. With the help of this modified model we can predict the path loss more effectively than the existing models.

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