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Evaluation for Suitable Large-Scale Propagation Models to Mobile Communications in Urban-Area

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Abstract: *Propagation models that characterize the rapid fluctuations of the receiver signal strength over very short travel distances (few wavelengths) or short time durations (in the order of seconds) are called small-scale or fading models. Many research activities, such as simulation and system design, need a model of the channel under study. Models are available in the literature, but often it is difficult to match the real scenario to the theoretical models at disposal. In this paper, the large-scale propagation performance of Okumura- Hate, cost231 and log-normal propagation models has been compared and evaluated varying Mobile Station (MS) antenna height, transmitter-receiver (T-R) separation distance and Base Station (BS) antenna height, considering the system to operate at 1800 MHz The main concentration in this paper is to find out a suitable model to provide guidelines to help the network designers. The simulation is done via mat lab tool to show the results of our search.* *Keywords- propagation models, large-scale propagation, Okumura-Hate model, cost231model and log-normal model.*

I. INTRODUCTION

The path loss propagation models have been an active area of research in recent years. Path loss is unwanted signal strength reductions that signal suffers when propagating from transmitter to receiver. The losses present in a signal during propagation from base station to receiver may be classical and already exiting. General classification includes three forms of modeling to analyze. These losses are shown in figure (1) [1] [2].

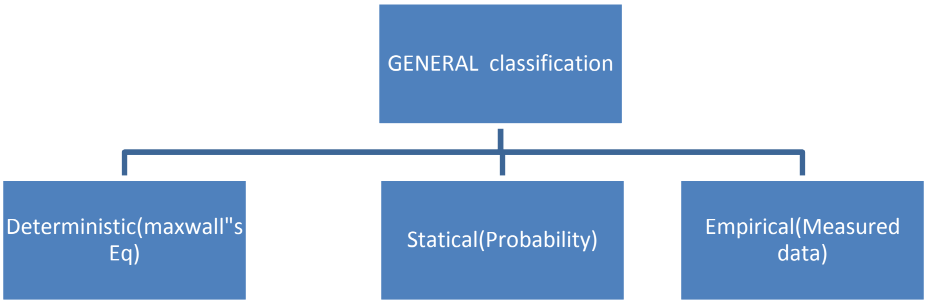

Fig.1. General Classification of path loss modeling

In the above models Deterministic models are better to find the propagation path losses. This model uses Maxwell's equations along with reflection and diffraction laws. The Statistical models use probability analysis by finding the probability density function. The empirical models uses Existing equations obtained from results of s measurement efforts .this model also gives very accurate results but the main problem with this type of model is computational complexity [2]. In mobile radio systems, path loss models are necessary for p roper planning, interference estimations, frequency assignments, and cell parameters which are basic for network Planning process as well as LBS techniques that are not based on GPS system [3].

II. LITERATURE REVIEW

Path loss characteristics of a channel are commonly important in wireless communications and signal propagation. Path loss may occur due to many effects, such as free-space loss, refraction, diffraction, reflection, aperture-medium coupling loss and absorption. Path loss is also influenced by terrain contours, environment (urban or rural, vegetation and foliage), propagation medium (dry or moist air), the distance between the transmitter and the receiver, and the height of antennas [3,4].

Path loss normally includes propagation losses caused by

- The natural expansion of the radio wave front in free space (which usually takes the shape of an everincreasing sphere)
- Absorption losses (sometimes called penetration losses)
- Losses caused by other phenomena.

The signal radiated by a transmitter may also travel alongmany and different paths to a receiver simultaneously; this effect is called multipath. Multipath can either increase or decrease received signal strength, depending on whether theindividual multipath wavefronts interfere constructively or destructively.

III. PROPAGATION PATH LOSS MODELS

We introduce in this session different kinds of propagation models with discussions and analysis.

3.1 Free-Space Propagation Model

In wireless communications, path loss can be represented by the path loss exponent, whose value is normally in the range of 2 to 4 (where 2 is for propagation in free space, 4 is for relatively lossy environments. In some environments, such as buildings, stadiums and other indoor environments, the pathloss exponent can reach values in the range of 4 to 6. On the other hand, a tunnel may acts a waveguide, resulting in a pathloss exponent less than 2 [4,5,6].

This is an ideal model used to compute the received signal strength when there is a direct LOS between a [1, 3,7] transmitter and a receiver unit, placed at distance (d) between them, without any obstacles near the line of sight. The power received in free space (P_r) is given by the Fries transmission equation

$$p_r(t) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L} \quad (1)$$

Where P_t is the transmitted power, G_t is the transmitter antenna’s gain, G_r is the receiver antenna’s gain, λ is the wavelength (expressed in the same unit as d) and L is the system loss factor (≥ 1, for example filter losses, antenna losses, etc…). From now on, without loss in generality, we assume L=1 the path loss or free-space loss L_{fs} is defined as the ratio between the effective transmitted power and the received power, which includes the effects of the antenna gains

$$L_{fs} = 10 \log \left(\frac{P_t G_t G_r}{p_r L} \right) = 20\log\left(\frac{4\pi d}{\lambda} \right) \quad (2)$$

The antenna gain is given by

$$G = \frac{4\pi A_e}{\lambda^2} \quad (3)$$

Where A_e is the effective size of the antenna. Theoretical and measurement-based models, developed in generic environments with or without LOS, indicate that the average received signal power decreases with the distance raised to some exponent. The exponent is 2, that is, the received power decreases as the square of distance.

The link Budget equation

$$P_r = P_t + G_t + G_r - L_f - L_p \quad (4)$$

Where

L_p: Path Loss, L_f: Feeder Loss and The path loss equation

$$L_p = 34.2 + 20\log(f_c) + 20\log(d) \quad (5)$$

Where

d: Distance between Tx and Rx in Km and fc: carrier frequency in MHz

3.2 Log-distance Path Loss Model

Theoretical and measurement based propagation models indicate that average received signal power decrease logarithmically with distance in radio channels. The expression for path loss in this model is [1]. In the lognormal path loss propagation model the average path loss for an arbitrary T-R couple, $\overline{L}_p(d)$ is expressed as a function of the distance d by using a path loss exponent, independently of the presence of a direct LOS between the transmitter and the receiver units.

Path loss $L_p(d)$ is a random variable that has a lognormal distribution around a mean value $\overline{L}_p(d)$ the mean path loss value, expressed in dB, is:

$$\overline{L}_p(d) \propto (\frac{d}{d_o})^n \quad (6)$$

$$\overline{L}_p(d)\Big|_{dB} = L_{fs}(d_o)\Big|_{dB} + 10\log(\frac{d}{d_o}) \quad (7)$$

Where ‘n’ is path loss exponent, ‘d’ is the T-R separation distance in meters and ‘d0’ is the close-in reference distance in meters [3].

3.3 Okumura-hata model

The Hate model (1980) is an empirical formulation of the curves provided by Okumura, approximated through analytical formulations.[1]

Hate presents the urban area path loss and supplies a correction factor to the formula for applying it to other situations. The formula for the median path loss in urban areas is given by:

$$L(urban) = 69.55 + 26.16\log f_c - 13.82\log h_t - a(h_r) + (44.9 - 6.55\log h_t)\log d \quad (8)$$

where the path loss is expressed in dB, f_c is the frequency in the range 150-1500 MHz, h_t is the effective transmitter antenna height ranging from 30 to 200 meters, h_r is the effective receiver antenna height ranging from 1 to 10 meters, d is the distance between transmitter and receiver in km, and $a(h_r)$ is the correction factor for the effective receiver antenna height, which depends on the environment. For a small or medium city, the correction factor is given by [8].

$$a(h_r) = (1.1\log f_c - 0.7)h_r - (1.56\log f_c - 0.8) \quad (9)$$

While, for a large city, it is given by

$$a(h_r) = 8.29(\log 1.54h_r)^2 - 1.1 \quad \text{For} \quad fc \leq 200MHz \quad (10)$$

$$= 3.2(\log 11.75h_r)^2 - 4.97 \quad \text{For} \quad fc \geq 400MHz \quad (11)$$

3.4 COST231 Extension to Hata Model

A model that is widely used for predicting path loss in mobile wireless system is the COST-231 Hata model [4,5]. The COST-231 Hata model is designed to be used in the frequency band (fc)from 500 MHz to 2000 MHz It also Contains corrections for urban, suburban and rural (flat) environments. Although its frequency range is outside that Of the measurements, its simplicity and the availability of correction factors has seen it widely used for path loss Prediction at this frequency band. The basic equation for path loss in dB is [1],

$$L_{(urban)} = 46.3 + 33.9\log(h_t) - a(h_r) + (44.9 - 6.55\log h_t)\log d + C_M \quad (12)$$

Where, f is the frequency in MHz, d is the distance between BTS and MS antennas in km, and ht is the BTS antenna height above ground level in meters. The parameter cm is defined as 0 dB for suburban or open environments and 3 dB for urban environments. The parameter a(h_r) is defined for urban environments as [5]

$$a(h_r) = (1.1\log f_c - 0.7)h_r - (1.56\log f_c - 0.8) \qquad (13)$$

Where $a(h_r)$ is defined in equations (9) and (10), and

IV. Simulation Results

Here in this session we will introduce the matlab simulation to describe relationship between power loss and user position in practical case and free space case we consider free space path loss model which is most commonly used idealistic model. We take it as our reference model; so that it can be realized how much path loss occurred by the others proposed models. For fc=1800 MHz, the relation between path loss and the change in distance between (T-R) from1m to 1000m when (BTS) ht=45 m and (MS) hr=1.5 m is shown in figure 2. The relation between path loss and the change in(MS) hr from 1m to 10m when(BTS) ht=45mand distance between (T-R) =1000m is shown in figure 3 Demonstrates the relationship between path loss and the change in (BTS) ht from30m to 200m when (MS) hr=1.5m and distance between (T-R) =1000m is shown in figure 4.

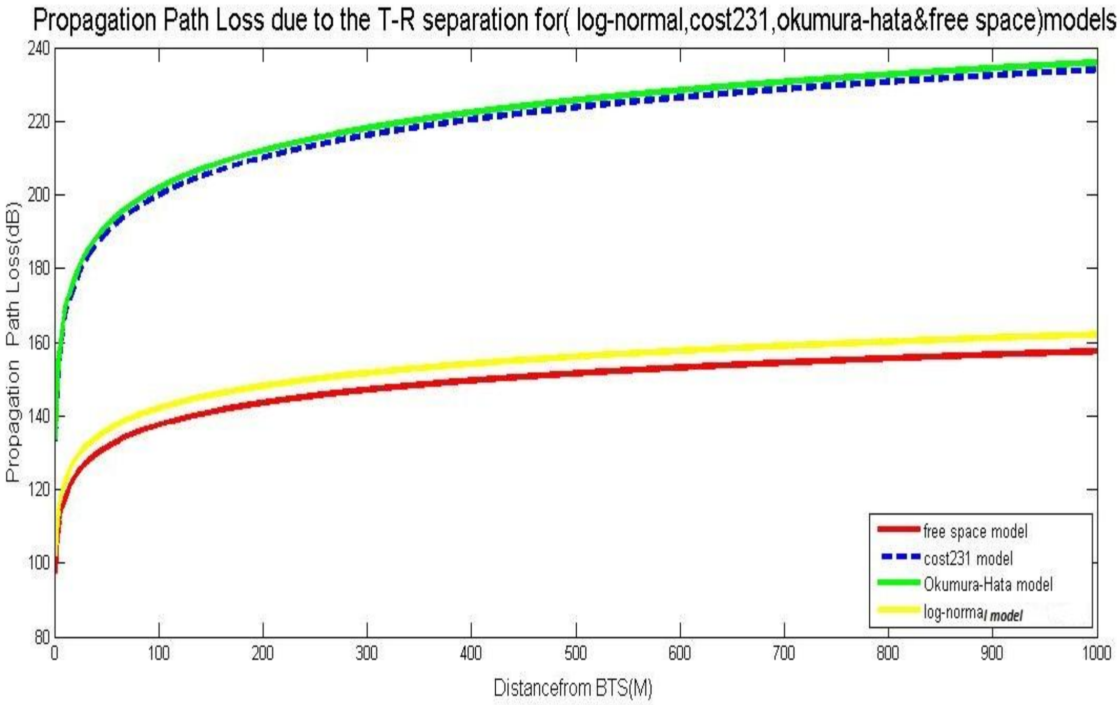

Fig.2. The Relationship between path loss and distance between (T-R)

The values of parameters used in the curve of figure are shown in table 1.

Table 1 System parameters

BTS/Node B antenna height (ht)	45 m
MS antenna height (hr)	1.5 m
BTS/Node B antenna Gain (Gt)	18 dbi
MS antenna Gain (Gr)	2 dbi
central frequency (fc)	1800 MHz
Service Area	1m to 1 Km2

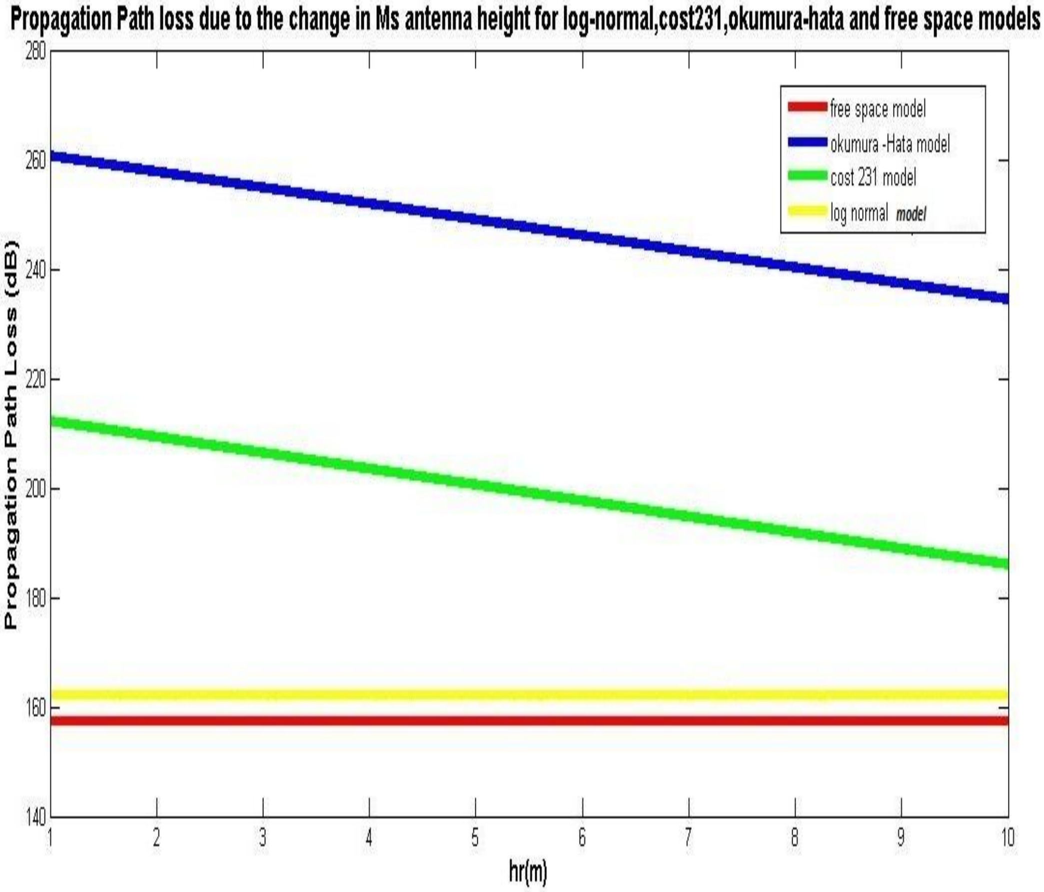

Fig.3. The Relationship between Path loss and hr (MS)

The values of parameters used in simulation of figure 3 are shown in table 2.

Table 2 System parameters

BTS/Node B antenna height (ht)	45m
MS antenna height (hr)	1 mto10m
BTS/Node B antenna Gain (Gt)	18 dbi
MS antenna Gain (Gr)	2 dbi
central frequency (fc)	1800 MHz
Service Area	1 Km2

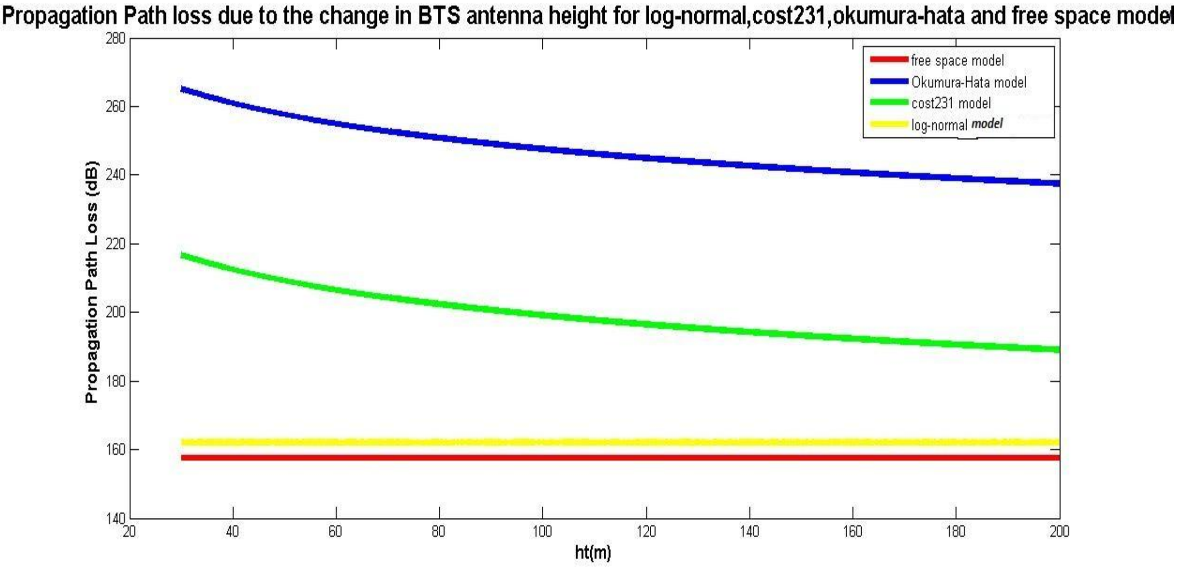

Fig.4. The Relationship between path loss and ht (BTS)

The values of parameters used in simulation of figure 4 are shown in table 3.

Table 3 System parameters

BTS/Node B antenna height (ht)	30 mto200m
MS antenna height (hr)	1.5m
BTS/Node B antenna Gain (Gt)	18 dbi
MS antenna Gain (Gr)	2 dbi
central frequency (fc)	1800 MHz
Service Area	1 Km2

V. Summary of results

From Fig. 2, it is seen that for Okumura –hata model path loss model the propagation path loss is highest due to the increase in MS(hr) distance from BTS(ht) than the other two models and Log-distance path loss model has the Lowest path loss. From the analysis it is seen that overall Log-distance path loss model shows the better performance than that of the other two models. And cost 231 model is better performance than okumura-hata model.

From Fig. 3, it is seen that the propagation path loss increases with the decrease in MS (hr) antenna height for all the models. For Okumura –hata model the loss is maximum, for cost 231 model the loss is medium and for Log-distance path loss model is minimum.

From Figure 4, it is seen that the propagation path loss decreases due to the increase in BTS (ht) antenna height for all the models. For Okumura –hata model the loss is maximum, for cost 231 mode l the loss is medium and for for Log-distance path loss model is minimum.

VI. Conclusions

In this paper, three widely known large scale propagation models are studied and analyzed. The analysis and simulation was done to find out the path loss by varying the BTS antenna height, MS antenna height, and the T-R separation. Okumura-hata model was seen to represent high power loss levels in the curves than cost231, Log-distance models. Log-distance model was seen to represent lowest power loss levels in the curves than cost231, Okumura-hata models. The result of this analysis will help the network designers to choose the proper model in the field applications. Further up-gradation in this result can be possible for the higher range of carrier frequency.

References

[1] T.S Rappaport, "Wireless communications –Principles and practice, 2nd Edition, Prentice Hall", 2001.

[2] Purnima K. Sharma Doctoral candidate Professor UTU, Dehradun (India) , R.K.SinghProfessorKEC, Dhawarahat (India), "Comparative Analysis of Propagation Path loss Models with Field Measured Data”, *International Journal of Engineering Science and Technology,* Vol. 2(6), 2010, 2008-2013.

[3] J. W. Mark, Weihua Zhuang, “Wireless Communications and Networking”, Prentice-Hall, India,2005

[4] F. D. Alotaibi and A. A. Ali, April 2008, “Tuning of lee path loss model based on recent RF measurements in 400 MHz conducted in Riyadh city, Saudi Arabia,” *The Arabian Journal for Science and Engineering,* Vol.33, no. 1B, pp. 145–152.

[5] A. Alim, M. M. Rahman, M. M. Hossain, A. Al-Nahid , "Analysis of Large-Scale Propagation Models for Mobile Communications in Urban Area", M. Electronics and Communication Engineering Discipline, *International Journal of Computer Science and Information Security,* Vol. 7, No. 1, 2010.

[6] http:// en.wikipedia.org/wiki/Radio_Propagation_model, June, 2008.

[7] V.S. Abhayawardhana, I.J. Wassell, D. Crosby, M.P. Sellers, M.G. Brown, "Comparison of empirical propagation path loss models for fixed wireless access systems", *Vehicular Technology Conference,*. IEEE Date: 30 May-1 June 2005 Volume: 1, On page(s): 73- 77 Vol. 1,2005

[8] H. R. Anderson, "Fixed Broadband Wireless System Design. John Wiley & Co.", 2003.