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Calculate Path Loss in Transmitter in Global System Mobile By Using Hata Model and Walkfisch Ikegami

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ABSTRACT

In this paper ,will be calculate the path loss the transmitter in gsm, in free space and within urban using two main techniques Hata Model and Walkfisch Ikegami with the use of values imposed of frequencies ,distances and tower high ,finaly will use the Matlab to comparison of results and represented graphically in two techniques

KEYWORDS :- *Calculate, path loss ,transmitter,*

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1. INTRODUCTION

The path loss is the difference (in dB) between the transmitted power and the received power Represents signal level attenuation caused by free space propagation, reflection, diffraction and scattering[1]. Reflection of an electromagnetic wave occurs when it impinges upon an object with different electrical properties and very large dimensions compared to the wavelength . The wave impinging upon a new medium is partially transmitted into the second medium and partially reflected back to the first medium. If the second medium is perfectly dielectric there is no energy loss during reflection. If one assumes a second medium which is a perfect conductor, all the incident energy is reflected back into the first medium without any loss. When the first medium is free space and the permeabilities of two media are , the electric field intensity of the reflected and the transmitted waves are related by the simplified *Reflection Coefficient.* when predicting the path loss between two fixed stations for large distances, the path profile between the stations is often reduced to single knife edges since the wavelength is short compared to the size of obstacles such as hills. The total path loss is then the free space loss[2].

2. PROPAGATION MODELS

The propagation models are divided into two basic types namely:
Free space propagation , Plane earth propagation model

A -Free space propagation model

In free space, the wave is not reflected or absorbed. Ideal propagation implies equal radiation in all directions from the radiating source and propagation to an infinite distance with no degradation. Spreading the power over greater areas causes the attenuation. Equation (1) illustrates the generic free space path loss formula[3],

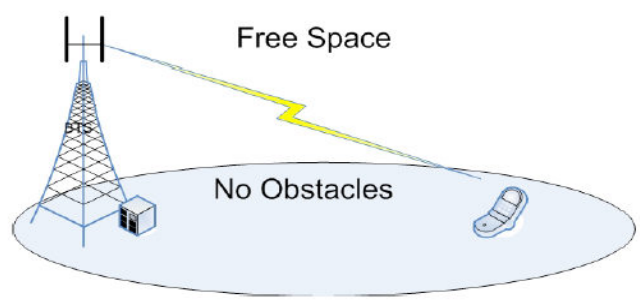

Fig.(1) free space propagation model

$$Lp\,(dB) = 32.5 + 20\log10\,(d) + 20\log10\,(f) \quad (1)$$

Where is
f : Frequency in MHz.
d: Distance in Km.

B. Plane Earth Propagation Model

The free space propagation model does not consider the effects of propagation over ground. When a radio wave propagates over ground, some of the power will be reflected due to the presence of ground and then received by the receiver. Determining the effect of the reflected power, the free space propagation model is modified and referred to as the 'Plain-Earth' propagation model. This model better represents the true characteristics of radio wave propagation over ground. The plane earth model computes the received signal to be the sum of a direct signal and that reflected from a flat, smooth earth. The relevant input parameters include the antenna heights, the length of the path, the operating frequency and the reflection coefficient of the earth. This coefficient will vary according to the terrain type (e.g. water, desert, wet ground etc)[4]. Path Loss Equation for the plane Earth Model is illustrated in equation (2).

$$L_{pe} = 40\log 10\ (d) - 20\log 10\ (h1) - 20\log 10\ (f) \quad (2)$$

C- The Okumura model

Okumura carried out extensive drive test measurements with range of clutter type, frequency, transmitter height, and transmitter power. It states that, the signal strength decreases at much greater rate with distance than that predicted by free space loss , By using vertical directional antennas for both transmitter and mobile, Okumura obtained extensive measurement data for median attenuation relative to free space for different distances and frequencies[2, 5].

D- The Hata model

The Hata model is one of the most common models in designing real systems. Many new models are still using it as a reference model because of its simplicity and accuracy. The Hata model uses four parameters for estimating the path loss: Carrier frequency *(Fc)* in MHZ, distance ® in km, base station antenna height *(hb)* in m, and mobile antenna height *(hm)* in m [2-3].

The model is restricted to:

1. Frequency (fc) from 150 to1500 MHz
2. BTS antenna height (hBTS) from 30 to 200 m.
3. Mobile antenna height hMobile from 1 to 10 m.
4. Distance (d) from 1 to 20Km.

The basic transmission loss (Ldb) can be calculated as follows.

Urban area Ldb =A+B log10®
Suburban area Ldb =A+B log10®-C (3)
Open area Ldb =A+B log10®- D

Where :

$$A = 69.55 + 26.16\log_{10}(f_c) - 13.82\log_{10}(h_b) - \alpha\ ,$$

$$B = 44.9 - 6.55\log_{10}(h_b)\ ,$$

$$C = 2(\log_{10}(f_c/28))^2 + 5.4\ ,$$

$$D = 4.78(\log_{10}(f_c))^2 - 18.33\log_{10}(f_c) + 40.94\ ,$$

$$\alpha = 3.2(\log_{10}(11.75h_m))^2 - 4.97 \qquad \text{large cities, } f_c \geq 300\text{ MHz}$$

$$\alpha = 8.29(\log_{10}(1.54h_m))^2 - 1.1 \qquad \text{large cities, } f_c < 300\text{ MHz}$$

$$\alpha = (1.1\log_{10}(f_c) - 0.7)h_m - (1.56\log_{10}(f_c) - 0.8) \qquad \text{small to medium cities .}$$

E- Walfisch-Ikegami Model.

This empirical model is a combination of the models of J. Walfisch and F. Ikegami. It was enhanced by the COST 231 project. The new name is therefore COST-Walfisch-IkegamiModel.

The model considers the buildings in the vertical plane between the transmitter and the receiver. Street widths, buildings heights as well as transmitter and receiver heights are considered.

The accuracy of this empirical model is quite high because in urban environments the propagation in the vertical plane and over the rooftops (multiple diffractions) is dominating. Especially if the transmitters are mounted above roof top levels.

If the wave guiding effects due to multiple reflections in streets are dominating, the accuracy of the COST Walfisch-Ikegami model is limited – because it is focused on the multiple diffractions in the vertical plane.[4, 5]

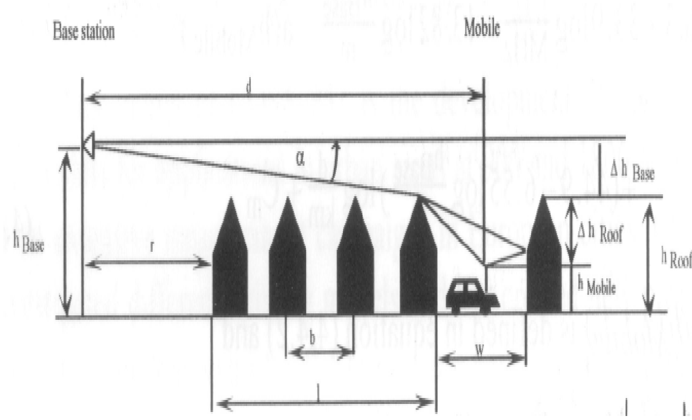

Figure.(2) propagation geometry for model by Walfisch – Ikegami.

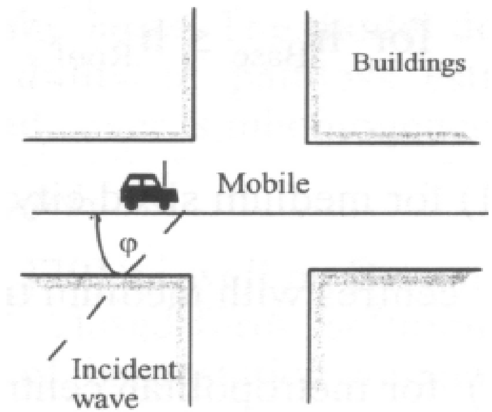

Figure.(3) propagation for model by Walfisch – Ikegami.

Restrictions :
- Frequency (*f*) between 800 MHz and 2000 Mhz
- TX height (*hBase*) between 4 and 50 m.
- RX height (*hMobile*) between 1 and 3 m.
- TX – RX distance (*d*) between 0.02 and 5 km.

Where: [1]

LOS: means line of sight

L_{LOS} [dB] = 42.6 + 26 log10 *d*[km] + 20 log10 *f* [MHz] (4)

NLOS: means Non line of sight

L_{NLOS} [dB] = L_{FS} + L_{rts} (w_r , *f*, Δh_{Mobile} ,ϕ) + L_{MSD} (Δh_{Base} , h_{Base} , *d*, *f*, *bS*). (5)

L_{FS} = free space path loss = 32.4 + 20 log10 d[km] + 20 log10(*f*) [MHz]. (6)

L_{rts} = roof-to-street loss

L_{MSD} = multi-diffraction loss

L_{rts} = -8.8 + 10log10 (*f*) [MHz]) + 20log10 (Δh_{Mobile} [m]) -10 log10 (*w* [m])+ L_{ori} . (7)

$$L_{ORI} = \begin{cases} -10 + 0.35\,\Phi & 0 \le \Phi < 35^\circ \\ 2.5 + 0.075\,(\Phi - 35) & 35^\circ \le \Phi < 55^\circ \\ 4.0 - 0.114\,(\Phi - 55) & 55^\circ \le \Phi < 90^\circ \end{cases}$$

L_{MSD} = L_{bsh} + k_a + k_d log10(*d* [km]) + k_f log10 (*f* [MHz]) - 9 log10(*b*) . (8)

$$\text{Where } L_{bsh} = \begin{cases} -18\log_{10}(1 + \Delta h_{Base}) & h_{Base} > h_{Roof} \\ 0 & h_{Base} \le h_{Roof} \end{cases}$$

$$k_a = \begin{cases} 54 & h_{Base} > h_{Roof} \\ 54 - 0.8\,\Delta h_{Base} & d \ge 0.5\text{ km},\ h_{Base} \le h_{Roof} \\ 54 - 0.8\,\Delta h_{Base}\, d\,[\text{km}]/0.5 & d < 0.5\text{ km},\ h_{Base} \le h_{Roof} \end{cases}$$

$$k_d = \begin{cases} 18 & h_{Base} > h_{Roof} \\ 18 - 15\,\Delta h_{Base}/\,h_{Roof} & h_{Base} \le h_{Roof} \end{cases}$$

$$k_f = -4 + \begin{cases} 0.7\,(f/925 - 1) & \text{medium sized city} \\ 1.5\,(f/925 - 1) & \text{metropolitan center} \end{cases}$$

3-RESULTS AND DISCUSSIONS

After the Matlab program using to obtain on the following

A -Hata model

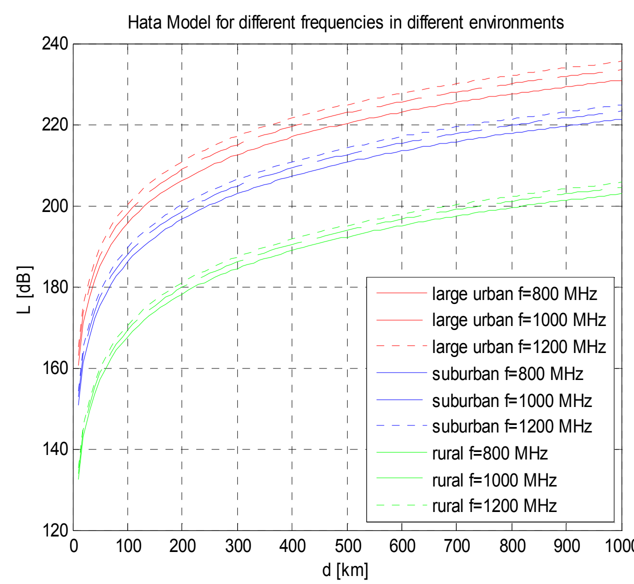

Figure (4). frequencies change

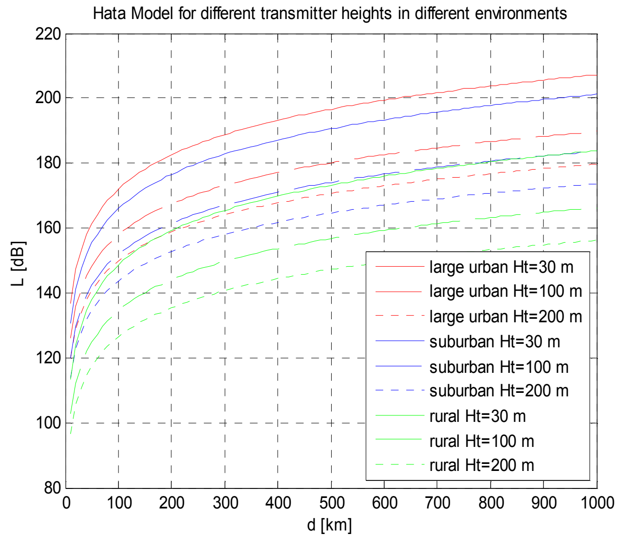

Figure.(5) change the base station antenna height values

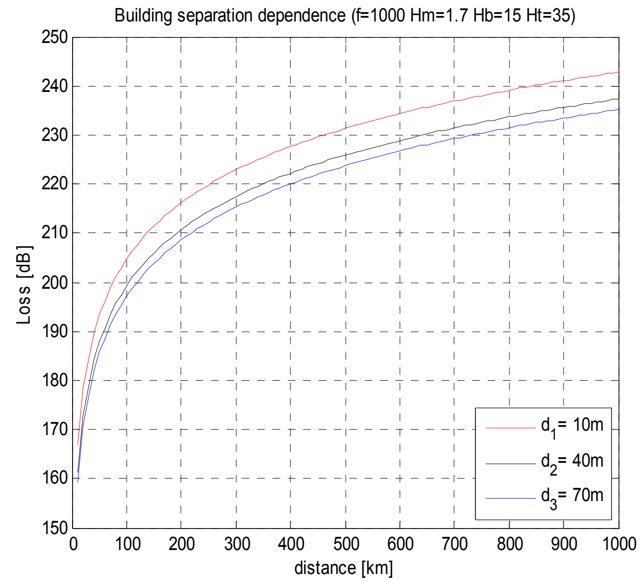

Figure.(7) Building separation height on dependence

B – Walkfisch model

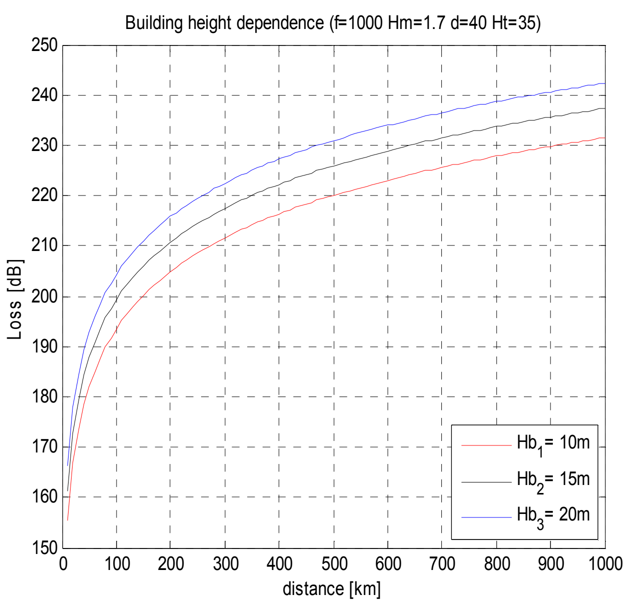

Figure.(6) The Building height on dependence

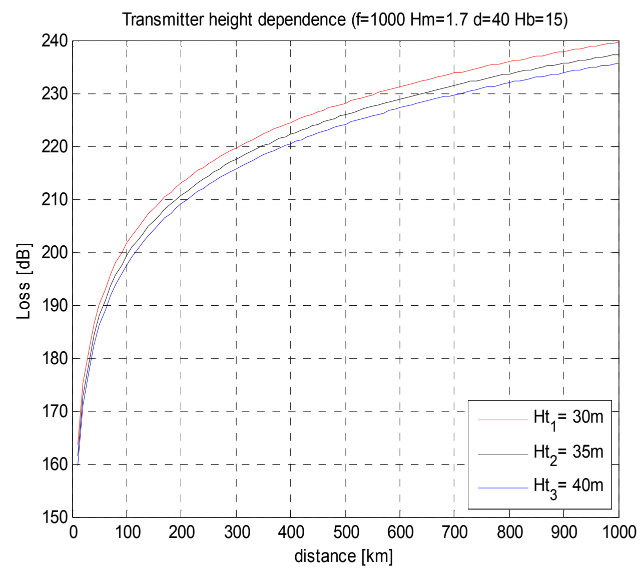

Figure.(8) Transmitter base station height dependence

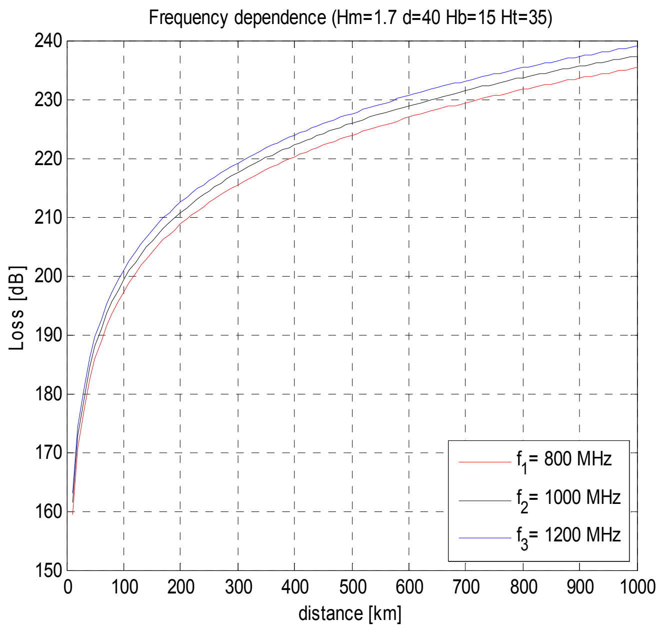

Figure.(9) The frequency on dependence

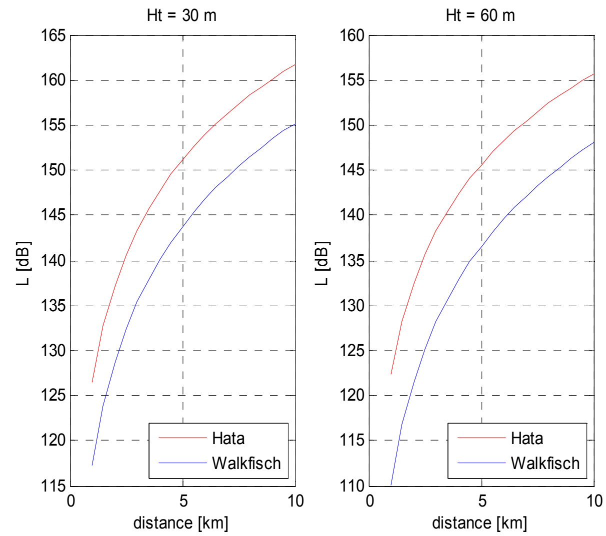

Figure.(11) Transmitter base station height on dependence

D – compare between Hata and Walkfisch model

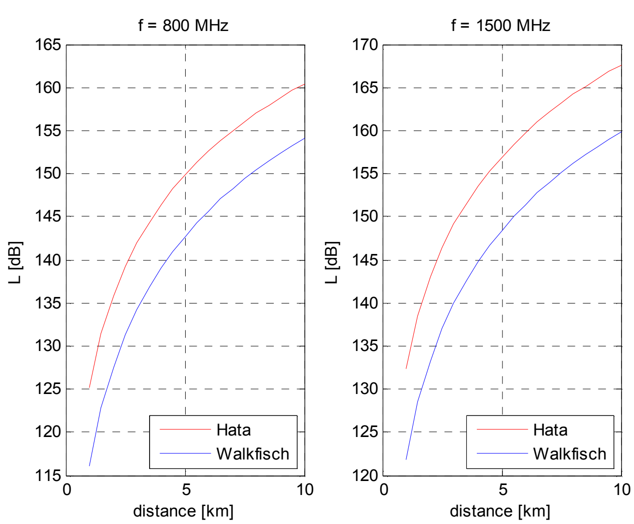

Figure.(10) The frequency on dependence

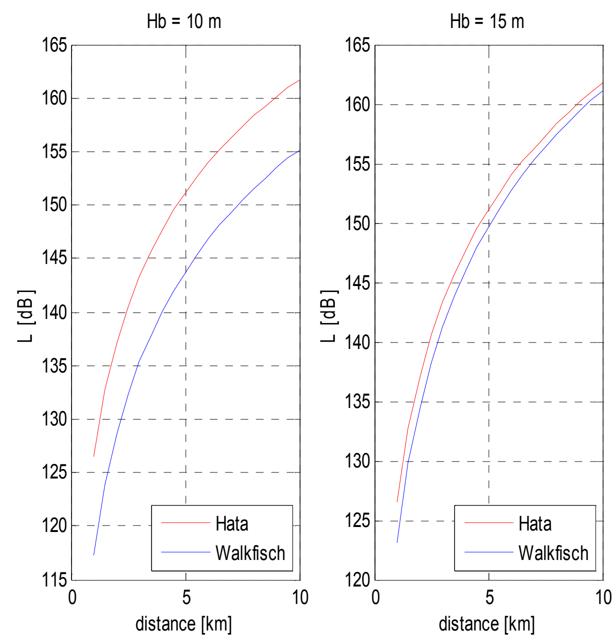

Figure.(12) The Building height on dependence

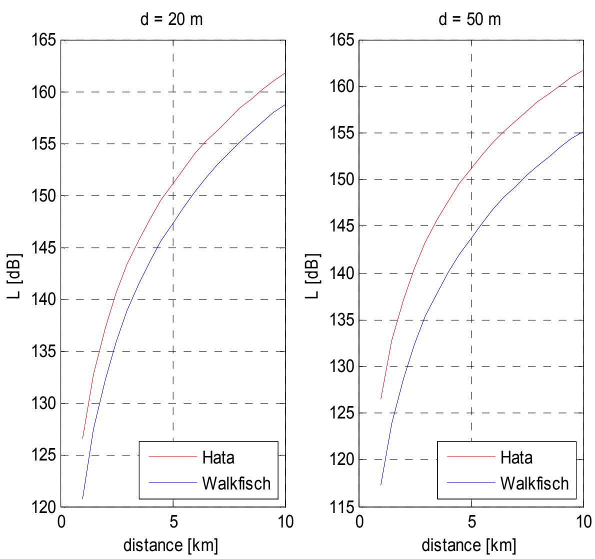

Figure.(13) Building separation height on dependence

4-CONCLUSION

When the frequencies are changed ,and the others parameters are constant values ,to obtain path loss using Hata model in large urban is grather than suburban and rural [db], whenever the frequency is decreased, the path loss is less, In Hata model ,when the base station antenna height values are changed, and other values are constant, the large path loss in large urban but in urban and rural[db] is less. whenever the base station antenna height increase is large path loss.
In Walkfisch model , when less building separation distance is smallest, there is loss in Walkfisch model, when is higher the base station antenna is more loss in Walkfisch model. Whenever, the frequency is increased, the path loss is increased. when the building height is large, more loss in Walkfisch model.

From the achieved simulation results it can conclude that, the Hata model is suitable for use in urban and rural areas, while, the Walkfisch can be used in large urban areas.

5- REFERENCES

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