Advances in Physics Theories and Applications
ISSN 2224-719X (Paper) ISSN 2225-0638 (Online)
Vol.21, 2013
www.iiste.org

Radio Field Strength Propagation Data and Pathloss calculation Methods in UMTS Network

Isabona Joseph[1], Konyeha. C. C[1], Chinule. C. Bright [1],Isaiah Gregory Peter[2]

1. Department of Basic Sciences, Benson Idahosa University, PMB.1100, Benin City, Nigeria

2. Department of Physics, University of Uyo, Uyo, Nigeria.

Email: josabona@yahoo.com, jisabona@biu.edu.ng, ckonyeha@gmail.com, brightchinule@gmail.com

ABSTRACT

The design of future-generation mobile communication systems depends critically on the pathloss prediction methods and their suitability to various signal propagation regions. An accurate estimation of radio pathloss is useful for predicting coverage areas of base stations, frequency assignments, determination of electric field strength, interference analysis, handover optimization, and power level adjustment. The radio path loss will also affect other elements such as the required receiver sensitivity, the form of transmission used and several other factors. As a result, it is necessary to understand the reasons for radio path loss, and to be able to determine the levels of the signal loss for a given radio path. In this paper, we investigated the radio signal path attenuation behavior, by conducting an experimental measurement survey in a UMTS network transmitting at 2100MHz band in Government Reservation Area (GRA), Benin City. The measured field strength data collected at various distances from the base stations was used to estimate the pathloss. Firstly, the effect of different parameters, such as distance from base stations was studied and it is observed that path loss increases with distance from the signal source due to a corresponding decrease in field strength. Secondly, the calculated pathloss data have been compared with data from other existing pathloss prediction methods. We find that the Okumura-Hata model pathloss values were closest of all the propagation models considered classifying the environment into consideration. Thus, the performance of Okumura-Hata model shows its suitability for path attenuation loss prediction in UMTS networks in GRA.

1. Introduction

The advent of mobile communications such as the Global System for Mobile communication (GSM) started its commercial operation in Nigeria in 2001. GSM system is very good at delivering voice services to its subscribers, and is the most common 2G system used all over the world. However, for data service, the situation is not the same. This has led to continuous network facility upgrade over existing GSM system in order to support more efficient data services.

Recently, a totally new air interface, namely third generation (3G)-based WCDMA air interface system is being deployed on existing GSM core networks in Nigeria with the goal of supporting more efficient service data transfers. This new system was called the UMTS. In fact 3G systems are designed for multimedia communication; the person to person communication can be enhanced with high quality images and video, and access to information and services will be enhanced by the higher data rates and new flexible communication capabilities.

However, UMTS networks with new air interface need the use of different base stations and base station controllers, which mean a huge cost for operators.

Moreover, UMTS network planning is far more complicated than GSM voice planning [1]. Because in UMTS, it is not possible to think of minimum received signal level to achieve one maximum interference threshold. Each service needs a specific threshold values and also network behavior changes with traffic. So the need for an accurate propagation prediction is now more vital than before [2, 3].

This research is aimed at calculating path attenuation loss at the mobile terminal via measured field strength propagation data in a 3G based UMTS network using a local telecom service provider. It transmits at a frequency of 2100MHz in the Government Reservation Area (GRA), Benin City, Edo State. This is to enable us obtain the most suitable pathloss prediction model from among the existing ones for mobile radio signal propagation in the study area. From the aim of the study, the objectives are to:

(i) Carry out signal strength measurement survey via drive test in outdoor UMTS network propagation environment.

(ii) Calculate path attenuation loss from the measured signal strength

(iii) Compare measured pathloss values with some key existing pathloss models such as; Lee Model, Cost231-Hata model, Hata model and Egli Model.

1.1 Research Motivation

The existence of poor signal strength and pathloss – due to the reduction of power density of an electromagnetic wave as it passes through multi-path propagation environment, has been a major challenge over the years in the use of radio mobile communications and this effect is greatly seen in cities with high population density such as Benin City [3]. This path loss may be due to many effects, such as free space loss, diffraction, reflection, aperture-medium coupling loss and absorption. Other times congestion of buildings also does obstruct greatly signal strength across board and this has hindered effective communication in the affected areas over the years. Due to the differences in city structures, local terrain profiles, weather etc., the path loss prediction with reference to the existing empirical path loss models such as the Okumura's model, Hata's model etc., may differ from the actual one. Furthermore, network planning and optimization has become complicated and difficult as high numbers of base stations are involved in a network with significant co channel interference.

The network operators may face huge losses resulting from complaints from the network users due to improper link budget calculations and path loss predictions. Thus, Base Station transmitters should be sited with thorough considerations on the effect of the location of other Base Stations on the signal strength, precise pathloss calculations and using appropriate propagation models.

Usually, the calculation of path loss is called pathloss prediction. An accurate estimation of path loss is useful for predicting coverage areas of base stations, frequency assignments, proper determination of electric field strength, interference analysis, handover optimization, and power level adjustment [4]. Most of the existing pathloss prediction models have limitations. By comparing them with the practical measured data, the most accurate path loss prediction model for mobile propagation environment can be determined. The telecommunication companies in Nigeria whether based on GSM or CDMA technologies operating at radio frequency band of 800 to 2100MHz, should apply the knowledge presented in this paper for radio link budget design and analysis so as to further improve their services. This will assist the telecom service operators to provide quality signals to their teeming subscribers.

2. Radio Signal Pathloss Basics in Physics

The signal path loss is essentially the reduction in power density of an electromagnetic wave or signal as it propagates through the environment in which it is travelling.

There are many reasons for the radio path loss that may occur:

Free space loss: The free space loss occurs as the signal travels through space without any other effects attenuating the signal it will still diminish as it spreads out. This can be thought of as the radio communications signal spreading out as an ever increasing sphere. As the signal has to cover a wider area, conservation of energy tells us that the energy in any given area will reduce as the area covered becomes larger.

Absorption losses: Absorption losses occur if the radio signal passes into a medium which is not totally transparent to radio signals. This can be likened to a light signal passing through transparent glass.

Diffraction: Diffraction losses occur when an object appears in the path. The signal can diffract around the object, but losses occur. The loss is higher the more rounded the object. Radio signals tend to diffract better around sharp edges.

Multipath Fading: In a real terrestrial environment, signals will be reflected and they will reach the receiver via a number of different paths as shown in figure 1. These signals may add or subtract from each other depending upon the relative phases of the signals. If the receiver is moved the scenario will change and the overall received signal will be found to vary with position. Mobile receivers (e.g. cellular telecommunications phones) will be subject to this effect which is known as Rayleigh fading.

Terrain: The terrain over which signals travel will have a significant effect on the signal. Obviously hills which obstruct the path will considerably attenuate the signal, often making reception impossible. Additionally at low frequencies the composition of the earth will have a marked effect. For example on the Long Wave band, it is found that signals travel best over more conductive terrain, e.g. sea paths or over areas that are marshy or damp. Dry sandy terrain gives higher levels of attenuation.

Buildings and vegetation: For mobile applications, buildings and other obstructions including vegetation have a marked effect. Not only will buildings reflect radio signals, they will also absorb them. Cellular communications are often significantly impaired within buildings. Trees and foliage can attenuate radio signals, particularly when wet.

Atmosphere: The atmosphere can affect radio signal paths. At lower frequencies, especially below 30 - 50MHz, the ionosphere has a significant effect; reflecting (or more correctly refracting) them back to Earth. At frequencies above 50 MHz and more the troposphere has a major effect, refracting the signals back to earth as a result of changing refractive index. For UHF broadcast this can extend coverage to approximately a third beyond the horizon.

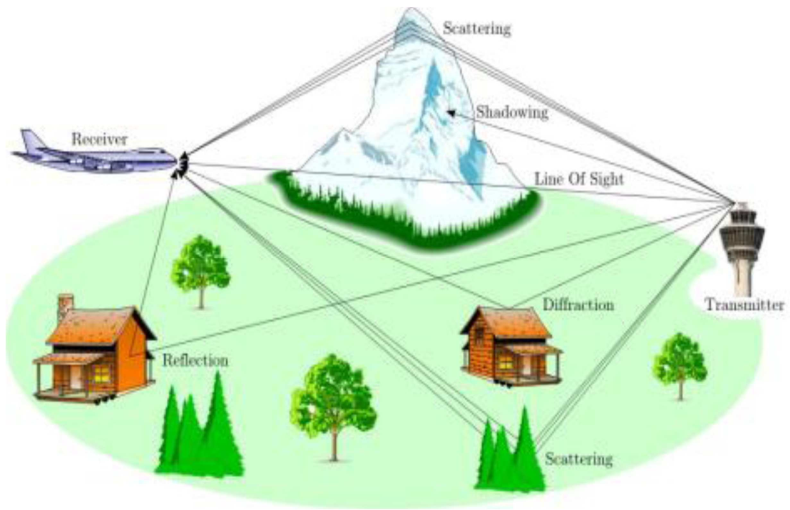

Figure 1: Multi-path Propagation

2.1 Calculating and Predicting Path Loss in UMTS

One of the main objectives of understanding the different elements that result in the radio signal path loss is to be capable to forecast the loss for a particular path, or to forecast the coverage that may be achieved for a given base station and broadcast station.

The prediction of the path loss is not easy for real life global applications, because many factors have to be taken into account for that purpose. In spite of this there are many wireless radio coverage prediction software programs and wireless survey tools that are available to predict radio path loss. Most path loss predictions are made using techniques outlined below [5]:

- *Statistical methods:* These methods of predicting signal path loss rely on measured and averaged losses for distinctive types of radio links. Different models can be used for different applications. This type of approach is generally used for cellular network planning, for estimating the coverage of Private Mobile Radio (PMR) links and to plan for broadcast coverage.

- *Deterministic methods:* This approach or method of predicting radio signal path loss and coverage utilizes the basic physical approaches as the basis for the calculations. This type of methods requires taking into consideration all the parameters within a given area and although they tend to give better accurate results, they need much additional data and computational power. In view of their complexity, they tend to be used for short range links where the amount of required data falls within acceptable limits. Though it is still essential to have a better understanding of radio propagation so that to correct figures can be entered and the results interpreted adequately.

Some key path loss models available in existing literature for network planning are chosen and analysed relative to calculated path loss from measured field strength data to see how accurate they are for path loss prediction for UMTS in the different locations of study. The selected models are [6]:

a. Lee Model

b. Egli Propagation Model

c. Hata Model

d. COST231 Extension to Hata Model

2.2. Description of Selected Models

In the beginning, the Lee model was developed for use at 900 MHz and has two modes: area-to-area and point-to-point [7]. Built as two different models, this model includes an adjustment factor that can be used to make the model more flexible to different regions of propagation. Lee model is suitable for use on data collected in a specific area. The model predicts the behaviour of all links that end in specific areas.

The Egli model is a terrain model for radio frequency propagation. This model, which was first introduced by John Egli in his 1957 paper [8], was derived from real-world data on UHF and VHF television transmissions in several large cities. It predicts the total path loss for a point-to-point link. Typically used for outdoor line-of-sight transmission, this model provides the path loss as a single quantity. The model is applicable to scenarios where the transmission is spread over an irregular terrain. However, the model does not take into account travel through some vegetation. Hata model is applicable for a frequency range of 150-1500 MHz [9]. Different correction factors are used for suburban and rural environments [10]. Hata model uses correction factor K values ranging from 35.94 for countryside to 40.94 for deserts [11]. Hata model provides extension to Okumura model for distances greater than 1km. However, it does not perform well for modeling of propagations in cellular system with higher frequencies and smaller sizes [12]. COST-231 Hata model is the extension of Hata model. It is used for frequency ranges from 1500-2000 MHz. It incorporates signal strength prediction of up to 20km from transmitter to receiver with transmitter antenna height ranging from 30 m to 200m and receiver antenna height ranging from 1m to 10m [13]. It is used to predict signal strength in all environments [14]. COST-231 WI model has separate equations both for line of sight and non-line of sight communications regarding path loss estimation. Different parameters are used to indicate free space loss, roof top to street diffraction and the multi-screen diffraction. It is more appropriate in rural environments when the communication is line of sight [11]. Non line of sight equation is used in suburban and urban environments.

3. Materials and Method

This research took place in Benin City, the capital of Edo State, Nigeria. The research covered three major areas in the GRA metropolis, which include – Ugbor Ville, Gapiona and the Benson Idahosa University campus.

3.1. Setup of the testbed for this Research

The set up for collecting data or measuring the network KPIs for this research consisted of a 3G WCDMA drive test campaign using the following:

1). LAPTOP – equipped with Ericsson TEMS 8.0 drive test software which provides a test platform for the radio-air-interface and can connect UEs, scanners, and GPS terminals through a serial port. PCI slot, or USB port.

2). TEMS handset (with data cable) – it simulates communication of terminal users so that the probe can record test data.

3). Global Positioning Satellite – GPS (External Antenna and Data Cable) – it is used to record the position of the test points during a test.

4). Vehicle – a car is essential for moving around the designated Base Station (BS) Transmitters with the equipment.

3.2. Experimental Details

Measurement-based Prediction (MbP) is a unique radio propagation process, which increases the accuracy of conventional propagation model predictions by making use of measured data to improve the model predictions around base station sites. The measurements were conducted from a UMTS network with WCDMA interface transmitters, located at the BIU Campus, Ugbor ville and Gapiona avenue, all evenly distributed in Government Reservation Area (GRA), Benin City. The drive routes in these different locations are shown in figure 2-4. The measured received signal strength data which is the Received Signal Code Power (RSCP) and transmitter-receiver (T-R) separation distance (d) are recorded in dBm and m. Every measurement points of received signal strength and T-R separation distance are recorded evenly from all the predefined routes of the three base stations.

Each measurement point is represented in an average of a set of samples taken over a small area ($10m^2$) in order to remove the effects of fast fading [15].

The Ericsson-model TEMS (Test Mobile Systems) cell planner tool for data collection had the antenna mounted on a moving vehicle (1.5 meter above ground level). The Global Positioning System Receiver Set (GPS system) and a piece of compass were connected to a personal computer. The personal computer serves as the communication hub for all other equipment in the system. The GPS operates with global positioning satellites to provide the location tracking for the system during data collection, on a global map which has been installed on the personal computer. The compass helps to determine the various azimuth angles of the base station transmitters. Average height of transmit antenna is about 30 – 32 meter above ground level, with the same transmit power. Sampling rate of the collected data, on the average, is about 2 – 3 samples per meter.

Using the ruler in TEMS software, the RSCP data at various distances from the BS were determined. This technique enabled us to calculate the Electric Field Strength (EFS) and pathloss at different distances from the BS. The results of the calculated pathloss are shown in Tables C_1, C_2 and C_3 in the appendix.

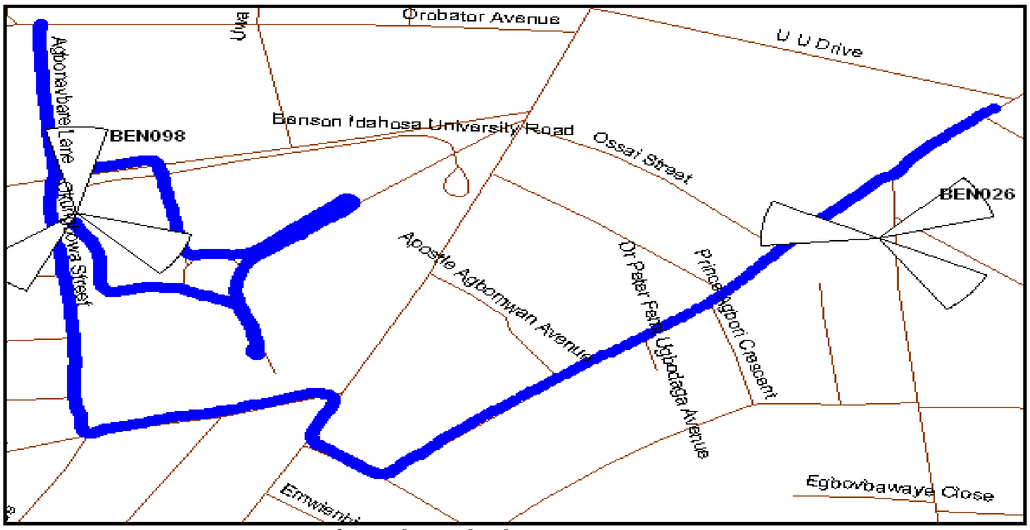

Figure 2 – Measurement route for Ugbor suburban city.

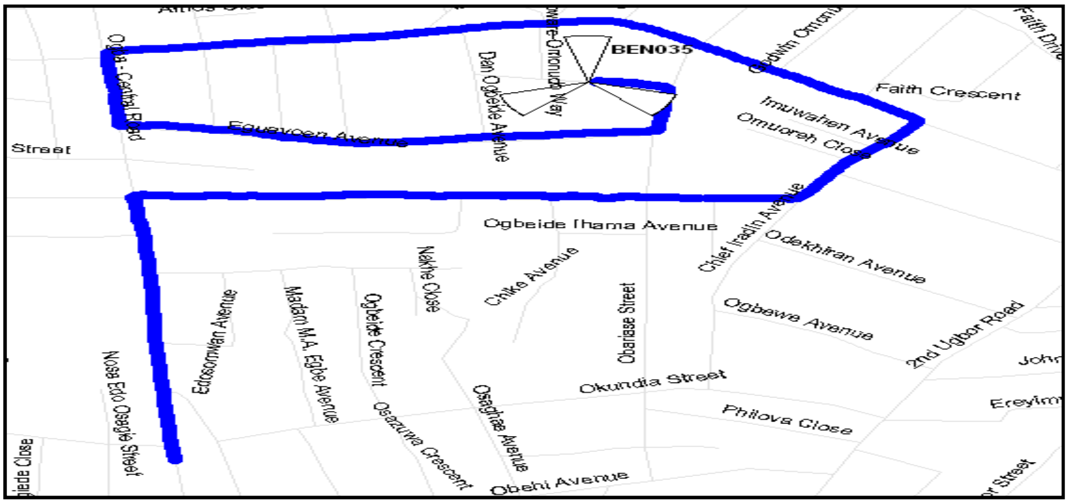

Figure 3 – Measurement route for the BIU campus.

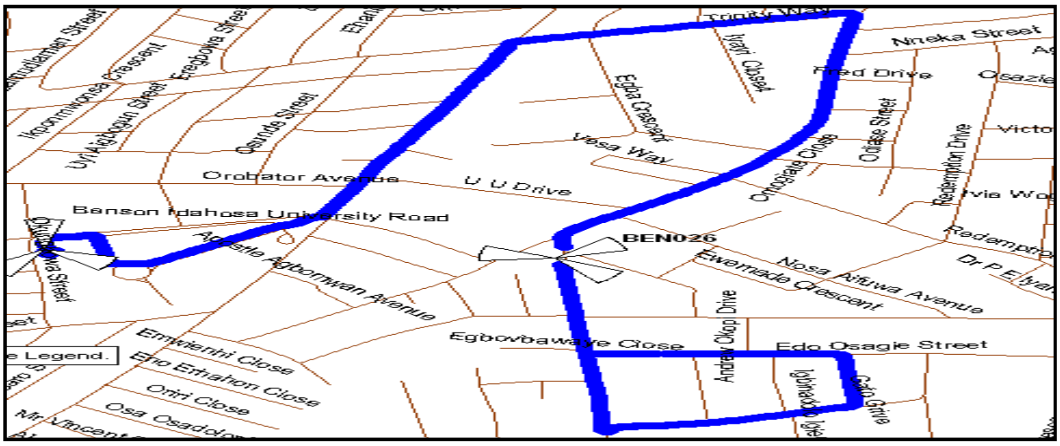

Figure 4 – Measurement route for Gapiona suburban city.

3.3. Calculation of Path Attenuation loss Method from Measured Data

Based on the reception mode, the minimum equivalent field strength of a signal at a receiver can be calculated using the following formulas [16]:

$$P_{s\min} = \frac{C}{N} + P_n \tag{1}$$

$$A_e = G + 10\log\left(\frac{1.64\lambda^2}{4\pi}\right) \tag{2}$$

$$\phi_{\min} = P_{s\min} - A_e \text{ For portable reception} \tag{3}$$

$$E_{\min} = \phi_{\min} + 120 + 10\log(120\pi) = \phi_{\min} + 145.8 \tag{4}$$

Where;

$P_{\min}$ = Minimum receiver input power {dBW}

A_e = Effective antenna aperture {dBm^2}

G = Antenna gain {dB}

λ = wavelength of the signal {m}

$\phi_{\min}$ = Minimum power flux density at receiving place {dB (W/m^2)}

$E_{\min}$ = Equivalent minimum field strength at receiving place {dB(μV/m)}

P_n = Receiver noise input power {dBW}

120π = Characteristic Impedance in ohms

The electric field strength E_{min} (dBμV/m) is obtained from the experimental results. Taking $P_{\min}$ from the above equations to be equivalent to the received power $P_R(dB)$, the corresponding path loss can be obtained as follows;

$$P_T(dB) = 10\log P_T(Watts) \tag{5}$$

$$P_T(Watts) = 20 \tag{6}$$

$$P_T(dB) = 43 \tag{7}$$

$$A_e = G + 10\log\left(\frac{1.64\lambda^2}{4\pi}\right) \quad (8)$$

Taking $G \approx 18dB$ for WCDMA Antenna (directional),

$$A_e = G - 25.75 = -7.75(dBm^2) \quad (10)$$

The equation for pathloss becomes:

$$P_L(dB) = 166.51 - E_{\min} \quad (11)$$

4. Results and Discussion

The actual path loss measurements can be analysed relative to the empirical models to see whether these propagation models are accurate to be used for path loss prediction in the study area. The pathloss calculation parameters include the following:

BTS Height (h_b) = 22m (Ugbor Avenue), 20m (BIU Campus), 24m (Gapiona Avenue)

Mobile Station Height (h_m) = 1.5 m

Frequency of operation (f_c) = 2100 MHz

By taking readings at various distances, it is possible deduce some conclusions about the performance of the base station transmitter. It can be seen from Figure 5, 6 and 7 that the path loss increases as the received field signal strength decreases and this implies a decreases quality of service. The reason for such performances may attributed to factors as discussed previously.

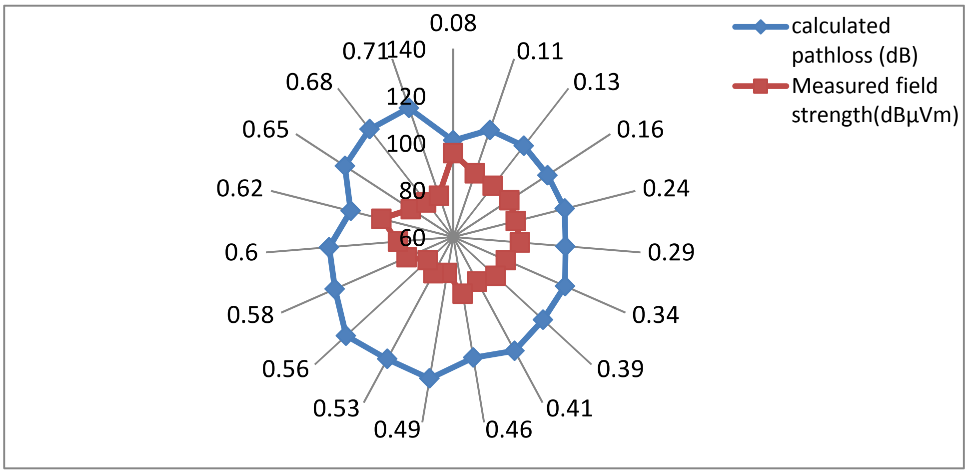

Figure 5: Field strength and Path attenuation loss pattern in BIU Campus

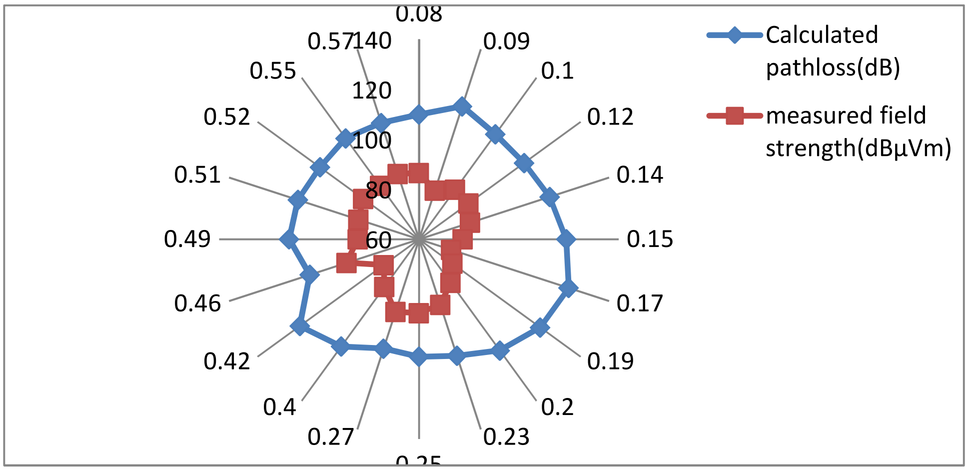

Figure 6: Field strength and Path attenuation loss pattern in Gapionaavenue

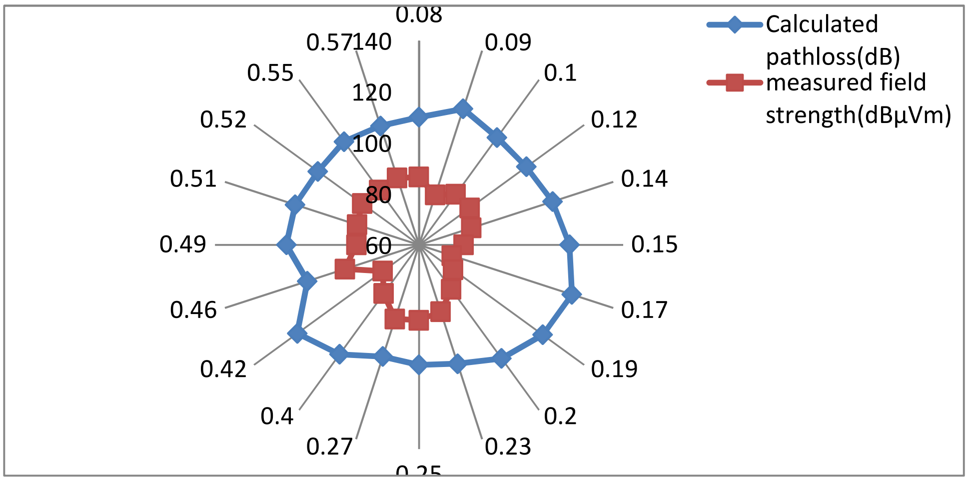

Figure 7: Field strength and Path attenuation loss pattern in Ugbor ville

Figs. 8-10 below show the path loss at various distance of from the BS for BIU Campus, Gapiona Avenue and Ugbor ville in comparison other existing path attenuation calculation models.

From the graphs for BIU Campus in Fig. 8, the following observations can be made for the BIU Campus environs:

The Lee model somewhat underestimates the path loss while the Okumura-Hata slightly overestimates the path loss.

The sudden drop at distance 0.62km can be a sharp turn around a building in this particular location, thus pathloss could have been influenced by diffraction over the surface. The other deviations (ups and downs) are normally the cause of shadowing, reflection, diffraction or scattering, most probably due to the presence of trees.

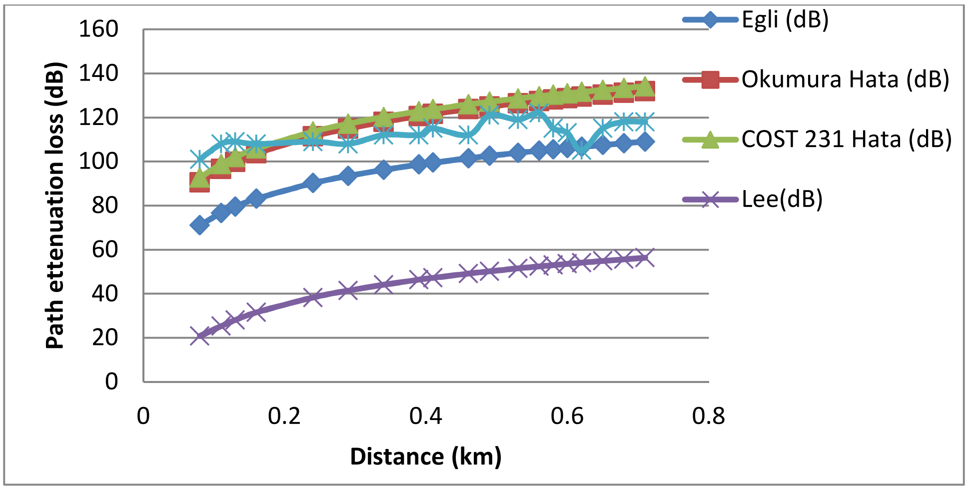

Figure 8 – Path attenuation loss (dB) analysis for BIU Campus with respect to distance (Km)

The following can be deduced from the graph for the Gapiona Avenue in Figure 9;

It is observed that the measured value experienced quite stability with zero fluctuation from distance 0.25km to about 0.41km. This may be attributed to an almost clear line of sight (LoS) between the transmitter antenna and the receiver antenna.

The Lee model again highly underestimates the path loss. This can be attributed to the fact that this model takes into consideration the effective base station antenna height which is highly dependent on the exact topology of the measurement environment.

The COST231 Hata model is observed to be the closest model to the measured value. This can be attributed to the fact that this model is originally suitable for microcells and small macrocells, when f_c is within 1.5GHz – 2GHz, h_r is within 1 – 10m and d is between 1 – 20km

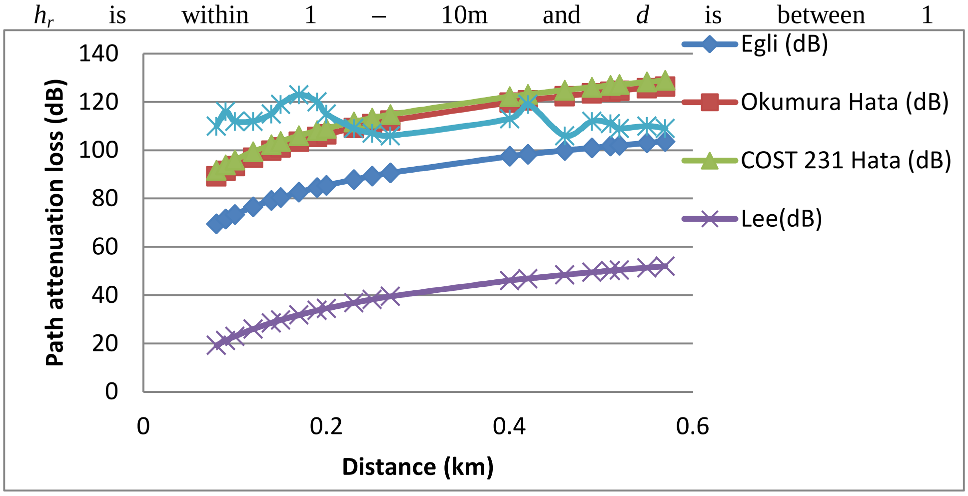

Figure 9 – Path attenuation loss (dB) analysis for Gapiona Avenue with respect to distance (Km)

The Okumura model closely follows the COST231 Hata model in proximity to the measured data for this particular location. This is because the COST231 Hata model is an extension of the Okumura model to 2GHz, and they both have the same specifications for BS antenna height above 30m, and can also be used when h_t is less than 30m provided the buildings in the region are well below 30m. (Lin Du and Swamy, 2010)

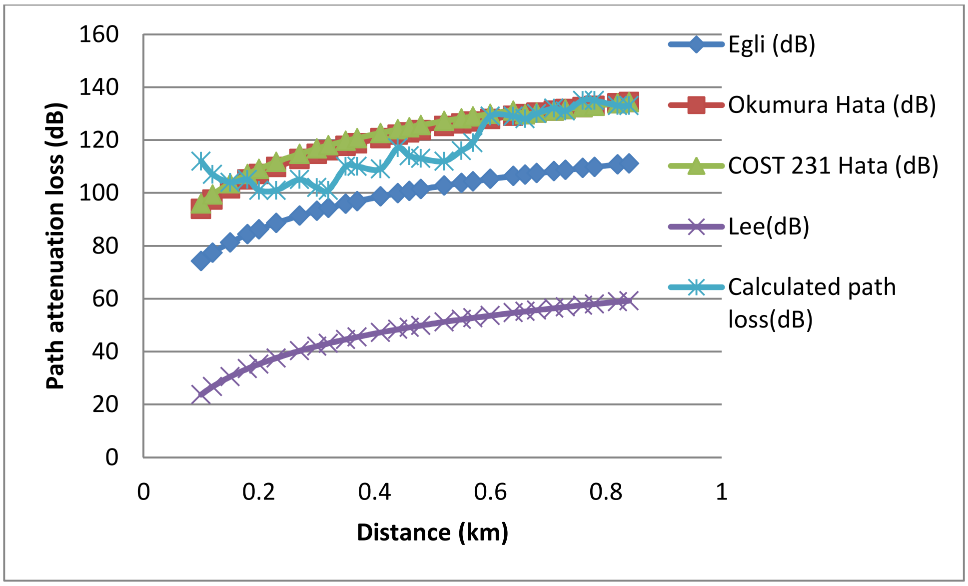

Figure 10 – Path attenuation loss (dB) analysis for Ugbor Avenue with respect to distance (Km)

From the graph in figure 10, the following observation has been made for Gapiona Avenue;

The Lee Model highly underestimates the path loss. This can be attributed to the fact that this model takes into consideration the effective base station antenna height which is highly dependent on the exact topology of the measurement environment.

The Egli model underestimates the losses most probably because it is designed basically for medium city or sub-urban areas.

The Okumura-Hata or the COST231-Hata can be used as an estimate for Path loss for the Ugbor Avenue suburban region. The deviations can be considered as negligible. The Okumura-Hata model is independent of Receiver antenna height hence the path loss for this particular region in experiment is also independent of the antenna heights.

The variation in the experimental values (non-straight line graph) can be attributed to the Ugbor Avenue environment having many obstructions in the path, like many high buildings in close proximity, as well as trees sandwiched in between houses.

Moreover, mean path losses from the various prediction methods were also calculated and compared with measured field data to validate the choice of Hata model for the studied area. The results are shown in figure 11-13.

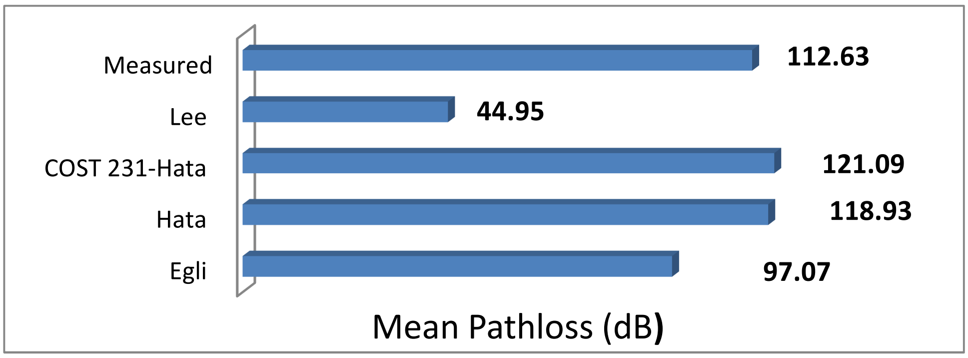

Figure 11: Calculated mean path attenuation loss from the various prediction models in comparison with measured field data in BIU Campus

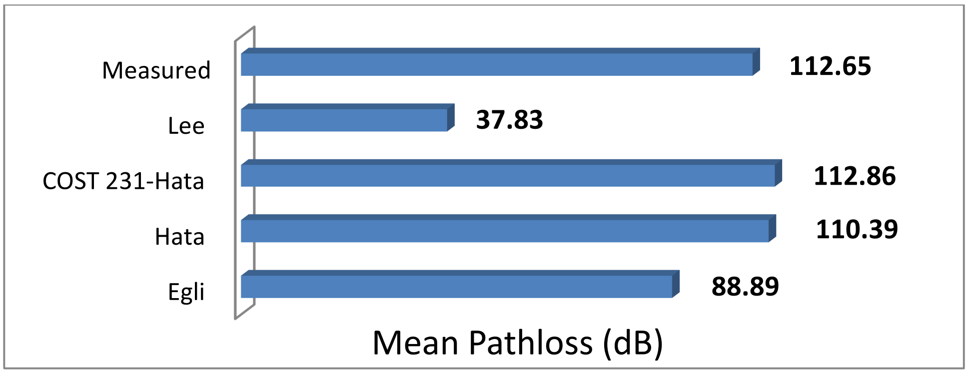

Figure 12: Calculated mean path attenuation loss from the various prediction models in comparison with measured field data in Gapiona Avenue

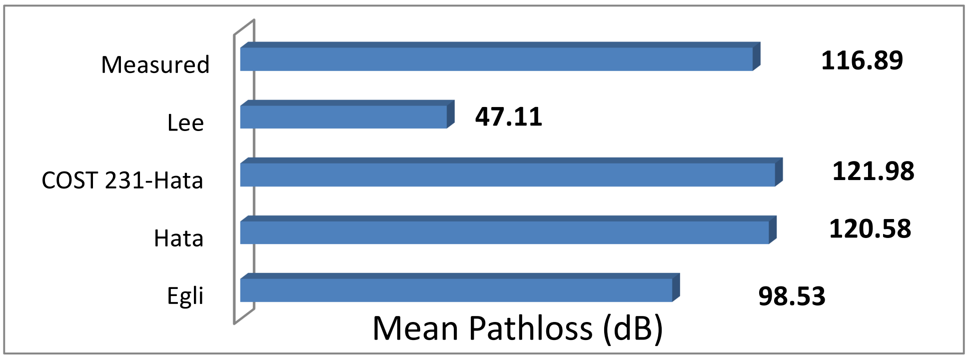

Figure 13: Calculated mean path attenuation loss from the various prediction models in comparison with measured field data in Ugbor Avenue

5. Conclusion

Though propagation models are available to predict the losses, they are not very accurate in determining the coverage area of a system. This is due to the fact that these models have been designed based on measurements elsewhere. Therefore, in-field measurements must support the path loss prediction models for better and accurate results. This study aims at conducting field strength measurement to calculate the path loss in a UMTS network operating in Government Reservation Area, Benin City. The measured field strength data collected over different distances from the base stations was used to estimate the path loss. Firstly, in our methodology, the effect of different parameters, such as distance from base stations was studied and it is observed that path loss increases with distance due to a corresponding decrease in field strength. Secondly, the observed results have been compared with various prediction methods. We find that the Okumura-Hata model pathloss values were closest of all the outdoor propagation models considered classifying the environment into consideration. Thus, the performance of Okumura-Hata model shows its suitability for path attenuation loss prediction in UMTS networks in GRA, Benin, the effect of different parameters, such as distance from base stations was studied and it is observed that path loss increases with distance due to a corresponding decrease in field strength. Secondly, the observed results have been compared with various prediction methods. We find that the Okumura-Hata model pathloss values were closest of all the outdoor propagation models considered classifying the environment into consideration. Thus, the performance of Okumura-Hata model shows its suitability for path attenuation loss prediction in UMTS networks in GRA, Benin. It also shows that model can be useful totelecommunicationproviders to improve their services for better signal coverage and capacity for mobile user satisfaction in the studied area.

REFERENCES

[1] Coinchon, M., Salovaara, A. P., and Wagen, J. E. (2002). “The impact of radio propagation predictions on urban UMTS planning”, *2002International Zurich Seminar on Broadband CommunicationsAccess Transmission-Networking*, February 19-21, Zurich, Switzerland.

[2]. SelimSeker, S., Yelen, S., and Fulya C.K. (2010). ‘‘Comparison of Propagation Loss Prediction Models of UMTS for Urban Areas, 18th Telecommunications forum TELFOR 2010 Serbia, Belgrade, November 23-25.

[3] Emagbetere, J. O. and Edeko, F. O. (2009). “Measurement of Validation of Hata like Models for radio Pathloss in Rural Environment at 1.8GHz”, Journal of Mobile Communications pp 17.

[4] Obot, A., Simeon, O., and Afolayan J. (2011). Comparative Analysis of Pathloss Prediction Models for Urban Microcellular, Nigerian Journal of Technology Vol. 30, No. 3, pp 50-59.

[5] Sharma, D. and Singh, R.K. (2010). The Effect of Pathloss on QoS at NPL, International Journal of Engineering Science and Technology, Vol. 2(7),pp 3018-3023.

[6] Isabona, J. and Isaiah G. P. (2013). CDMA2000 Radio Measurements at 1.9GHz and Comparison of Propagation Models in Three Built-Up Cities of South-South, Nigeria, American Journal of Engineering Research, Vol. 02, Issue-05, pp 96-106.

[7] Lee W. C. Y. (1993). “Mobile Communication Design Fundamentals”, 2nd ed., Wiley, New York, pp. 59–67.

[8] Egli, John J. (1957). "Radio Propagation above 40 MC over Irregular Terrain". *Proceedings of the IRE* (IEEE) **45** (10): 1383–1391

[9] Abhayawardhana, V.S., Wassel, I.J., Crosby, D., Sellers, M.P. and Brown, M.G. (2005). “Comparison of empirical propagation pathloss models for fixed wireless access systems”. 61th IEEE Technology Conference, Stockholm.

[10]Seybold, John S. (2005). *Introduction to RF propagation*.John Wiley and Sons.

[11] Sahajahan, M. and Abdulla, A.Q. (2009). “Analysis of propagation models for WiMAX at 3.5 GHz”, Master Thesis Blekinge Institute of Technology.

[12] Hata, M. (2008). “Empirical formula for propagation loss in land mobile radio services”, IEEE Transactions on Vehicular Technology, vol. 29, pp. 317-325.

[13] Mardeni, R. and Priya, T.S. (2010). “Optimized COST 231 Hata models for WiMAX pathloss prediction in suburban and open urban environments,”.Modern Applied Science, vol. 4(9).

[14] Goldsmith, A. (2005). “Wireless Communication.” Cambridge University Press, New York.

[15] Takahashi, S., Kato, A., Sato, K., and Fujise, M. (2004). “Distance dependence of pathloss for millimeter wave inter-vehicle communication” IEEE Vehicular Technology pp. 26-30 vol.1.

[16] Armoogum, V. and Munnee, R. (2010). Pathloss Analysis for 3G Mobile Networks for Urban and Rural Regions of Mauritius. Sixth International Conference on Wireless and Communication systems (ICWMC), pp.164-169.

Joseph Isabona is a lecturer in the department of Basic Sciences (Physics Unit), Benson Idahosa University, Benin City, Nigeria**.** He received Ph.D and M.Sc. degrees in Physics Electronics, 2013 and 2007 from the University of Benin and Uyo respectively, and a B.Sc in Physics in 2003, from Ambrose Alli University, Ekpoma, Edo State. He is a member of the Nigerian Association of Mathematical Physics (NAMP) and Nigeria Institute of Physics. He has published both nationally and internationally in the area of wireless communications. His area of specialization is signal processing and radio resource management in wireless networks.

Konyeha Cyprian is an academic staff of Benson Idahosa University, Benin City, where he lectures Physics and Electronics subjects. He received an M.Eng. degree in Electronics and Telecoms Engineering from the University of Benin in 2008 and an MBA degree from the University of Lagos in 2004. He is a member of Nigeria Society of Engineers. His research Interests include RF planning and optimization for 2G, 3G and 4G mobile networks, communication networks simulation using opnet ITGAE and NS2, simulation and field studies of WLANs, WLAN security, studies in wireless sensor networks, software defined radio, communication channel performance enhancement.

Chinule Bright received a B.Sc. degree in Physics (Electronics) from Benson Idahosa University, He is currently working towards a Master's Degree in Communications Physics with specialisation in Telecommunications. He is a self-development and communications coach

Isaiah Peter Gregory was born in December 1968 in Ikot Ambang Ibiono, Ibiono Ibom L.G.A., Akwa Ibom State, Nigeria. He holds a B.Eng. degree in Electrical/ Electronics Engineering and M.Sc. degree in electronics/ Communications. He is the Chief Technologist, and Administrative Head/Technical Coordinator of Workshop/ Laboratory Unit, Department of Physics, University of Uyo.

APPENDIX

Table A_1: Calculated Pathloss, RSCP and EFS for BIU Campus

Distance of Mobile from BS (m)	RSCP(dBm)	EFS(dBμVm)	Pathloss(dB)
80	-58	95.55	101
110	-65	88.55	108
130	-66	87.55	109
160	-65	88.55	108
240	-66	87.55	109
290	-65	88.55	108
340	-69	84.55	112
390	-69	84.55	112
410	-72	81.55	115
460	-69	84.55	112
490	-78	75.55	121
530	-76	77.55	119
560	-79	74.55	122
580	-72	81.55	115
600	-70	83.55	113
620	-62	91.55	105
650	-72	81.55	115
680	-75	78.55	118
710	-75	78.55	118

Table A_2: Calculated Pathloss, RSCP and EFS for Gapiona Avenue

Distance of Mobile from BS (m)	RSCP(dBm)	EFS(dBμVm)	Pathloss(dB)
80	-67	86.55	110
90	-73	80.55	116
100	-69	84.55	112
120	-69	84.55	112
140	-72	81.55	115
150	-76	77.55	119
170	-80	73.55	123
190	-77	76.55	120
200	-72	81.55	115
230	-66	87.55	109
250	-64	89.55	107
270	-63	90.55	106
400	-70	83.55	113
420	-76	77.55	119
460	-63	90.55	106
490	-69	84.55	112
510	-68	85.55	111
520	-66	87.55	109
550	-67	86.55	110
570	-66	87.55	109

ISSN 2224-719X (Paper) ISSN 2225-0638 (Online)
Vol.21, 2013

Table A_3: Calculated Pathloss, RSCP and EFS for Ugbor Avenue

Distance of Mobile from BS (m)	RSCP(dBm)	EFS(dBμVm)	Pathloss(dB)
100	-69	84.55	112
120	-64	89.55	107
150	-61	92.55	104
180	-62	91.55	105
200	-58	95.55	101
230	-58	95.55	101
270	-62	91.55	105
300	-59	94.55	102
320	-58	95.55	101
350	-67	86.55	110
370	-67	86.55	110
410	-66	87.55	109
440	-74	79.55	117
460	-71	82.55	114
480	-70	83.55	113
520	-69	84.55	112
550	-73	80.55	116
570	-76	77.55	119
600	-86	67.55	129
640	-86	67.55	129
660	-85	68.55	128
680	-87	66.55	130
710	-89	64.55	132
730	-88	65.55	131
760	-92	61.55	135
780	-92	61.55	135
820	-90	63.55	133
840	-90	63.55	133