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# Determination Of A Pathloss Model For Long Term Evolution (Lte) In Yenagoa

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***ABSTRACT***
*The analysis of propagation model in urban terrains is essential owing to the fact that the surroundings is composed of diverse material obstructions. These models are functional planning tools that allow the network planner of wireless communication networks to realize optimal levels for the base station exploitation and meeting the anticipated service level requirements. In this work, five experimental broadcast models- FSPL, EGLI, ECC, COST 231 and ERICSSON Model are considered for pathloss performance investigation in the urban area of Yenagoa. A drive test was conducted to acquire the actual field data on the LTE with a frequency of 700MHz network deployed in the area under study. All forecast calculations were carried out in the TEMS Investigation and Discovery network planning tool. Ericsson model was found to best predict the environment with a minimum deviation of 10.11dB being closest to measured pathloss with 2.01dB compared to the other models*

***Keywords****- Pathloss, LTE, Base Station, Model, Broadcast*

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## I. INTRODUCTION

Call drops; slow data rate is gradually becoming an issue in broadband transmission. This could be as a result of poor capacity, low average, and attenuation when waves are propagated from one point to another [1]. Radio propagation planning is highly important in wireless network development in any region. Wireless network can be propagated via different mechanism scattering, diffraction and reflection. Pathloss is the power reduction of EM waves as it propagates through space[2]. Pathloss is simply the difference between the power transmitted and power received[3]. In planning 4G network, pathloss is a key component. It is the attenuation of EM waves as it propagate from one point to the other through space. A whole lot of factors can influence the pathloss, environment (Urban, sub-urban, rural), distance between the transmitter and the receiver, the location and the height of the antenna. As signal passes through multi-path propagation, it tends to reduce due to density of electromagnetic waves and reduction of power. This poses a high challenge in the use of mobile radio communications and its effect can be felt in highly populated cities such as Yenagoa. Due to the various differences in city structures, local terrain profiles, weather etc., predicting the pathloss with reference to the existing empirical path loss models such as the SUI, Ericsson model, Hata's model etc., may differ from the actual one. Therefore determination of pathloss for a particular terrain becomes highly necessary for network planning and optimization engineers.

## II. LITERATURE REVIEW

LTE is a standard of 4G that uses MIMO and OFDM technology. LTE was developed by 3GPP to improve UMTS wireless standard. LTE has huge merit ranging from better spectrum efficiency, high peak data rate to low latency. LTE technology uses multiple-input-multiple output (MIMO). This could either be spatial multiplexing and space-time coding [4].

[5] in their paper did a pathloss study of 3 regions: urban, sub-urban and rural terrain using a VHF Omni directional ratio (VOR). Their analysis were carried out using monte carlos simulation technique. They deduced that increase in cell radii resulted to an increase in pathloss which in turn reduced the signal strength. They concluded that before an effective signal coverage can be achieved in cellular network, the cell radius should be relatively small to reduce path for effective signal strength. [6] carried out their measurement pathloss and on pathloss models. Their test measurements were carried out in sub-urban, urban and rural areas under terrians with non line of sight. They carried out drive test with the use of spectrum analyzer tool and they were able to measure the pathloss values of various terrain. In their experiment, they considered a frequency of 940Mhz GSM frequency. They obtained 85 dB in urban region, 102 dB in rural region and 89 dB in sub-urban region and this was less compared to free space pathloss value. Hata pathloss model had a high value with

respect to 158 dB in urban area, 139 dB in rural region and 142 dB in sub-urban region. As displayed in their result, it caused higher probability of RF signal errors. On the basis of observation and with the help of clutter, they presented a pathloss model which can be used to predict the model within the discussed regions. [7] carried out an empirical test to predict the most suitable pathloss model in mobile communication. The frequency of operation considered was 900Mhz GSM. The site location where test was carried out was in Tanzania. They considered SUI, COST, ECC, Ericson amd Hava-Okumura model. From their findings, the ECC model showed the best prediction while other model underestimated the pathloss when being considered for urban area. (Akpado et al, 2013) compared for Hata okumura, Cost 231, ECC 33 with MATLAB for a GSM 900Mhz. Results obtained showed clearly that as distance increases, the pathoss for the various model also increased. They also observed that Hata Okumura and cost model were lesser than the threshold value and should be preferred for maximum coverage to reduce handoff. [8] in their paper considered pathloss model using Geographic information systems. They compared their result with a previous test in Western Nigeria. The high value of pathloss in Shagamu and Abeokuta was a result of heavy forest which include palm and vegetation. They predicted low receiving signal if measures are not taking to improve signal quality within this terrain.

## III. EMPIRICAL METHOD OF PATHLOSS ANALYSIS

Models have been postulated considering different factors including geographical terrain, frequency of operation over a given distance. They could be applicable to other environment other than the one that was predicted but most times, they become less accurate.

### Cost 231 Hata Model

COST 231 HATA model is used for predicting path loss in mobile wireless system is the COST-231 Hata model. It is a revised version and an extension to the Hata-Okumura model. The designated frequency of operation is between the range of 500 MHz to 2000 MHz. there are also provisions for antenna factor corrections for flat environment. Due to its provision for correction factor and simplicity, it is often used to predict pathloss. The basic equation for path loss in dB

$$PL = 46.3 + 33.9\log(f) - 13.82\log(h_b) - ah_m + (44.9 - 6.55\log(h_b)\ logd + C_n \quad (1)$$

where, f is the frequency in MHz, d is the distance between AP and CPE antennas in km, and $h_b$ is the AP antenna height above ground level in metres. $C_n$ is 0dB for suburban and 3dB for urban region. $ah$ can be defined for urban region as

$$ah_m = 3.20(\log(11.75hr))^2 - 4.97,\ for\ f > 400MHz \quad (2)$$

And for sub-urban and rural environments,

$$ah_m = (1.1logf - 0.7)hr - (1.56logf - 0.8) \quad (3)$$

### EGLI MODEL

This model is good in predicting point to point links. It is most preferred where the one antenna is mobile and the other fixed. It is not applicable in terrains where there is vegetation obstructing line of sight. Egli model is given by

$$(dB) = G_b G_m (\frac{h_b h_m}{d^2})^2\ (\frac{40}{f})^2 \quad (4)$$

Where

$G_b$ is the BTS antenna gain

$G_m$ is the mobile station antenna gain

$h_b$ is the base station height

$h_m$ is the obile station height

d is the distance in meters

f is the frequency in Hz

### Stanford University Interm (Sui) Model

The Stanford University Interm (SUI) model development took place under the institute of Electrical and Electronic Engineers (IEEE) 802.16 broad band wireless access working group. This model takes into consideration correction factors for the Hata model with frequencies above 1900MHz. This model consist of three terrains; A, B and C. Type A is for hilly terrains, type C is for areas with reduced pathloss and densities. Type B is with flat terrains with light tree densities [9]. SUI equation model is given by

$$(dB) = A + 10\gamma\log_{10}\left(\frac{d}{d_0}\right) + X_f + X_h + s \quad \text{for } d > d_0 \quad (5)$$

where, d is the distance between the BTS and the mobile device in m, d0 = 100 m and s takes the effect of shadowing into consideration and is a log normally distributed factor and has a value between 8.2 dB and 10.6dB . Other parameters are defined as

$$A = 20\log_{10}(\frac{4\pi d_0}{\lambda}) \quad (6)$$

$\gamma = a - bh_b - c/h_b$ (7)
where, the $h_b$ is the base station height in metres. The constants a, b and c are defined in the table 1 below. The parameter $\gamma$ in is equivalent to the exponent of the pathloss.

**Table 1**: SUI Constants

| Model Parameters | Terrain A | Terrain B | Terrain C |
|---|---|---|---|
| a | 4.6 | 4 | 3.6 |
| b | 0.0075 | 0.0065 | 0.005 |
| c | 12.6 | 12.6 | 20 |

The antenna correction factors for the frequency and for the mobile equipment antenna height for the SUI model are $X_f = 6.0\, log_{10} \left(\frac{f}{2000}\right)$
(8)

$$X_f = -10.8\, log_{10} \left(\frac{h_r}{2000}\right) \quad for\ Terrain\ A\ and\ B \quad (9)$$

$$= 6.0\, log_{10} \left(\frac{f}{2000}\right) \quad for\ Terrain\ C \quad (10)$$

**Ericsson Model**

The modification of the Okumura hata Model according to a propagation environment gave room for change in parameters which eventually lead to Ericsson model. Network engineers used a software to actually develop this model. According to this model, the pathloss is given by

$Pl = a_0 + a_1 \log_{10} d + a_2 \log_{10} h_b + a_3 \log_{10} h_b \log_{10} d - 3.2(\log_{10}(11.75h_r))^2 + g(f)$
(11)
Where $(f) = 44.49 \log_{10} f - 4.78(\log_{10} f)^2$
(12)
Where f is the frequency in Mhz
$h_b$ is the distance in m
hr is the receiver antenna height in m
The default values of these parameters ($a_0$, $a_1$, $a_2$ and $a_3$) for different terrain are given in Table 2 below

**Table 2:** Ericsson Constants

| **Environment** | **$a_0$** | **$a_1$** | **$a_2$** | **$a_3$** |
|---|---|---|---|---|
| Urban | 36.2 | 30.2 | 12.0 | 0.1 |
| Sub-Urban | 43.2 | 68.93 | 12.0 | 0.1 |
| Rural | 45.95 | 100.6 | 12.0 | 0.1 |

The value of parameter $a_0$ and $a_1$ in suburban and rural area are based on the Least Square (LS) method [10]

## IV. DESIGN METHODOLOGY

**Drive Test**

A drive test was conducted with the aid of a laptop with TEMS investigation 15.3.3. the mobile device is a Samsung S5 galaxy pre installed with TEMS pocket and GLO LTE enabled sim. An inverter provided power supply for the laptop and a GPS was used to record coordinate of site. The BTS antenna was located at 26m height while the mobile station height is 1m. the car was driven at a speed not more than 40km/hr while the TEMS recorded the received power(RSRP). Measurements were taken twice in a day for a period of six month and mean average values of received signal strength obtained for this work.

**Pathloss Equation Analysis**

Path loss can be defined as the ratio of the transmitted to received power, usually expressed in decibels. The equation for the Least Square (LS) regression analysis shows the path loss at distance d in the form

$10 \log (mw) = (dBm)$ (13)
Where $P_r$ is the receive power
$(d_i)(dB) = (d_0) + 10n \log(\frac{d}{d_0})$ (14)
Where
$(d_i)$ is the measured pathloss with respect to distance
$(d_0)$ is the predicted pathloss with respect to reference distance $d_0$ = 0.1km
LOG NORMAL SHADOWING MODEL

During transmission, obstructions are caused by objects such as buildings and trees thus causing some part of the signal being lost via diffraction, scattering, absorption and reflection. This effect is referred to as shadowing. Based on this, equation 14 above can be modeled into

$$PL(d_i) = PL(d_o) + 10_n \log\left(\frac{d}{d_o}\right) + \chi_\sigma \tag{15}$$

Where $\chi_\sigma$ is a Gaussian distributed random variable with standard deviation $\sigma$
$PL(d_o)$ is the pathloss at reference distance
$PL(d_i)$ is the measured pathloss at various distances $n$ is the pathloss exponent

$$n = \frac{PL(d_i) - PL(d_o)}{10 \log(\frac{d}{d_o})} \tag{16}$$

In the above equation, we can analyse it with linear regression where pathloss exponent n can be evaluated by obtaining the mean square error and minimizing it.

$$\eta = \frac{\sum_{i=1}^{K} PL(d_i) - PL(d_o)}{\sum_{i=1}^{k} 10 \log\left(\frac{d_i}{d_o}\right)}$$

(17)

The standard deviation σ can be obtained via the formula below

$$\sigma = \sqrt{\sum_{i=1}^{k} \frac{PL(d_i) - PL(d_o)^2}{N}} \tag{18}$$

Where N is the number of set points

**Table 3**: SITE PARAMETERS

| SITE NAME | EBAY_322(YENEGOA) |
|---|---|
| BTS power | 45dB |
| BTS antenna height | 26m |
| LTE Operating frequency | 700Mhz |
| Mobile station height | 1m |

**Table 4**: REFERENCE POWER RECEIVED SIGNAL (RSRP)

| Distance | EBAY_322(YENEGOA) |
|---|---|
| (Km) | Measured RSRP (dBm) |
| 0.1 | -73.8 |
| 0.2 | -76.1 |
| 0.3 | -79.3 |
| 0.4 | -81.7 |
| 0.5 | -83.9 |
| 0.6 | -85.7 |
| 0.7 | -87.3 |
| 0.8 | -89.2 |
| 0.9 | -92.2 |
| 1 | -94.1 |

From table 4, we can calculate the average power received Pr at various distances

$$P_r\,(dBm) = 10 \log P\,(mW) \tag{19}$$

$$\mathrm{Pl}(d_o) = 10\log(\frac{P_t}{P_r}) \tag{20}$$

where
$Pt$ is the BTS transmit power at 45dBm
$P\,r$ is the RSRP in dBm
$\mathrm{Pl}(d_o)$ is the measured pathloss value in dB

**Table 5:** MEASURED PATHLOSS AND THE RECEIVED POWER FOR THE VARIOUS DISTANCES

| Distance | EBAY_322(YENAGOA-Urban) | PLm |
|---|---|---|
| (Km) | Measured RSRP(dBm) | dB |
| 0.1 | -73.8 | 118.8 |
| 0.2 | -76.1 | 121.1 |
| 0.3 | -79.3 | 124.2 |
| 0.4 | -81.7 | 126.9 |
| 0.5 | -83.9 | 128.9 |
| 0.6 | -85.7 | 130.7 |
| 0.7 | -87.3 | 132.7 |
| 0.8 | -89.2 | 134.3 |
| 0.9 | -92.2 | 137.2 |
| 1 | -94.1 | 139.1 |

Based on table 5, it can be deduced that the pathloss measurement increases as distance increases. The rate at which the pathloss increases exponentially (n) with respect to distance can be computed taken into consideration the effect of log normal shadowing

$$\mathrm{Pl}(d_i) = \mathrm{Pl}(d_o) + 10n\log\left(\frac{d_i}{d_o}\right) \quad (21)$$

Where $\mathrm{Pl}(d_o)$ is 120.8 and $d_o$ is the reference distance 0.1Km.

**Table 6:** PREDICTED PATHLOSS

| Distance | EBAY_322 | Measured PLm | Predicted PL |
|---|---|---|---|
| (Km) | Measured RSRP(dBm) | dB | |
| 0.1 | -73.8 | 118.8 | 118.8 |
| 0.2 | -76.1 | 121.1 | 118.8+3.01n |
| 0.3 | -79.3 | 124.2 | 118.8+4.77n |
| 0.4 | -81.7 | 126.9 | 118.8+6.02n |
| 0.5 | -83.9 | 128.9 | 118.8+6.99n |
| 0.6 | -85.7 | 130.7 | 118.8+7.78n |
| 0.7 | -87.3 | 132.7 | 118.8+8.45n |
| 0.8 | -89.2 | 134.3 | 118.8+9.03n |
| 0.9 | -92.2 | 137.2 | 118.8+9.54n |
| 1 | -94.1 | 139.1 | 118.8+10.00n |

Applying least square method of regression analysis, we can obtain the mean square error by applying the formula below

$$\mathrm{MSE} = e(n) = \sum_{i=1}^{k}[\mathrm{Pl}(d_i) - \mathrm{Pl}(d_o)]^2 \quad (22)$$

$$= 521.40n^2 - 1761.16n + 1527.79$$

Since the MSE is a function of n, we can obtain n by minimizing the equation above and equating it to zero.

$$\frac{\partial e(n)}{\partial n} = 2[521.40] - 1761.16 = 0$$

$1042.8n = 1761.16$

$n = 1.68$

Substituting n in the equation below

$$\mathrm{PL}(d_i) = \mathrm{PL}(d_o) + 10n\log\left(\frac{d}{d_o}\right)\chi_\sigma \quad (23)$$

$$\mathrm{Pl}(d_i) = 118.8 + 16.8\log\left(\frac{d}{d_1}\right) + \chi_\sigma$$

To obtain the standard deviation $\sigma$ we use the formula

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{k}(\mathrm{Pl}(d_i) - \mathrm{Pl}(d_o))^2} \quad (24)$$

$$\sigma = \sqrt{\frac{1}{10}((521.40n^2 - 1761.16n + 1527.79))}$$

$\sigma = 2.02dB$

The resultant model will be

$$\mathrm{Pl}(d_i) = 118.8 + 10(1.68)\log\left(\frac{d_i}{d_o}\right) + 2.02$$

$$\mathrm{Pl}(d_i) = 122.82 + 16.8\log(D) \quad (25)$$

*where*

$$D = \frac{d_i}{d_o}$$

$di$ is the distance at any point

$d0$ is the reference distance point

The pathloss model of YENAGOA town Bayelsa can be predicted by equation (25)

To give room for comparism, we need to compare the measured pathloss model against empirical pathloss models.

**Table 7:** MEASURED AND CALCULATED EMPIRICAL PATHLOSS VALUES

| D(Km) | Measured (dB) | Free space (dB) | Egli model (dB) | Cost 231 (dB) | Ecc33 (dB) | Ericsson (dB) |
|---|---|---|---|---|---|---|
| 0.1 | 118.8 | 69.34 | 76.56 | 89.52 | 96.74 | 101.95 |
| 0.2 | 121.1 | 75.36 | 88.60 | 100.24 | 103.09 | 111.08 |
| 0.3 | 124.2 | 78.88 | 95.65 | 106.52 | 107.24 | 116.43 |
| 0.4 | 126.9 | 81.38 | 100.64 | 110.97 | 110.37 | 120.22 |
| 0.5 | 128.9 | 83.32 | 104.52 | 114.42 | 112.92 | 123.16 |
| 0.6 | 130.7 | 84.90 | 107.69 | 117.24 | 115.07 | 125.56 |
| 0.7 | 132.7 | 86.24 | 110.37 | 119.63 | 116.93 | 127.59 |
| 0.8 | 134.3 | 87.40 | 112.68 | 121.70 | 118.59 | 129.35 |
| 0.9 | 137.2 | 88.43 | 114.73 | 123.52 | 120.08 | 130.90 |
| 1 | 139.1 | 89.34 | 116.56 | 125.15 | 121.43 | 132.29 |

**Table 8:** MSE EVALUATIONS FOR VARIOUS EMPIRICAL METHOD

| | $(pL_m - PL_{FSPL})^2$ | $(PL_m - PL_{EGIL})^2$ | $(PL_m - PL_{COST231})^2$ | $(PL_m - PL_{ECC})^2$ | $(PL_m - PL_{ERICSSON})^2$ |
|---|---|---|---|---|---|
| D(Km) | FSPL | EGIL | COST231 | ECC | ERICSSON |
| 0.1 | 2648.13 | 1957.06 | 978.66 | 578.93 | 355.32 |
| 0.2 | 2279.11 | 1190.08 | 522.45 | 400.40 | 144.48 |
| 0.3 | 2239.18 | 933.54 | 387.41 | 359.60 | 95.45 |
| 0.4 | 2258.15 | 798.42 | 321.52 | 343.25 | 75.34 |
| 0.5 | 2263.86 | 695.90 | 271.52 | 323.42 | 59.91 |
| 0.6 | 2284.84 | 625.63 | 238.90 | 310.99 | 50.98 |
| 0.7 | 2348.37 | 592.18 | 227.14 | 315.70 | 50.55 |
| 0.8 | 2391.21 | 557.67 | 213.30 | 313.75 | 48.30 |
| 0.9 | 2577.59 | 598.73 | 245.92 | 365.77 | 68.89 |
| 1.0 | 2679.10 | 602.15 | 254.45 | 386.91 | 77.62 |
| | $\sum = 23969.54$ | $\sum = 8551.37$ | $\sum = 3661.26$ | $\sum = 3698.72$ | $\sum = 1026.85$ |

To obtain the standard deviation

$$\sigma = \sqrt{\frac{1}{N}\sum(Pl_m - Pl_{emptricat})^2} \quad (26)$$

**Table 9:** CALCULATED STANDARD DEVIATION OF PATHLOSS MODELS

| $\sigma_{measured}$ | $\sigma_{ericsson}$ | $\sigma_{COST\ 231}$ | $\sigma_{ECC}$ | $\sigma_{EGLI}$ | $\sigma_{FSPL}$ |
|---|---|---|---|---|---|
| 2.01dB | 10.11dB | 18.14dB | 18.21dB | 30.44dB | 47.87dB |

## V. RESULTS AND DISCUSSIONS

MATLAB was used to plot the graphs of both empirical and measured pathloss against distance

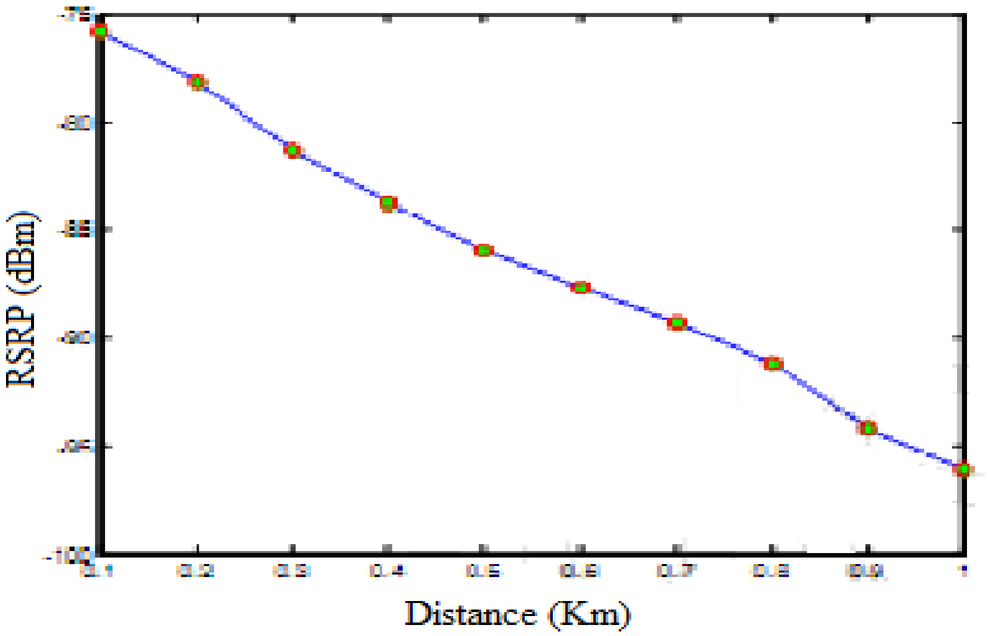


**FIG 1:** PLOT OF RECEIVED POWER AGAINST DISTANCE

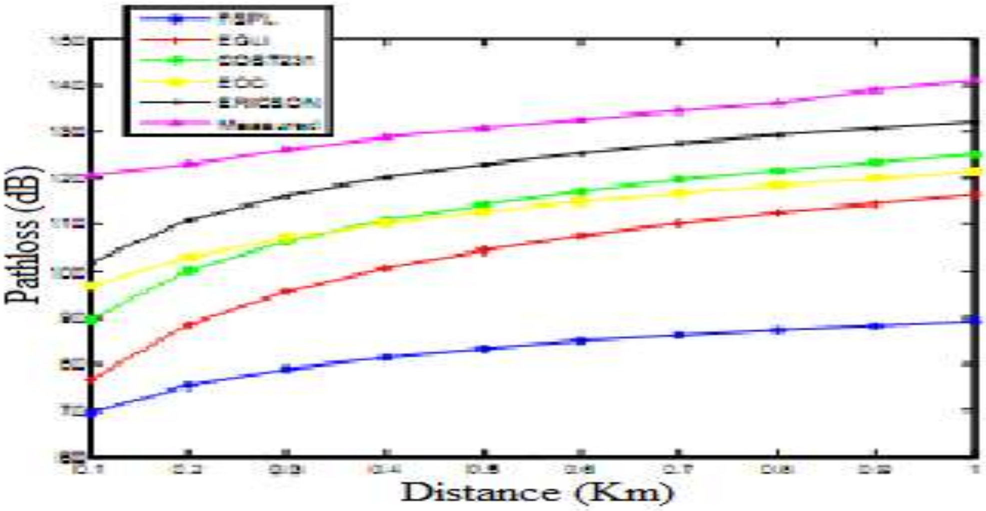


**FIG 4:** PLOTS OF MEASURED AND EMPIRICAL PATHLOSS AGAINST DISTANCE

From fig 4 which shows a mutual plot of measured pathloss and empirical pathloss model against distance, it is observed that the free space pathloss(FSPL) under-predicts the urban environment. This could be deduced from the fact the FSPL does not take into consideration, correction factors for base station height hb and receiver station height hr. Also we notice the FSPL has the highest standard deviation of value 48.96dB. The EGLI model shows a standard deviation of 29.24dB. Based on its deviation, it truly shows it is more conservative when compared to FSPL. COST 231 and ECC shows a standard deviation of 19.13dB and 19.23dB respectively. Both values wereclose and it could also be observed from the plot in fig above as both curves lie side by side. Ericsson show the best prediction of the environment compared to the measured pathloss model when compared from the plot. Also, the standard deviation shows minimum deviation with a value of 10.13dB as compared to the measured pathloss with 2.02dB. In predicting the value of n for the measured pathloss, we adopted the log normal shadowing effect which can be analyzed using least square method(LS). Ericsson model constant a0 and a1 were also obtained using LS method thus best predicting the measured pathloss for the environment as seen from the plots and the deviation compared to other models.

## REFERENCE

[1]. Akpado K.A, Oguejifor O.S, Abeadwale, Ejiofor A.C (2013) “Pathloss Prediction for a typical mobile communication system in Nigeria using empirical models”. International Journal of Computer Networks and wireless Communications Vol. 3, No. 2, pp 1215-1226.

[2]. Nwalozie Gerald .C. Ufoaroh S.U. Ezeagwu C.O Ejiofor A.C (2013) “Pathloss Prediction for GSM Mobile Networks for Urban Region of Aba, South East Nigeria “International Journal of Compuver Science and Mobile Computing, Vol.3, Issue. 2, February 2014, pg. 267-281.

[3]. Obot, O. Simeon and J. Afolayan (2011), “ Comprehensive analysis of pathloss prediction models for urban macro cellular environments.” Nigerian Journal of Technology, Vol. 30.

[4]. Shakti Raj, Navjot Kaur, Himashu Monga (2016), “Space time coding in MIMO”. India Journal of Science and Technology. Vol.9.

[5]. Biebuma J.J, Omijeh B.O, Nathaniel M.M (2014), “ Signal Coverage Estimation Model for Microcellular Network Propagation” IOSR Journal ofElectronics and Communication Engineering Vol. 9, Issue 6, pp 45-53.

[6]. Omijeh B.O, and Iroegbu C.N (2018) Determination of pathloss model for long term evolution (LTE) in Yenagoa Town Lagos, International Journal of Scientific and Engineering Research, Vol.9, Issue 2.

[7]. Michael S. Mollel, Michael Kisagiri (2014) ”Comparism of Emperical Propagation Pathloss Models for mobile Communication” Computer engineering & Invelligent system vol. 5 No. 9, 2014.

[8]. Biebuma, J.J, Omijeh, B.O (2013), “Pathloss Model Using Geaographic Information System, International Journal of Engineering and Technology. Vol.3 No.3.

[9]. Sami A. Mawjoud(2013) Path Loss Propagation Model Prediction for GSM Network Planning, International Journal of Computer Applications (0975 – 8887) Volume 84 – No 7, December 2013

[10]. Gupreet Singh Bola and Gurpreet Singh Saini(2013) Path Loss Measurement and Estimation Using Different Empirical Models For WiMax In Urban Area, Area International Journal of Scientific and Engineering Research, Volume 4, Issue 5, May 2013

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