DETERMINATION OF PATH LOSS OF GSM SIGNAL IN KAZAURE TOWN

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Abstract- This paper studied path loss propagation for GSM 900MHz for four different network at four different base station in kazaure town. The received signal strength were measured at different distance from base station for four different network namely AIRTEL, MTN, ETISALAT AND GLO using spectrum analyzer (SPECTRAN HF4040) and wheel meter. The data obtained were used to compare the performance of the various existing path loss prediction models such as Okumura-Hata, Cost 231 and ECC-33. It has been showns that Cost 231 performed better in AIRTEL, MTN, ETISALAT AND GLO network. The propagation path loss exponent were determined which ranges from 2.43 to 3.52. The paper then recommend the use of COS231 in the studied area.

Keywords- Pathloss propagation, GSM network, wheel meter, spectrum analyzer.

I. INTRODUCTION

One of the fastest growing industry in Nigeria is telecommunication. Owing to the interference and attenuation in radio propagation which is caused by climate change, tower, irregular terrain high rise in building which hinder the efficiency of radio propagation and also increases the path loss. These hindrances are beyond the knowledge and control of the site engineer. The quality of coverage of any wireless network depend on the accuracy of propagation model. Models are usually developed to predict the behaviour of propagation for all similar links under similar constraints. It provides a platform of simulating the behavioural characteristics of the radio channel before the proper deployment of the cellular mobile network. Propagation models are used in the design and development of wireless communication networks. Path loss is the reduction in power density of an electromagnetic wave as it propagates through space [1]. For design accuracy, propagation model are estimated from signal strength measurement taken in the location of interest. Many countries like United States, United Kingdom, China Japan etc have obtained their own propagation data with their propagation path loss exponent for their various cities and town [2]. The propagation model used in this work are existing model that are used to predict the path loss.

II. DETAIL EXPERIMENT

Material and Method

In this work, material used are spectrum analyzer (SPECTRAN HF4040) and wheel meter. Four base stations were used namely: Amaryawa road base station (Airtel), Zainab memorial base station (MTN), Katoge base station (GLO) and Back of Gunduma Hospital base station (ETISALAT). The Nigerian communication commission saddled with responsibility to monitor the frequency at which the network provider operate, stipulated that for suburban area, the operating frequency for AIRTEL ranges from 955MHz – 960MHz, MTN ranges from 950MHz-955MHz, GlO ranges from 945- 950 and ETISALAT ranges from 890- 895MHz.

Amaryawa road base station was the first base station that the received signal strength were measured with spectrum analyzer. The spectrum was set to frequency of GSM operator then using the wheel meter the distance were taken at interval of 100m and reading of received signal strength were taken from spectrum analyzer. This is done for ten interval at differences of 100m each and the reading for signal strength were taken at each interval. The same procedure is done for three other base stations and the readings were equally taken at different interval.

III. MODEL USED

According to [3-7] COS 231, OKUMURA-HATA and ECC33 model can be expressed as Follows:

COS 231 MODEL

$$PL = 46.3 + 33.9\log10(f) - 13.82\log10(hb) - a(hm) + [44.9 - 6.55\log10(hb)]\log10(d) + cm \quad (1)$$

For suburban;

$$a(hm) = [1.1\log10(f) - 0.7]hm - (1.56\log(f) - 0.8) \quad (2)$$

CM = 0, hm = 3m, hb= 30m

Where a(hm) is correction factor in DB

Hm is mobile antenna in meter

hb is height of base station antenna in meters

d is distance in km

f is frequency

OKUMURA-HATA MODEL

$$LP(DB) = A + B\log_{10}(d) \quad (3)$$

$$A = 69.55 + 26.16\log_{10}(f) - 13.82\log_{10}(hb) - a(hm) \quad (4)$$

$$B = 44.9 - 6.55\log_{10}(hb) \quad (5)$$

$$a(hm) = [1.1\log10(f) - 0.7]hm - (1.56\log(f) - 0.8) \quad (6)$$

ECC33 MODEL

$$LP = Afs + Abm - Gt - Gr \quad (7)$$

$$Afs = 92.4 + 20\log_{10}(d) + 20\log(f) \quad (8)$$

$$Abm = 20.41 + 9.83\log(d) + 7.894\log(f) + 9.56\log(f)2 \quad (9)$$

$$Gt = \left(\frac{hb}{200}\right)[13.98 + 5.8(\log(d))2] \quad (10)$$

$$Gr = [42.57 + 13.7\log(f)(\log(hm)) - 0.585] \quad (11)$$

Where;
Afs = free space attenuation
Abm= basic Median path loss
Gt= Base station height gain
Gr= Received antenna height gain factor
In the work of [8], received and transmitting power can be expressed as

Received power $Pr = Ant(\frac{Rss}{10})$ (12)

$$Pl = 10\log_{10}(\frac{pt}{pr}) \quad (13)$$

Where $Pt = 30w$

Table 1: Path loss for Airtel Network

DISTANCE (M)	RSSI IN (dbm)	Cos 231	0KUMURA	ECC 33	MEASURED
100	-41	87.83	88.07	271.94	55.77
200	-41	98.44	98.67	278.47	55.77
300	-43	104.64	104.87	282.71	57.77
400	-44	109.04	109.28	285.88	58.77
500	-47	112.46	112.69	290.05	61.77
600	-50	115.25	115.48	290.61	64.77
700	-55	117.60	117.84	292.49	69.77
800	-56	119.	119.88	294.	70.77
		65		15	
900	-57	121.45	121.68	295.64	71.77
1000	-60	123.06	123.29	297.00	74.77

Table 2: Path loss for MTN Network

DISTANCE IN (M)	RSSI IN (dbm)	COS 231	OKUMURA	ECC 33	MEASURED
100	-32	87.76	88.01	224.59	46.77
200	-35	98.37	98.61	231.12	49.77
300	-45	104.57	104.81	235.34	59.77
400	-46	108.97	109.22	238.51	60.77
500	-53	112.39	112.63	241.09	67.77
600	-54	115.18	115.42	243.25	68.77
700	-57	117.53	117.78	245.12	71.77
800	-62	119.58	119.82	246.78	76.77
900	-63	121.38	121.62	248.27	77.77
1000	-65	122.99	123.23	249.64	79.77

Table 3: Path loss for Etisalat Network

DISTANCE IN (M)	RSSI IN (dbm)	COS 231	OKUMURA	ECC 33	MEASURED
100	-30	86.85	87.28	222.17	44.77
200	-32	97.45	97.87	228.70	46.77
300	-32	103.65	104.08	232.92	46.77
400	-35	108.05	108.48	236.10	49.77
500	-36	111.47	111.89	238.67	50.77
600	-37	114.25	114.68	240.83	51.77
700	-37	116.62	117.04	242.	51.77
				71	
800	-38	118.66	119.08	243.87	52.77
900	-38	120.46	120.88	245.87	52.77
1000	-40	122.07	122.49	247.22	54.77

Table 4: Path loss for GLO Network

DISTANCE IN (M)	RSSI IN (dbm)	COS 231	OKUMURA	ECC 33	MEASURED
100	-41	87.70	87.95	224.46	55.77
200	-46	98.30	98.55	230.93	60.77
300	-46	104.50	104.76	235.16	60.77
400	-50	108.90	109.17	238.34	64.77
500	-52	112.32	112.57	240.91	66.77
600	-58	115.12	115.36	242.95	72.77
700	-60	117.68	117.72	244.15	74.77
800	-62	119.51	119.76	246.61	76.77
900	-65	121.31	121.56	248.11	79.77
1000	-68	122.92	123.17	249.46	82.77

Fig 1 to fig 4 shows the graph of Distance against path loss for COS231, OKUMURA HATA, ECC33 and the MEASURED.

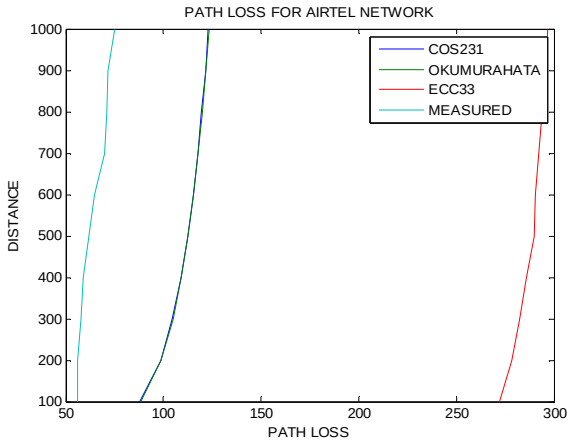


Fig 1: Path loss of GSM signal for AIRTEL NETWORK

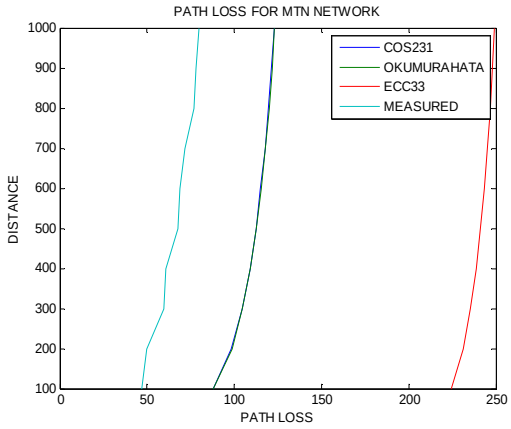


Fig 2: Path loss of GSM signal for MTN NETWORK

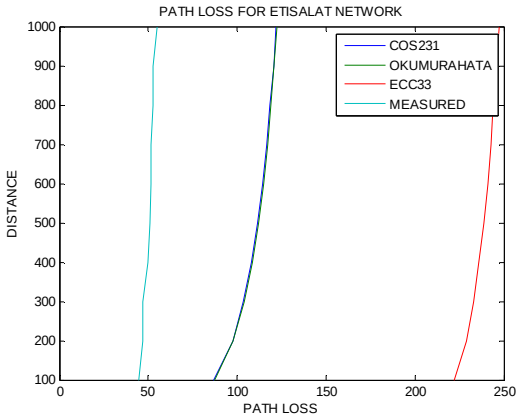


Fig 3: Path loss of GSM signal for ETISALAT NETWORK

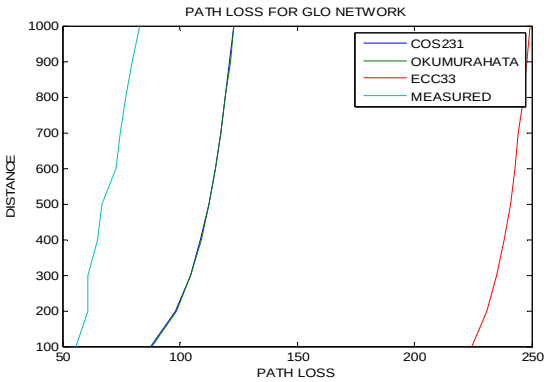


Fig 4: Path loss of GSM signal for GLO NETWORK

According to [9, 10], the path loss exponent is expressed as

$$n = \sum_{i=1}^{j} Pl(di) - Pl(do) / \sum_{i=1}^{j} 10\log(\frac{di}{do}) \quad (14)$$

The path loss exponent for model used are stated in table 5 below

Table 5: Path loss exponent values

S/N	MODEL NAME	PATH LOSS EXPONENT (n)
1	COS 231	3.52
2	OKUMURA HATA	3.35
3	EEC 33	2.43

IV. RESULT DISCUSION

Table 1 to table 4 above present the measured received signal strength at different base station and their respective path loss. The three model used shows that ETISALAT NETWORK has the least path loss, followed by GLO Network, MTN NETWOK and AIRTEL NETWORK. This is obtained due to variation in the frequency range of mobile operator. The path loss exponent are 3.52 for COS 231, 3.35 for OKUMURA-HATA and 2.43 for EEC 33 as seen from table 5. Fig 1 to fig 5 shows the path loss graph for the studied area.

CONCLUSION

This work is carried out to know to what extent is path loss of the GSM network of the four major

mobile network operator operating in this community. It has been shown that out of the three model used, COS231 has better performance in comparison to Okumura and ECC33 for all the four network. The exponent path loss also lies between 2.43 to 3.52 which is in the range of acceptable values for path loss exponent in suburban area. This work will help the site engineer when there is need for upgrade as well as planning to set up mobile network in suburban area.

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REFERENCES

[1] Isabona Joseph, Konyeha. C. C, Chinule. C. Bright, Isaiah Gregory Peter, "Radio Field Strength Propagation Data and Pathloss calculation Methods in UMTS Network", Advances in Physics Theories & Applications Vol.21, No.3, 2013.

[2] Segun Isaiah Popoola, Olasunkanmi Fatai Oseni, "Empirical Path Loss Models for GSM Network Deployment in Makurdi, Nigeria", International Refereed journal of Engineering and Science, Vol. 3, Issue 6, June 2014.

[3] Mr. Anil Kumar Koduri, Mr. Vsrk. Sharma, Mr. M. Khaleel, Ullah Khan, "Propagation Characteristics of a Mobile Radio Channel for Rural, Suburban and Urban Environments", IIJEC, Vol. 2, Issue 9, 2014.

[4] Shoewu, O and F.O. Edeko, "Analysis of radio wave propagation in Lagos environs. American Journal of Scientific and Industrial Research", 2011.

[5] Ogbulezie, J.C., Onuu, M.U., Bassey, D.E and Etienam-Umoh, S., "Site Specific Measurements and Propagation Models for GSM in Three Cities in Northern Nigeria", American Journal of Scientific and Industrial Research 2013.

[6] Ryszard J. Katulski, Jacek Stefański, and Jarosław Sadowski, "Propagation Path Loss Modeling in Container Terminal Environment", Journal of Telecommunication and information Technology, 2009.

[7] P.Elechi and P.O. Otasowie, "Path Loss Prediction Model for GSM Fixed Wireless Acess. European Journal of Engineering Research and Science", Vol. 1 No 1, July 2016.

[8] N. Rakesh, Dr.S.K.Srivatsa, "A Study on Path Loss Analysis for GSM Mobile Networks For Urban, Rural and Suburban Regions of Karnataka State", IJDPS, Vol. 4, No. 1, 2013

[9] Dominic S. Nyitamen, Musa Ahmed, Tonga A. Danladi, "Path Loss Propagation Model prediction for GSM Mobile Network Planning in Kaduna Town", IJSERT, 4(4) 2015.

[10] Akujobi Ekeochai, Onyebuchi Nosiri & Lazaus Uzoechi, "Path Loss Characterization of 3G wireless Signal for Urban and Suburban Environment in Port Harcourt City, Nigeria", IRJET, Vol3. Issue 3, March 2016.

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