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Investigation of the Variability of Signal Strength of Wireless Services in Umuahia, Eastern Nigeria

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Abstract: *This work evaluated the path loss ad received signal strength level (RSSL) of a GSM (Globacom) Network at 900MHz in Umuahia- Eastern Nigeria using Drive test. Low Quality of signal (Q_OS) was discovered in Umuahia within the period of investigation. Results from simulation of the acquired data using Matlab reviewed a considerable decline in the Receive Signal Strength Level (RSSL) in all sectors under investigation due to increase in population, building heights and vegetations. It is recommended that the frequency band be increased from 900MHz to 1800MHz to help remedy the effect of path loss within Umuahia.*

Keywords- *Path Loss, Signal Strength, Quality of Service, Propagation, Wireless Network, Transmission.*

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I. Introduction

The world is now a global village and communication is a major factor in this globalization, of which telecommunication is a key player. The enormous development seen in the telecommunications industry throughout the world is very huge as one improvement replaces the other within a very short period of time. The most important advance is the wireless telephone system, which comes either in the form of fixed wireless lines or in the form of global system for mobile communication (GSM) (Wojuade, 2005).As at May 2005, Nigeria which has a population estimated to be 128,771,988, had more than 9 million GSM subscribers, which makes the country one of the fastest growing markets for GSM in the world. At present, there are basically four GSM operators in Nigeria: Globacom, MTN, Airtel and 9Mobile. Though MTN enjoys the highest patronage with over 4 million subscribers, Globacom seems to have a wider coverage. It was forecasted that between 2003 and 2006, the GSM market in Nigeria would be the fastest-growing mobile market in Africa. The competition gets fiercer by the day with operators competing extremely for the same potential subscribers. At present, the focus of GSM operation in Nigeria is slowly shifting from coverage provision to providing quality service. The regulating body Nigeria Communication Commission (NCC) is pressurizing GSM operators to improve the quality of service accessible to Nigerians and in this light, awarded contracts to private companies to conduct comparative analyses of the quality of service offered by the operators. There are many factors affecting the propagation of these signals but the major factors is path loss otherwise referred to as attenuation. Path loss is the decrease in power of an electromagnetic wave as it travels through space. It is a key factor in analysis and design of link budget of any communication system. It relies on parameters such as frequency, antenna height, receive terminal location relative to obstacles and reflectors, link distance, etc. The prediction of Propagation path loss plays a prominent role in the design of cellular systems to denote key system parameters such as frequency, transmission power, antenna heights etc.(Isabona and Isaiah, 2013).

II. Objectives Of The Study

This research which is aimed at evaluating the path loss and received signal strength level (RSSL) of wireless network, propagating at 900MHz frequency band in Calabar South using a single sector verification method of drive test is guided by the following objectives:

1. To carry out signal strength level measurement survey.
2. To ascertain reasons for low quality of signal noticed in some parts of Umuahia.
3. To evaluate the path loss values at various distances from the transmitter
4. To calculate the path loss (attenuation) from the measured received signal strength level (RSSL).

III. Drive Test Investigation Approach

Drive test is the most used measurement tool by radio network operators in the investigation of the quality status and solving of network problems. Drive Testing is a scheme of measuring the Capacity, Coverage, and Quality of Service (QoS) of a radio network (Ahmadi et al, 2014). It is conducted for examining the coverage criteria of the cell site with the aid of Radio Frequency (RF) drive test tool. The data acquired by the drive test tool in form of log files are assessed in other to evaluate the different RF parameters of the system.

Table 1: Details of Base Station.

SYSTEM PARAMETERS	STATIONS
Latitude and Longitude	5°52'50.82'N 7°49'22.46E
Antenna Type	Sectorial
BS Antenna Height	31m
Transmitting Frequency	900MHz
Transmitting Power	30dBm
Path Length	50m – 800m
Mobile station height	2.7m
Receiver height sensitivity	-110dBm

IV. Experimental Setup

A site investigation exercise was done using testing tools. The measurement tools used includes;

1. Ericsson Transmission Evaluation and monitoring system (TEMS) Phone.
2. A Global Positioning System (GPS).
3. A laptop with installed TEMS software.

An Ericsson TEMS phone with sensitivity of -110dBm was used to initiate calls to get the received signal strength level on the network.

The Global Positioning system (GPS) is a location tracking device. It operates with Global Positioning Satellite for location tracking. The GPS device displays locations in different formats including longitude and latitude, it measures the velocity of a body on which it is placed and also measures the distance of a location from a reference location.

For this experiment, the GPS was used to track the location of each the sites under test. It is also used to measure the receiver distance from reference base stations. Fig.1. is the block diagram showing the measurement procedure.

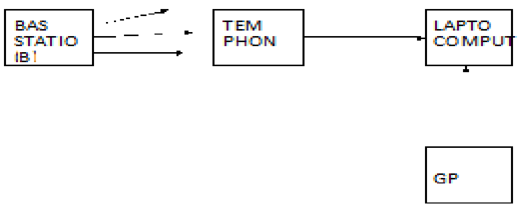

Fig 1. Block diagram of the measurement procedures.

V. Data Collection

Prior to the commencement of drive test, the desired configurations on the TEMS equipment were done. Measurement were taken in all the three sectors by initiating calls at each test point at a specific reference space of 50 m until it is recognized and the signal strength data transmitted between the base station and the mobile station were read and documented in a log file. In addition, the GPS data were recorded, which made it easy to determine the radial distance seperating the base station from the mobile station, the location coordinates and the altitude. For every sector investigated, received signal strength (RSS) was measured at a specified distance of 50 m from the base station and at subsequent intervals. In general, the experimental data were taken at distances ranging from 50 to 800 meters as the measurement varies at same distance in the various sectors monitored.

VI. Result And Discussion

Sector A is tilted towards a well populated area. This sector services the community area of Afaraukwu. The community has building heights of 2m to 5m high with little vegetations around it. Shown in Table 2 is the unfiltered Received Signal Strength Level. Figure 2 is a graphical representation of the servicing and neighboring signals of sector A. It can be deduced from the graph that close to the base station, attenuation is relatively low at -63dBm and increases as it approaches 300m from the base station to -95dBm.

Sector B is tilted towards Ibeku community. This sector serves a more populated area than Sector A. The building heights are between 2m-7m with vegetations such as trees within the path which allows the signal to suffer more from diffraction, reflection, absorption and scattering. Shown in figure 3 and Table 3 are the graphical representation and the unfiltered Received Signal Strength Level (RSSL).

Sector C is tilted towards Okpara Square. This sector is surrounded by a more populated area due to high social, economic and religious activities. The environment has a building height of 2m-10m high with vegetations such as trees within the path which allows the signal to suffer more from diffraction, reflection, absorption and scattering. Shown in figure 4 and table 4 is the Graphical representation of the Unfiltered Received Signal Strength of Sector C and the Unfiltered Received Signal Strength Level

Table 2: Unfiltered Received Signal Strength of Sector A.

Distance (M)	Signal 1(dBm)	Signal 2(dBm)	Signal 3(dBm)	Signal 4(dBm)
50	-79	-81	-83	-85
100	-81	-89	-89	-91
150	-79	-88	-89	-95
200	-91	-97	-102	-111
250	-87	-92	-108	-110
300	-97	-91	-108	-113
350	-88	-89	-103	-107
400	-82	-84	-102	-106
450	-79	-79	-100	-105
500	-80	-82	-101	-108
550	-80	-86	-101	-106
600	-77	-81	-98	-102
650	-76	-82	-98	-101
700	-82	-83	-104	-107
750	-83	-85	-105	-108
800	-82	-86	-105	-107

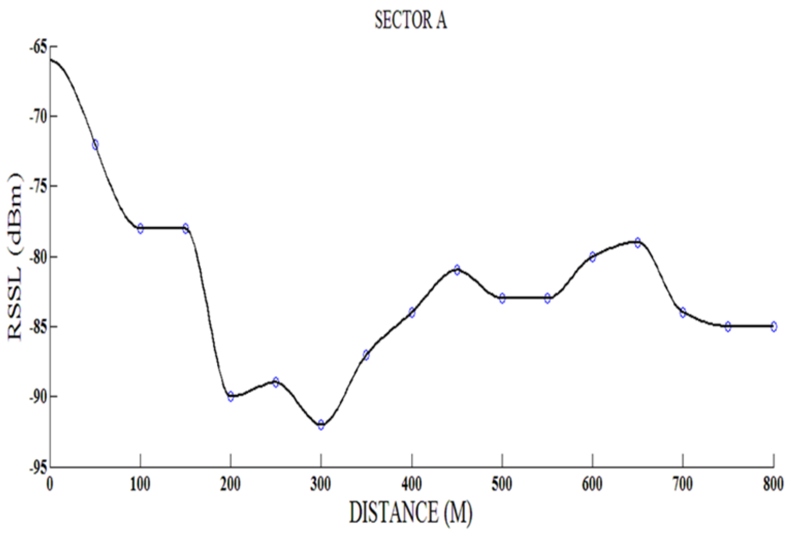

Fig. 2: Graphical representation of the Unfiltered Received Signal Strength of Sector A.

Table 3: Unfiltered Received Signal Strength Level of Sector B.

Distance (M)	Signal 1(dBm)	Signal 2(dBm)	Signal 3(dBm)	Signal 4(dBm)
50	-90	-98	-109	-116
100	-91	-99	-113	-116
150	-92	-96	-111	-114
200	-90	-101	-111	-114
250	-84	-99	-112	-114
300	-78	-93	-109	-110
350	-73	-91	-108	-112
400	-76	-91	-97	-112
450	-93	-97	-110	-111
500	-88	-107	-121	-123
550	-87	-102	-118	-122
600	-89	-91	-115	-123
650	-89	-95	-110	-121
700	-94	-95	-110	-121
750	-90	-92	-97	-101
800	-94	-99	-100	-103

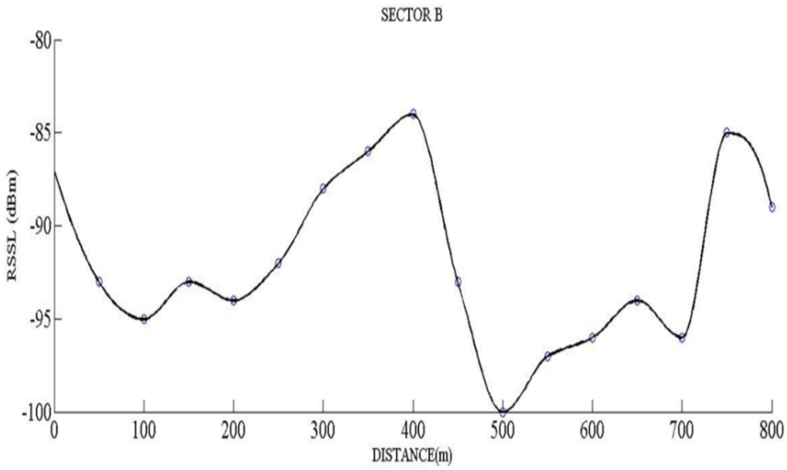

Fig. 3: Graphical representation of the Unfiltered Received Signal Strength of Sector B.

Table 4:

Distance (m)	Signal 1(dBm)	Signal 2(dBm)	Signal 3(dBm)	Signal 4(dBm)
50	-96	-102	-110	-115
100	-95	-109	-115	-118
150	-101	-118	-121	-122
200	-98	-102	-117	-118
250	-100	-106	-115	-119
300	-102	-118	-121	-122
350	-99	-102	-117	-119
400	-98	-102	-117	-119

Unfiltered Received Signal Strength Level of Sector C.

450	-98	-101	-115	-118
500	-99	-104	-111	-118
550	-102	-108	-117	-120
600	-100	-104	-117	-118
650	-100	-105	-116	-118
700	-103	-108	-110	-116
750	-103	-108	-110	-116
800	-103	-105	-113	-119

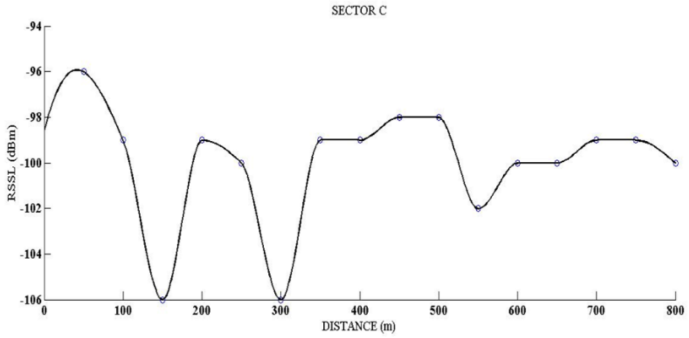

Fig. 4: Graphical representation of the Unfiltered Received Signal Strength of Sector C.

Table 4: Filtered Received Signal Strength with Calculated Path Loss of Sector A

DISTANCE (M)	RSSL (dBm)	MEASURED PATH LOSS (dB)
50	-70	86
100	-72	88
150	-70	86
200	-82	98
250	-78	94
300	-88	104
350	-79	95
400	-73	89
450	-70	86
500	-71	87
550	-71	87
600	-68	84
650	-67	83
700	-73	89
750	-74	90
800	-75	91

Table 6: Filtered Received Signal Strength with Calculated Path Loss of Sector B.

DISTANCE (M)	RSSL (dBm)	MEASURED PATH LOSS (dB)
50	-81	103
100	-82	102
150	-83	108
200	-81	105
250	-75	107
300	-69	109
350	-64	106
400	-67	105
450	-84	105
500	-79	106
550	-78	109
600	-80	107
650	-80	107

700	-85	110
750	-81	110
800	-85	110

Table 7: Filtered Received Signal Strength with Calculated Path Loss of Sector C.

DISTANCE (M)	RSSL (dBm)	MEASURED PATH LOSS (dB)
50	-87	97
100	-86	98
150	-92	99
200	-89	97
250	-91	1
300	-93	85
350	-90	80
400	-89	83
450	-89	100
500	-90	95
550	-93	94
600	-91	96
650	-91	96
700	-94	101
750	-94	97
800	-94	101

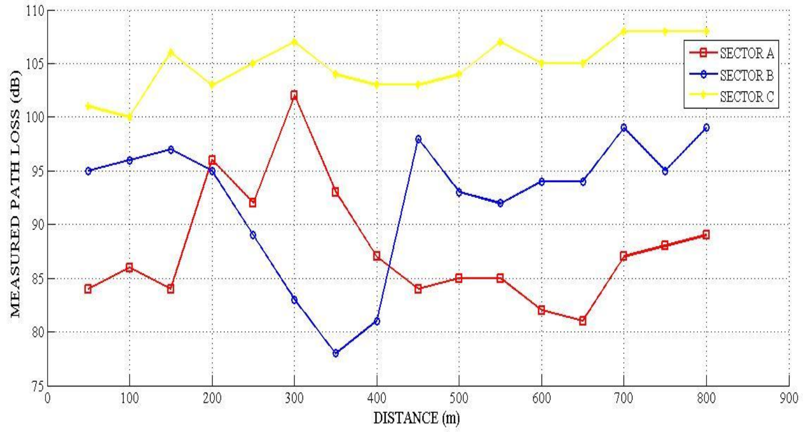

Fig. 5: A comparison of measured path loss of all sector signals.

From Fig. 5, it is observed that sector A has its lowest path loss at about 85dB at a distance of 650 m absent from the base station with its peak loss at about 104dB at 300 m absent from the transmitter, it can alsobe observed in sector A that the path loss decreases with distance at 300m away from the transmitter up to about 700 m and became slightly stable at 700 m to 800 m, It can be deduced that in sector B the lowest path loss is at 80dB at a distance of 350 m from the transmitter and increase rapidly from 80 dB to about 100 dB from a distance of 400 m to 450 m with its highest loss at 101dB at about 700m away from the transmitter. Sector C has its lowest attenuation at 102dB with its highest attenuation at 109dB. Though its signal quality is poor, it can be seen that sector C has a more stable signal propagating path with distance.

It can also be deduced that the three sectors have significant differences. It can be seen that sector C has a poor signal strength compared to sector A and B. At distances closer to the transmitter, the signal strength of both sector A, B and C are relatively poor, but sector A has a good network of 85 to 93 dB which is better when compared to sector B with loses of 95 to 97 dB and sector C with loses between 103 to 108 dB . At the intermediate field (300 to 600 m) the network is good at sector B with a path loss of 80 dB and very poor at sector A and C at about 104 and 109 dB respectively. At the far field, it is relatively the same with the near field, which shows that sector B was tilted towards the intermediate field while sector A was tilted towards the near fie

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ity solutions are thus directly related to factors like topography and building heights. The influence of these ecological factors must be emphasized and accurately accounted for when radio planning applications are considered. This research has shown that the constant increase of population in Umuahia has brought about more vegetation's, building heights increase and more calls, thereby giving rise to poor signal strength. The sectors under investigation shows that the 900MHz frequency band is relatively poor compared to the population and vegetation within Umuahia.

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