Original Research Article

Comparative Analysis of GSM Quality of Service in Effurun, Warri Delta State, Nigeria Using Petroleum Training Institute as a Case Study.

Abstract: *Quality of service has become the major challenges being faced by telecommunication services users and the service providers (MTN, GLO and AIRTEL) have been trying as much as possible to fight the disease that is faced by this sector by minimizing the losses that occurs during transmission from the transmitter to the end users but signal losses still remain the major challenges in this generation and the generation to come. This is so because losses cannot be eliminated in communication systems and as such noise cannot be eliminated which has direct impact on the quality of service. This papers focuses on the signal strength in the selected locations using an application called network monitor to measure the signal strength in the selected locations, how the environments affect the quality of service and thereby drawing a conclusion on the best service provider to use by the occupants of these locations.*

Keywords: *Network monitor, signal strength, path-loss, quality of service*

1. INTRODUCTION

As the world is increasing in population, developmental activities and technologies around this said area increases daily, also problem begins to arise in the communication services, like traffic in system and signals, Low capacity, less coverage area and poor quality of service. Telecommunication industries today have a major problem which is losses that occur during transmission of signals from the point of transmission (transmitter) to the receiving end (receiver). In wireless channels, the path loss exponent (PLE) has a strong impact on the quality of links, and hence, it needs to be accurately estimated for the efficient design and operation of wireless networks [6]. The wireless channel displays an imposing test as a medium for solid high-rate communication. It is capable not just for the construction of the spread signal yet in addition aims erratic spatial and transient varieties in this loss because of client development and changes in nature. With a specific end goal to catch every one of these impacts, the path loss for RF signals are generally spoken to as the result of a deterministic distance segment (vast scale path loss) and an arbitrarily changing part (little scale fading). The vast scale path loss demonstrated that the got signal strength tumbles off with distance as per a power law at a rate named the path loss exponent (PLE) [7]. Fading depicts the deviations of the got signal strength from the power-law rot because of shadowing and the helpful and ruinous expansion of its multipath parts. While the little scale fading conduct of the wireless channel can be very much spoken to utilizing stochastic procedures, it is basic to precisely evaluate the PLE for the productive plan and task of wireless systems [5].

2. LITERATURE REVIEW

[7] works on path loss exponent in a particular location where it was observed that path loss exponent has a great negative effect on signal strength of any location and it was also stated by these authors that the losses depend on the type of terrain, the environmental factors and the suitability of the mathematical model used. From their conclusion on the experiment conducted, it was shown that the log-distance model from literature have some limitation compare to the developed model by the authors which give better results.

2.1. PATH LOSS EXPERIMENT

In wireless communication, path loss is addressed to be the path loss exponent, whose regard is routinely in the extent of 2 to 4, where 2 is for propagation in free space, 4 is for modestly lossy conditions and for the example of full specular reflection from the earth surface implied as the level earth show. In a couple of conditions, the path loss exponent can accomplish values in the extent of 4 to 6. Of course, an entry may go about as a waveguide, realizing a path loss exponent under 2. Path loss is ordinarily communicated in dB. In its most direct shape, the path loss can be processed using the condition.

L = 10 n + C (1) Where L is the path loss in decibels, n is the path loss exponent, d is the partition between the transmitter and the recipient, ordinarily assessed in meters, and C is a reliable which speak to system losses. The estimation of C regularly vacillates and is commonly dependent on the sort of showing under idea. Once-over of common path loss exponents gained in various adaptable circumstances has showed up in Table 1.

Table 1: Path Loss Exponent for Different Environments [1, 2, 3, 4, 5]

Environment	Path loss exponent, n
Free space	2
Urban area cellular radio	2.7 to 3.5
Shadowed urban cellular radio	3 to 5
In building line-of-sight	1.6 to 1.8
Obstructed in building	4 to 6
Obstructed in factories	2 to 3

2.2. PATH LOSS PREDICTION TECHNIQUES

The way toward computing the path loss is generally called forecast. Correct forecast is conceivable just for less intricate cases, for example, the beforehand specified free space propagation or the level earth show. In useful cases the path loss is computed by utilizing various approximations. Measurable techniques (moreover called stochastic or exact) rely upon assessed and landed at the midpoint of losses along run of the mill classes of radio associations. Probably the most normally used techniques are Hata, Okumura-Hata, the COST Hata show, W.C.Y.Lee and so on which are also called radio wave propagation models and are ordinarily used as a piece of the arrangement of cell systems and open land adaptable systems (PLMN). The Okumura-Hata as refined by the COST-231 venture is the strategy utilized for wireless communications in the specific high recurrence (VHF) and ultra-high recurrence (UHF) recurrence band (the bands used by walkie-talkies, police, moves and cell phones). For FM radio and the TV broadcasting, the path loss of 3 is most normally anticipated using the ITU demonstrate as depicted in ITU-R P.1546 suggestion. Other surely understood models are those of Walfisch-Ikegami, W.C.Y Lee, and Erceg. Beam following is one of the deterministic strategies in perspective of the physical laws of wave propagation that are also used as they are required to deliver more exact and strong forecasts of the path loss than the observational techniques however are extensively costlier in computational effort and depend upon the positive and precise depiction of all items in the propagation space, for example, structures, housetops, windows, portals and dividers. They are in this manner utilized transcendently for short propagation paths. Among the most usually utilized techniques in the arrangement of radio apparatus, for example, antennas and supports is the constrained distinction time-space procedure. Tantamount strategies are utilized in anticipating the path loss in other recurrence bands (medium wave (MW), short wave (SW or HF), smaller scale wave (SHF) despite the fact that the genuine estimations and conditions may marginally be not at all like those for VHF/UHF. Tried and true forecast of the path loss in the SW/HF band is especially troublesome, and its precision is practically identical to climate expectations [1-5]. Simple approximations for figuring the path loss over distances altogether shorter than the distance to the radio horizon: In free space the path loss increments with 20 dB consistently (multi decade is the point at which the distance between the transmitter and the beneficiary expands ten times) or 6dB for each octave (one octave is the point at which the distance between the transmitter and the recipient sets). This can be used as an extremely cruel first demand figure for (microwave) communication joins. The path loss increments with approximately 35-40 dB for every decade (10-12 dB for every octave) for signals in the UHF/VHF band spreading over the surface of the Earth which can be used as a piece of cell organizes as a first figure. The estimation of the path loss in created areas can achieve 110-140 dB for the primary kilometer of the association between the base transmitter station (BTS) and the adaptable in cell systems, for example, UMTS and GSM, which work in the UHF band. The path loss for the underlying ten kilometers might be 150-190dB. These characteristics are extremely inaccurate and are given here just as a depiction of the range in which the numbers used to express the path loss regards can in the long run be; these are not definitive or limiting figures. Studies have demonstrated that the path loss might be exceptionally unprecedented for a comparable distance along two remarkable paths and it can be unmistakable even along a comparable path if evaluated at different conditions. In radio wave condition for adaptable antennas is near the ground. Perceptible pathway propagation (LOS) models are very adjusted.

The signal path from the BTS antenna regularly raised over the housetop tops is refracted down into the neighborhood physical condition (slants, trees, houses) and the LOS signal just all over achieves the antenna. Nature will deliver a couple of diversions of the immediate signal unto the antenna, where ordinarily 2-5 diverted signal parts will be vector included. These refractions and avoidance forms cause loss of signal strength, which changes when the flexible antenna moves (Raleigh fading), causing snappy assortments of up to 20 db. The system is in this manner expected to give an overabundance of signal strength contrasted with LOS of 8-25 db depending upon the possibility of the physical condition, and another 10 db to keep up a vital distance from the fading as a result of advancement. [5-8]

3. METHODOLOGY

The method adopted in the realization of the experiment involves the following;

I. Measurement of the data needed using a software called network monitor; this software has the ability to give the received signal strength, the distance to site, the cell Id, the latitude and longitude of the chosen location.
II. The software was installed in an android mobile phone, see diagrams below showing the front view of the application and the mobile phone

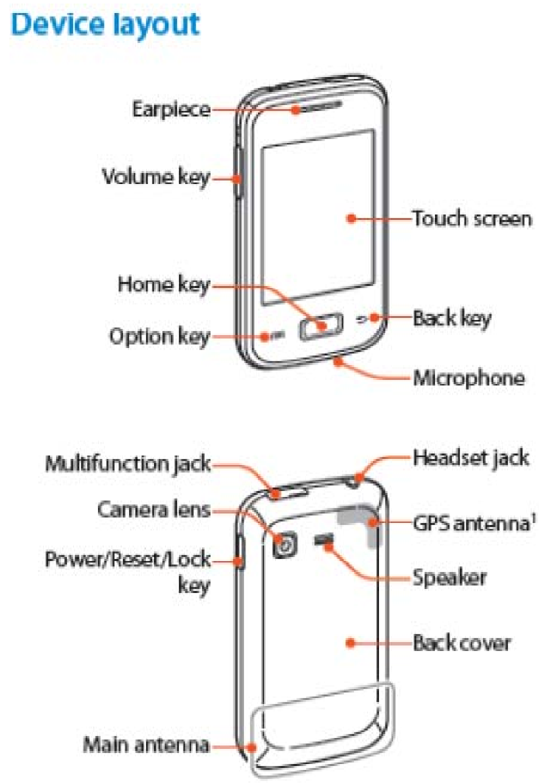

Figure 1: Front view of the mobile device

3.1. LOCATIONS USED:

The locations where the measurements were taken are outside some blocks of classrooms where students take lectures. The pictures of the class rooms and their GPS locations are as follows.

Figure 2: LT (AUDITORIUM)

LATITUDE: 5.57314100

LONGITUDE: 5.79500300

Figure 3: N BLOCK

LATITUDE: 5.5673000

LONGITUDE: 5.79412600

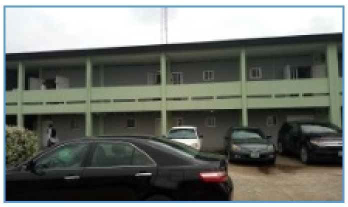

Figure 4: NN BLOCK

LATITUDE: 5.5678500

LONGITUDE: 5.7965400

Figure 5: LH BLOCK

LATITUDE: 5.56573000

LONGITUDE: 5.79412600

Figure 6: NB BLOCK

LATITUDE: 5.57266100

LONGITUDE: 5.79599000

Figure 7: ELF BLOCK

LATITUDE: 5.56396800

LONGITUDE: 5.78865700

3.2. MEASUREMENT PROCEDURE

The general aim was to determine the best GSM network and internet service provider in the chosen locations. The signal strength of three different networks (MTN, GLOBACOM AND AIRTEL) was then measured and recorded. The geographical locations parameters and their descriptions were all recorded. The geographical locations parameters and their descriptions were taken from the beginning of the tested locations and the parameters include: mobile latitude, mobile longitude and mobile heading. The GPS function of the Samsung galaxy pocket must be switch ON before the network monitor can work otherwise, it will fail to function.

4. DATA PRESENTATION

Table 2: LT (AUDITORIUM) (OUTSIDE)

MONTH	SERVICE PROVIDER: AIRTEL; DISTANCE TO SITE: 319m	SERVICE PROVIDER: MTN; DISTANCE TO SITE: 414m	SERVICE PROVIDER: GLO; DISTANCE TO SITE: 454m
	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH
January	-83	-69	-69
February	-81	-67	-69
March	-81	-69	-67
April	-83	-69	-67
May	-79	-67	-71
June	-79	-65	-67

Table 3: N BLOCK (OUTSIDE)

MONTH	SERVICE PROVIDER: AIRTEL; DISTANCE TO SITE: 389m	SERVICE PROVIDER: MTN; DISTANCE TO SITE: 432m	SERVICE PROVIDER: GLO; DISTANCE TO SITE: 458m
	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH
January	-81	-63	-83
February	-79	-61	-85
March	-79	-69	-83
April	-81	-69	-85
May	-77	-67	-81
June	-75	-69	-83

Table 4: NN BLOCK (OUTSIDE)

MONTH	SERVICE PROVIDER: AIRTEL; DISTANCE TO SITE: 389m	SERVICE PROVIDER: MTN; DISTANCE TO SITE: 532m	SERVICE PROVIDER: GLO; DISTANCE TO SITE: 467m
	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH
January	-81	-83	-79
February	-81	-81	-75
March	-78	-81	-77
April	-83	-85	-71
May	-81	-79	-71
June	-81	-79	-79

Table 5: LH (AUDITORIUM) (OUTSIDE)

MONTH	SERVICE PROVIDER: AIRTEL; DISTANCE TO SITE: 410m	SERVICE PROVIDER: MTN; DISTANCE TO SITE: 361m	SERVICE PROVIDER: GLO; DISTANCE TO SITE: 551m
	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH
January	-71	-75	-71
February	-73	-73	-73
March	-77	-75	-71
April	-71	-73	-75
May	-73	-81	-75
June	-75	-79	-81

Table 6: NB BLOCK (OUTSIDE)

MONTH	SERVICE PROVIDER: AIRTEL; DISTANCE TO SITE: 380m	SERVICE PROVIDER: MTN; DISTANCE TO SITE: 602m	SERVICE PROVIDER: GLO; DISTANCE TO SITE: 583m
	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH
January	-73	-75	-71
February	-77	-73	-73
March	-79	-75	-71
April	-77	-73	-75
May	-81	-80	-75
June	-77	-79	-77

Table 7**: ELF BLOCK (OUTSIDE)**

MONTH	SERVICE PROVIDER: AIRTEL; DISTANCE TO SITE: 330m	SERVICE PROVIDER: MTN; DISTANCE TO SITE: 647m	SERVICE PROVIDER: GLO; DISTANCE TO SITE: 908m
	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH	AVERAGE SIGNAL STRENGTH
January	-65	-79	-69
February	-61	-81	-71
March	-66	-81	-71
April	-63	-83	-69
May	-65	-79	-73
June	-61	-85	-77

5. GRAPHICAL REPRESENTATION OF DATA

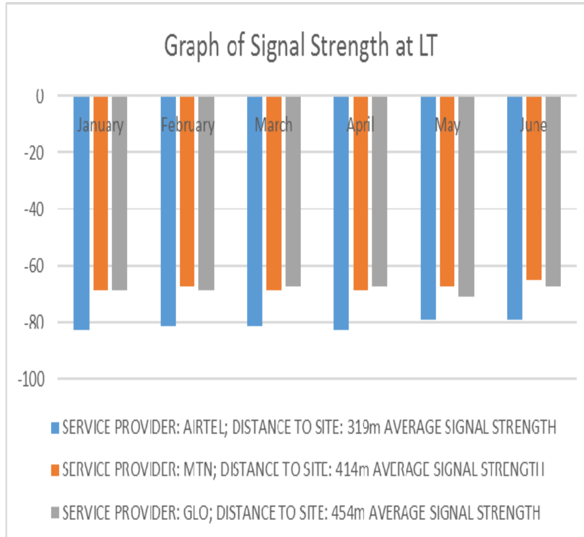

Figure 8 : Graph of Signal Strength at LT

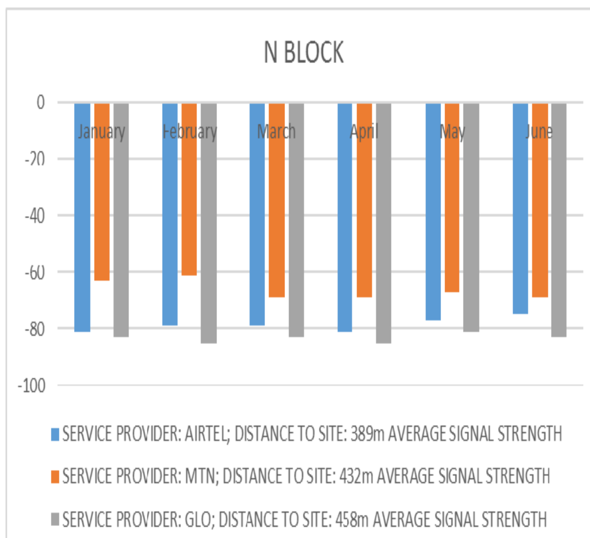

Figure 9: Graph of Signal Strength at N Block

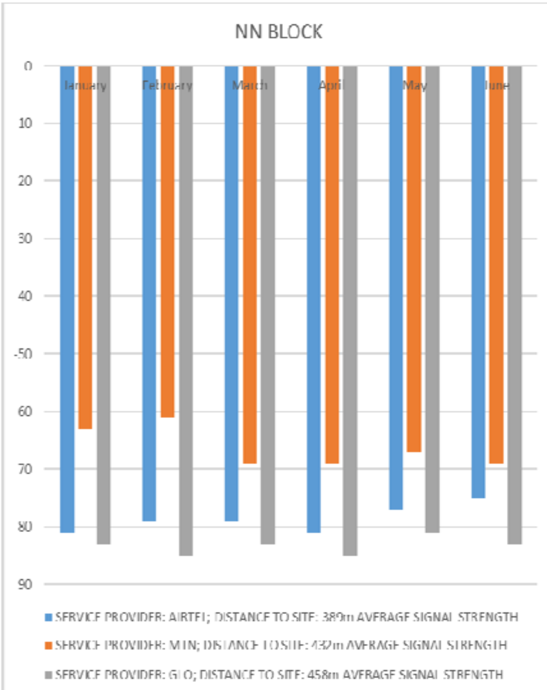

Figure 10: Graph of Signal Strength at NN Block

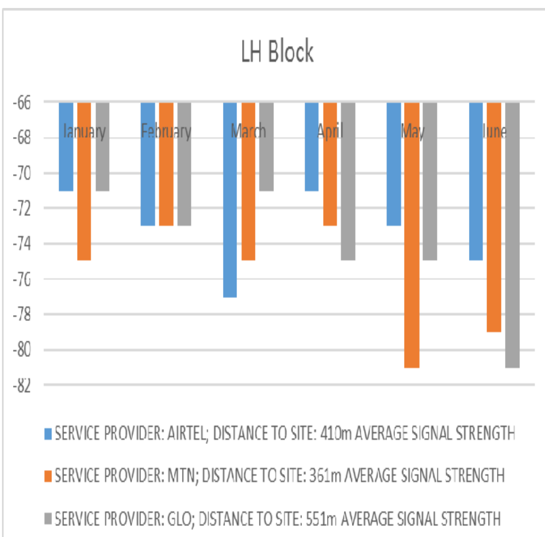

Figure 11: Graph of Signal Strength at LH Block

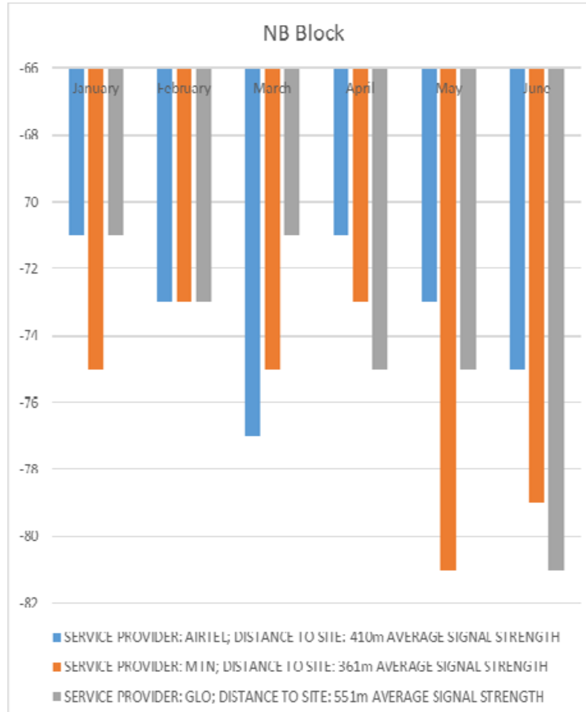

Figure 12: Graph of Signal Strength at NB Block

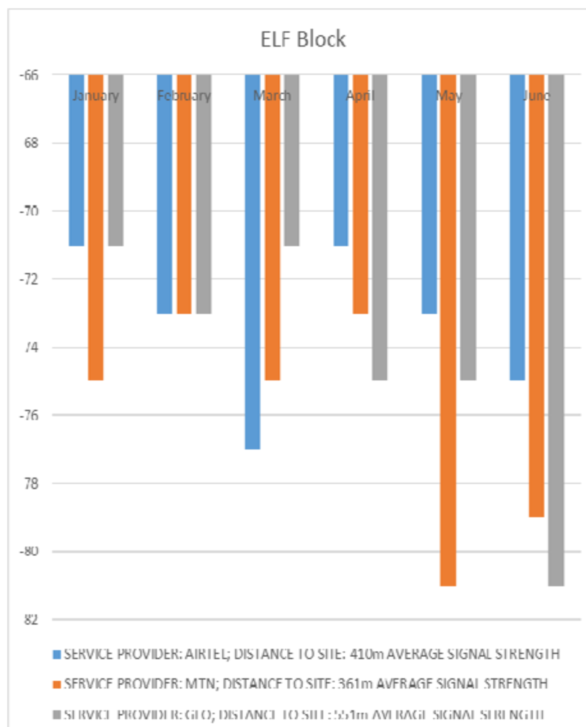

Figure13 : Graph of Signal Strength at ELF Block

6. RESULT DISCUSSION AND CONCLUSION

From figure 8, it was observed that AIRTEL has the best quality of service around this location while MTN and GLO have almost the same quality of service. Taking a look at figure 9 and 10, it shows that AIRTEL and Glo have the same QoS while MTN has the lowest quality of service over the six months in analysis. Figure 11, 12, and 13 show that aside the month of feburary, 2018 where the QoS was the same in all the service providers, AIRTEL and MTN have the best QoS in other months in analysis. This variation could be as a result of the following factors;

a. Weather conditions
b. Time of the day the data was collected
c. The terrains
d. The surrounding environment
e. Equipment failure on the side of the service providers (MTN, GLO and AIRTEL).

These results have validated the literatures in references 2, 6, 7 and 8 where the authors stated that the factors mentioned above in (a, b, c, d, e) have a great effect on the signal strength of a GSM providers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

Competing Interests Disclaimer:

The company name used for this research are commonly and predominantly selected in our area of research and country. There is absolutely no conflict of interest between the authors and company because we do not intend to use those company as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the company rather it was funded by personal efforts of the authors.

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