Monitoring and Evaluation of Global System for Mobile Communication (GSM) Signal Strength at 900MHz in Sub Urban Area

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Summary
In this work we monitored the variation of signal strength in terms of shadow or multi path fading using Log normal and Rayleigh distribution. Measurements were conducted at the center of the foot ball pitch of Adamawa state University Mubi in two weeks from 10/01/2010 - 24/01/2010; total of 700 observations were made altogether for two GSM operators namely Glo and Zain, the investigation revealed that GSM signal strength was attenuated at the chosen location (where the signal is received) due to the fading phenomenon and the overall result established that the GSM signal strength received at Adamawa State University is fairly adequate but not sufficient enough to meet up with customer's demand.

Key words: Network bars, Customers, Network problems, BSTs and Signal Quality.

1.0 Introduction

Today most of the problems that GSM subscribers face in Mubi is the poor quality of GSM signal deliver to the user's of GSM mobile Phone; lost of the signal may be attributed due to complex environment like buildings, trees, human activities and other geographical features, these factors reduce the signal strength and consequently hamper effective communication [3 & 7].
Nigeria in 60 - 90's depend solely on conventional telephone system and turaya technology as the only means of telecommunication services but, the reliability of their services was not sufficient to meet up with the demand of the customer's in the entire country and their service cost was relatively beyond the reached of common man in Nigeria. As at 2001 communication was made cheap, readily available and accessible to almost every Nigerian by the introduction of GSM technology in the Country [2]; however the services of the GSM operators in Nigeria become the area of great concern to the Customer's, there are still a lots of complains of poor quality of services such as frequent call drop, echo during radio conversion, cross talk, poor inter and intra connectivity, network congestion (network busy) and many other network problems, these problems may be attributed to poor quality of GSM signal strength deliver to the end user of the GSM Mobile Unit (MU). The following are also additional factors that affect the radio propagation or quality of GSM signal strength; free space loss, absorption losses, diffraction, multipath reflection, terrain, vegetation and atmospheric parameters. [4 & 5]. In this investigation a specific location was chosen to monitor the GSM signal strength using MU at the center of the foot ball pitch of Adamawa State University, although the assessment using this method may be fairly accurate since in real life terrestrial application it is not easy as there are many factors to take in consideration, it is not always possible to gain accurate assessments of the effects they will have. This paper aims at investigating the GSM signal strength, the frequency of the occurrence of the network service bars, examine how the signal strength varies and provide useful suggestion that may improve the quality of signal strength in Mubi since the fundamental aim of any GSM Operator is to deliver sufficient signal quality from source to destination without losing any meaning information (To meet up with Customers requirements).

2.0 Materials and Methods

2.1 Study area and method of data collection

Mubi falls within the Sudan Savannah belt of the Nigerian Vegetation Zone in the North East of the Country. The zone is made of dry and weeds interspaced by shrubs and woody plants; the plants are of two categories indigenous and exotic woody plants, the indigenous woody plants are Tamarin, Shear butter, Locust bean, Burasus aethiopus " Giginya" their height ranges
between 7 – 12m, and exotic woody plants are Neem, Mohagany, Date palm " Dipino", Cashew, Mango and Guava almost of the same height [1]. Adamawa State University, Mubi foot pitch is located at the almost center of the University Campus surrounded by vegetation and buildings for example the highest building is five (4) storey building of approximately 15.20m height. There are six (6) Base station

transceivers (BSTs) in Mubi town for the two GSM operators considered in this investigation. The BSTs were planted at different locations at the strategic positions for receiving GSM signal; 3 BSTs for Glo network operator (Operator A) and 3 BSTs for Zain network operators (Operator B). The BSTs were planted approximately at 1 – 5 Km away from where the signal is received; the BSTs were installed at 30 -35m height, depending on the topology of the area. The MU used for detecting the signal strength is Nokia L600 GSM dual band supported by GPRS. The SIM CARD for the two GSM operators were inserted into the MU which enable us to monitor the signal strength of the two GSM operators concurrently, the MU was placed at 1.7m high in all the measurements. In the measurements it was observed that the MU display maximum of six (6) and minimum of zero (0) GSM network service bars depending on the signal strength detected at a given time, this implies that the strongest signal strength is 6 bars while the weakest signal strength is 0 bars.

2.2 Method of Data Analysis

Data were collected at specific location as early stated in every 30 minutes for the period of two (2) weeks from 10/01/2010 – 24/01/2010. The data were first analyzed using XP – 2006 EXCEL SOFTWARE on a digital computer as depicted in Figure 1, 2. Before computing the statistical parameters such as mean, standard deviation, standard error, relative standard error, approximate log normal distribution and Raleigh distribution, the data obtained is two large and the analysis will be cumbersome or tedious, hence the data need to be group; in the grouping the number of the groups that the whole information should be divided must be ascertained. The assignment of the data were grouped as follows, x = 6, 5, 4, 3, 2, 1 and 0 best on their numbers of appearance. The mean and the standard deviation of the data were estimated using the following expressions below respectively

$$\mu = \sum \frac{f(x)}{f} \quad (1)$$

$$\sigma = \left[\frac{\sum fx^2 - \frac{\left(\sum fx\right)^2}{f}}{f-1} \right]^{\frac{1}{2}} \quad (2)$$

Where x is the signal strength in terms of network bars, f is the frequency of occurrence of the signal strength bars, the analysis further continuous by determining some parameters like;

$$E = \frac{\sigma}{\sqrt{f}} \quad (3) \text{ and}$$

$$RSE = \frac{E}{\mu} \quad (4)$$

Where E and RSE are the standard error and relative standard error respectively.

To further examine the rate of the signal strength variation in terms of shadow fading and multi path fading phenomenon log normal or Gaussian distribution (LND) and Raleigh distribution (RRD) respectively were considered as given in the equation (5) and (6).

$$LND = \frac{1}{\sigma\sqrt{2\pi}} e^{-\left(\frac{(x-\mu)^2}{2\sigma^2}\right)} \quad (5)$$

$$RRD = \frac{\mu}{\sigma^2} e^{-\left(\frac{\mu^2}{2\sigma^2}\right)} \quad (6)$$

3.0 Results

The results of the statistical analysis are presented in Table 1 and 2.

Table 1: Analyzed signal strength parameters for the first week.

Parameter	Operator A	Operator B
μ	3.71	3.35
σ	1.52	1.78
E	0.31	0.36
RSE	0.08	0.10
LND	0.23	0.21
RRD	0.72	1.06

Table 2: Analyzed signal strength parameters for the second week.

Parameter	Operator A	Operator B
μ	4.68	4.28
σ	0.87	1.31
E	0.17	0.26
RSE	0.04	0.06
LND	0.06	0.19
RRD	1.22	1.33

4.0 Discussion

The signal strength received by the Nokia L600 depends upon path, shadow fading and multipath fading, the distance of the MU from the BSTs, between the BSTs and the MU there are many obstacle for example trees, building, human or vehicles movement and other geographic features, those obstacles create temporal variation of signal strength over the main path loss as recorded in Table 1 and 2. This variation may be known as shadow fading or multi path fading. The Nokia L600 receives line of sight (LOS) from BSTs over a certain distance which may not be hitch free from transmission impairment [6] is main focus of this work, after grouping the data monitored in two weeks the mean and standard deviation were first estimated which enable us to determined the signal strength in error, the purposed of evaluating the relative standard error is to examine how much percentage of the signal received were affected due to attenuation. In the first week the signal strengths received at the desired location were affected by 40% for operator A while 60% for operator B, the signal strength of operator B much follows Rayleigh distribution whereas operator A follows Log normal distribution (Gaussian distribution), the situation follows almost the same pattern in the second week only that the signal strength is much more affected and signal both follows Rayleigh distribution. The status of the variation of the signal strength monitored is described by the ogives as depicted in Figure 1 and 2.

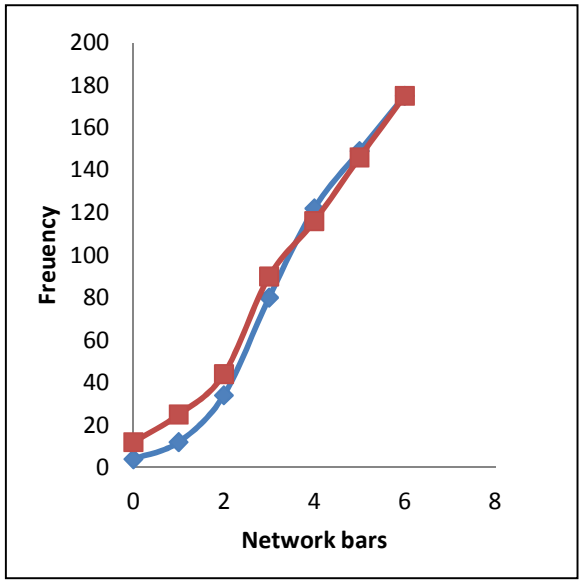

Figure 1: Variation of the signal strength in first week

Figure 1, described the performance of signal strength monitored in the first week in terms of network service bars, 4 bars of Operator A appeared 46 times out of 175 observations, it seems to be the highest followed by 4 bars of Operator B which appeared 42 times, followed by 2 bars of Operator B which also appeared 30 times out of 175 observations, for the both the Operators 1bar and 0 bar were the least.

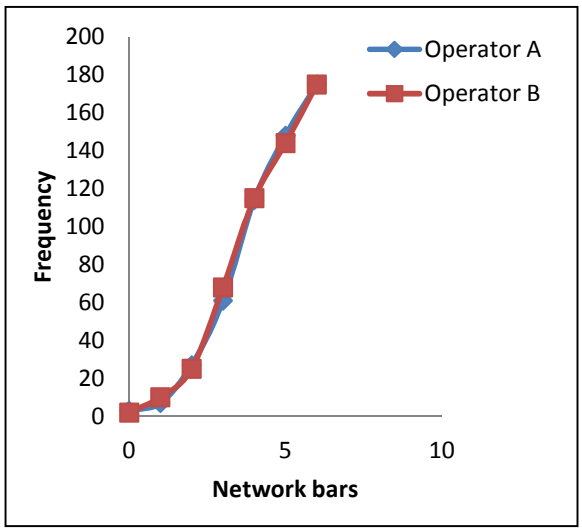

Figure 2: Variation of the signal strength in the second week

Figure 2, presents also the performance of the signal strength monitored in the second week in terms of network service bars, this time 3bars of Operator A is the highest followed by 4 bars of Operator B, followed by 2 and 5 bars of Operator A. 0 bar of Operator B is the least followed by
1 bar of Operator A.

5.0 Conclusion

GSM signal strength has been investigated and recorded at Adamawa State University for a period of two (2) weeks from 10th January, 2010 to 23rd January, 2010. Total of 700 observations were made, 350 samples for each operator. The study revealed that large amount of signal strength is affected by multi path fading. This work was conducted to serve as a preliminary work on how to investigate variation of GSM signal strength using common available GSM equipment. If the following recommendation can be put in place by the GSM operators it will surely improve the quality of the GSM signal strength in Mubi town.

6.0 Recommendation

i. For more detail result this type of investigation should be carried out at least for two years**.**
ii. GSM Operators should have adequate clearance (considerable BSTs height).
iii. Expand their cells to accommodate reasonable number of subscribers
iv. Increase number of BSTs as the number of subscribers increases
v. GSM Operators should employ more skillful personnel to maintain and address technical problems that occurs on frequent basis
vi. GSM Operators should adapt technique of cell sectorization in other to increases number of cells

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