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An evaluation of global system for mobile communication (GSM) signal strength at 900MHz in Mubi Adamawa State, Nigeria

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Abstract

This work aim at evaluating GSM signal strength in terms of network service bars and to determine the frequency of the occurrence of the network service bars, also to provide useful suggestion that may improve the quality of signal strength in Mubi. The measurement was conducted at the center of the foot ball pitch of Adamawa state University Mubi. Total of 700 observations were made for the two Operators from 10/01/2010 - 24/01/2010, the investigation revealed that 3 – 4 bars seems to appeared more frequent. The evaluation established that the quality of the GSM signal strength is fair but not sufficient enough to meet up with customer's satisfaction. Therefore the quality of signal strength needs to be improve to meet up with customers requirements in Mubi town.

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

INTRODUCTION

A well – known problem facing first responders who rely on radio communication is the loss of signal in complex propagation environment such as building, trees, basements, collapsed structures and other geographical features reduce the signal strength due to attenuation, and these factors can hamper communication [6].

There are cell phone base station tower networks across many nations globally that do not have good reception among the nations is Nigeria. Some rural areas in Nigeria are unlikely ever to be effectively covered since the cost of erecting a cell tower is too high for few customers. Even in high reception areas it is often found that basements and the interiors of large building have poor reception. Weak signal can also be caused by destructive interference of the signal from local towers in urban areas, or by the construction materials used some buildings causing rapid attenuation of the signal strength. Large buildings such as warehouses, hospitals and factories often have no usable signal further than a few meters from the outside walls [11]

Nigeria in 60 – 90's depend sorely 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 is 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 [3]; 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 may be factors that affects the radio propagation or quality of GSM signal strength; free space loss, absorption losses, diffraction, multipath reflection, terrain, building, vegetation and atmospheric parameters. [5, 8 & 9]

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, Mubi Nigeria. 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 and also to 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).

MATERIALS AND METHODS

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 [2]. 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 (5) 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 Global network communication (Operator A) and 3 BSTs for Zain network communication (Operator B). These were planted 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 as shown in Figure 5. 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. The measurement was conducted at foot ball pitch of Adamawa state university, Mubi Nigeria in the month of January, 2010 for the period of two weeks.

Method of Data Analysis

Data were collected at specific location that is at the center of the foot ball pitch of Adamawa State University Mubi in every 30 minutes for the period of two (2) weeks from 10/01/2010 – 24/01/2010. The data were analyzed using XP – 2006 EXCEL SOFTWARE on a digital computer as depicted in Figure 1, 2 and 3, these data were further transformed into network bars angle information with the view to determine the frequency of the occurrence of the network service bars using the expression below.

$$SS_{GSM} = \frac{360n}{N} \quad (1)$$

Where SS_{GSM} is the GSM signal strength in degrees, n is the number of a network service bars that appears at the instance of measurement and N is the total number of network service bars in two weeks for each Operator [4].

Before transforming the GSM network service bars obtained into GSM network service bars angle information, 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 [1]. The assignment of the data are as follows, let T = 6 bars while U, V, W, X, Y and Z be equal to 5, 4, 3, 2, 1 and 0 respectively.

RESULTS

The results obtained in the investigation for the first week is shown in Table 1 while for the second week is shown in Table2. Table 3 and 4 were derived from Table 1 and 2 respectively; the results shown in Table 3 and 4 were obtained by grouping the number of occurrence of the network service bars, each of the network service was counted based on the number of appearance then noted and presented in the Tables while Table 5 is an addition of network service bars column wise from Table 3 and 4 which specify the frequency of occurrence of the network service bar for the period in which the research was conducted. Table 6 shows how the network bars is transform into network service bar angle information using Equation (1).

Table 1: GSM signal strength monitored in the first week

Time	MON	TUE	WED	THR	FRI	SAT	SUN	Time	MON	TUE	WED	THR	FI	SAT	SUN
(s)	A B	A B	A B	A B	A B	A B	A B	(s)	A B	AB	A B	A B	A B	A B	A B
6.00am	3 0	6 5	6 6	5 6	4 5	6 6	4 5	12.30pm	6 3	2 3	4 3	3 0	3 2	3 4	0 3
6.30am	2 0	6 6	6 6	5 4	3 6	6 5	4 6	1.00pm	0 5	4 3	3 3	3 0	5 5	4 5	1 3
7.00am	33	4 5	6 6	6 3	6 6	6 6	4 5	1.30pm	1 2	3 3	4 2	41	6 6	3 6	0 4
7.30am	4 3	3 4	6 6	4 4	5 6	5 6	5 5	2.00pm	3 2	3 4	2 3	2 1	5 4	5 6	3 5
8.00am	2 3	3 3	6 5	6 5	5 5	5 6	5 6	2.30pm	2 2	2 5	3 1	3 0	4 4	6 6	4 5
8.30am	6 5	2 3	6 5	3 3	4 6	6 6	3 6	3.00pm	3 1	5 3	4 3	2 0	4 3	5 6	5 2
9.00am	4 5	3 4	5 4	4 1	3 2	4 4	6 6	3.30pm	2 3	2 2	3 2	4 0	3 5	6 5	3 3
9.30am	2 3	2 2	5 3	5 3	4 6	5 4	1 0	4.00pm	3 3	3 1	1 1	3 1	2 4	6 6	3 2
10.00am	4 4	1 3	6 3	4 3	5 5	5 3	2 3	4.30pm	2 2	1 1	2 3	3 0	3 3	5 5	4 5
10.30am	5 6	4 2	2 3	3 2	5 4	4 5	4 4	5.00pm	1 4	0 3	4 5	3 0	3 3	5 5	4 5
11.00am	3 4	4 4	3 3	3 2	3 3	4 4	4 3	5.30pm	3 2	1 4	6 6	4 1	4 4	3 2	2 3
11.30am	4 2	4 4	4 3	3 1	3 4	5 5	3 2	6.00pm	3 3	2 4	5 6	6 1	3 3	3 4	4 4
12.00 am	3 4	5 3	2 6	4 0	4 3	6 5	4 1								

Table 2: GSM signal strength monitored in the second week

Time	MON	TUE	WED	THR	FRI	SAT	SUN	Time	MON	TUE	WED	THR	FI	SAT	SUN
(s)	A B	A B	A B	A B	A B	A B	A B	(s)	A B	AB	A B	A B	A B	A B	A B
6.00am	4 4	6 6	5 6	2 6	4 4	6 6	1 6	12.30pm	3 3	4 4	3 3	4 6	5 4	5 3	4 1
6.30am	5 6	6 6	4 3	3 4	5 6	6 5	2 4	1.00pm	2 3	3 4	2 1	4 3	4 4	4 4	5 0
7.00am	4 3	5 6	5 5	2 5	4 3	6 4	2 3	1.30pm	4 3	4 3	0 2	5 5	4 3	4 5	5 1
7.30am	6 6	6 6	4 4	3 4	5 4	5 4	3 4	2.00pm	3 3	3 3	0 2	2 6	4 2	5 3	4 2
8.00am	6 5	6 5	4 6	2 6	6 6	5 3	4 3	2.30pm	4 4	3 6	5 1	3 6	3 4	5 5	5 0
8.30am	6 4	6 4	5 3	4 5	4 6	4 4	5 3	3.00pm	5 3	4 3	4 4	1 5	4 4	5 4	4 4
9.00am	4 4	4 5	2 1	2 6	3 4	4 2	5 5	3.30pm	2 1	3 2	3 5	2 5	4 3	3 4	6 3
9.30am	5 3	5 6	4 4	2 5	4 6	3 4	5 5	4.00pm	3 2	2 3	6 6	4 6	4 3	4 4	4 2
10.00am	3 3	4 4	3 4	3 4	3 4	3 5	6 6	4.30pm	2 4	4 1	6 6	3 3	4 2	3 5	3 3
10.30am	4 5	5 6	5 3	4 3	4 4	4 1	2 6	5.00pm	5 5	3 2	6 5	3 4	3 3	6 5	4 2
11.00am	5 5	6 4	4 3	2 5	6 5	5 4	4 5	5.30pm	0 3	3 3	5 5	3 5	3 4	2 6	6 4
11.30am	4 3	3 4	4 4	3 5	6 6	5 6	5 3	6.00pm	1 2	2 3	6 4	2 4	5 4	1 3	6 5
12.00am	3 2	4 3	4 5	4 4	6 3	6 3	3 3								

Table 3: Break down of GSM signal strength monitored in the first week

	MON	TUE	WED	THR	FRI	SAT	SUN	TOTAL
SS	A B	A B	A B	A B	A B	A B	A B	A B
T	2 1	2 1	8 7	3 1	2 6	8 9	1 4	26 29
U	1 3	2 3	3 3	3 1	6 5	9 8	3 7	27 30
V	4 4	5 7	5 1	7 2	7 6	5 5	9 2	42 27
W	9 8	6 9	4 10	10 4	9 6	3 2	5 6	46 45
X	6 6	6 3	4 2	2 2	1 2	0 1	3 3	22 19
Y	2 1	3 2	1 2	0 7	0 0	0 0	2 1	08 13
Z	1 2	1 0	0 0	0 8	0 0	0 0	2 2	04 12
TOTAL	25 25	25 25	25 25	25 25	25 25	25 25	25 25	175 175

Table 4: Break down of GSM signal strength monitored in the second week

	MON	TUE	WED	THR	FRI	SAT	SUN	TOTAL
SS	A B	A B	A B	A B	A B	A B	A B	A B
T	3 2	6 7	4 4	0 6	4 5	5 3	5 4	27 31
U	5 4	3 2	6 5	1 8	4 1	8 6	7 3	34 29
V	7 5	7 6	8 6	6 6	12 11	6 9	7 4	53 47
W	4 10	7 7	3 5	8 3	5 6	4 5	3 7	34 43
X	4 3	2 2	2 2	9 2	0 2	1 1	1 2	20 15
Y	1 1	0 1	1 0	1 0	0 0	1 1	1 2	04 08
Z	1 0	0 0	2 0	0 0	0 0	0 0	0 2	03 02
TOTAL	25 25	25 25	25 25	25 25	25 25	25 25	25 25	175 175

Table 5: Break down of GSM signal strength monitored for the two weeks

	MON	TUE	WED	THR	FRI	SAT	SUN	TOTAL
SS	A B	A B	A B	A B	A B	A B	A B	A B
T	5 3	8 8	12 11	3 7	6 11	13 12	6 8	53 60
U	6 7	5 5	9 8	4 9	10 6	17 14	10 10	61 59
V	11 7	12 13	13 7	13 8	19 17	11 14	16 6	95 74
W	13 18	13 16	7 15	18 7	14 12	7 7	8 13	80 88
X	10 9	8 5	6 4	11 4	1 4	1 2	5 6	42 34
Y	3 2	3 3	1 5	1 7	0 0	1 1	3 3	12 12
Z	2 2	1 0	2 0	0 8	0 0	0 0	2 4	7 14
TOTAL	50 50	50 50	50 50	50 50	50 50	50 50	50 50	350 350

Table 6: Signal strength angle calculation

SS	A	B	a = A+B	a°
T	53	60	113	58.11
U	61	59	120	61.71
V	95	74	169	86.91
W	80	88	168	86.40
X	42	34	76	39.09
Y	12	21	33	16.97
Z	07	14	21	10.80
TOTAL	350	350	700.00	360.00

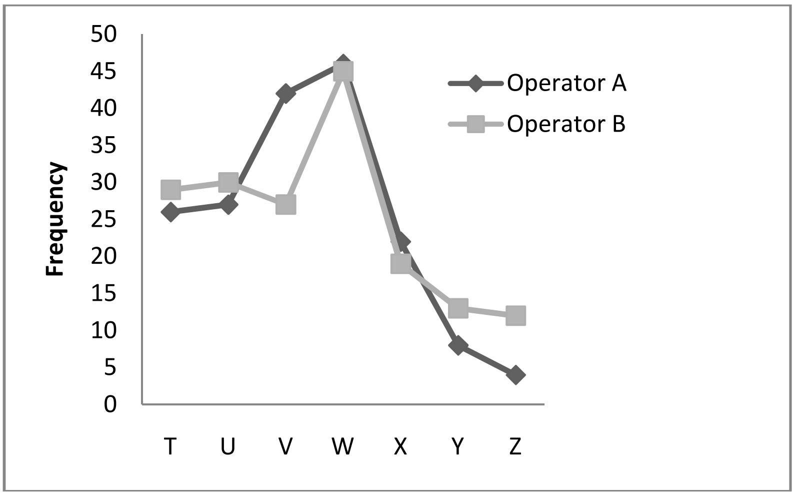

Figure 1: GSM signal strength monitored in the first week

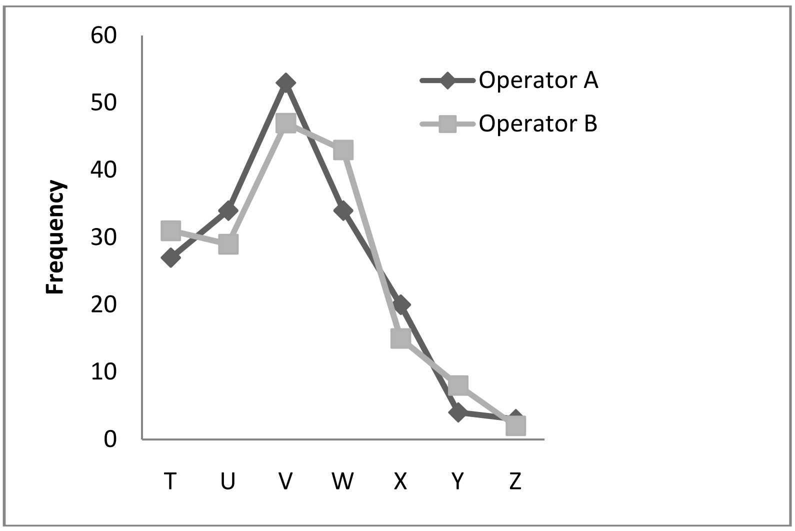

Figure 2: GSM signal strength monitored in the second week

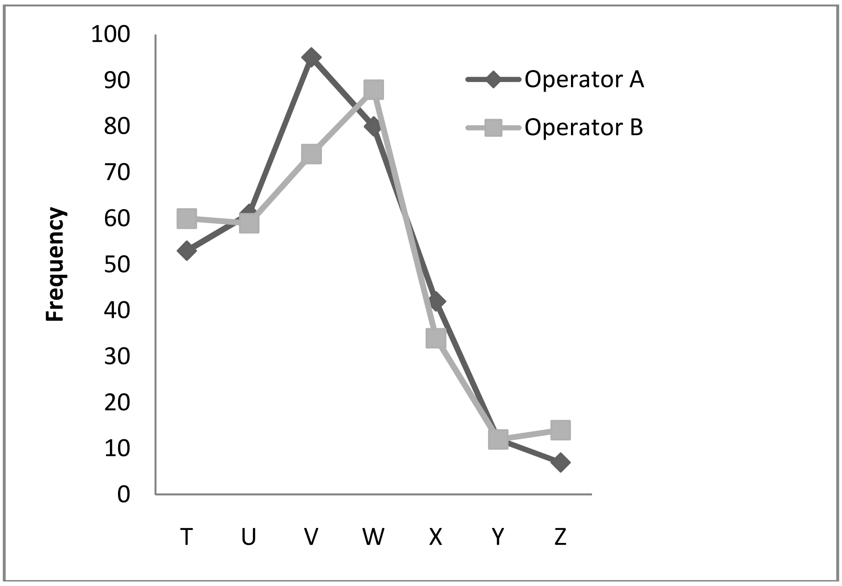

Figure 3: GSM signal strength monitored in two weeks

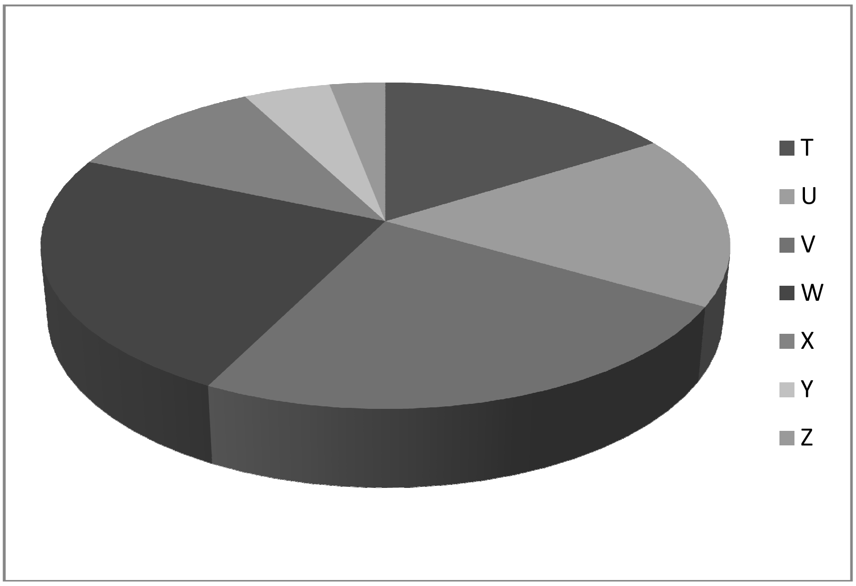

Figure 4: Frequency of occurrence of the network bars for the two operators

DISCUSSION

The signal strength received by the Nokia L600 depends upon path, shadow fading and multipath fading. The path loss depends on the distance of the MU from the BSTs. Between the BSTs and the MU there are many obstacle for example trees, building, vehicles and other geographical features, those obstacles create variation of signal strength over the main path loss as recorded in Table 1 and 2. This variation is known as shadow fading which allows log normal distribution that is standard deviation of shadow fading in dB follows normal or Gaussian distribution [7]. The Nokia L600 receives line of sight (LOS) from BSTs and signal reflected from different place, those multipath components result in multipath fading. Multipath is found to follow Reyleigh distribution [10]. In this work we tried to investigate the signal strength obtainable at Adamawa State University, Mubi with view to give suggestions on how to improve the quality of signal strength in order to address the frequent complain of the customers in Mubi. The status of the signal strength was monitored as described in Figure 1 to 4.

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 1 bar and 0 bar were the least.

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.

Figure 3, presents the performance of the signal strength combined together for the two weeks for both the two Operators, 4 bars appeared 95 times out of 350 observations of Operator A, followed by 3 bars of Operator B which appeared 88 times out of 350 observations, then 3 bars of Operator A and 4 bars of Operator B. in this case 1 and 0 bar were also the least although 1 bar of Operator A appeared 12 times less than 0 bar of Operator B which appeared 14 times out of 350 observations.

Figure 4, described the frequency of the occurrence of the signal strength for both the two Operators. The signal strength with 4 bars appeared frequent followed by 3 bars with just slight difference, followed by 5 bars then 6bars. Signal strength with 0 bars is the least followed by 1 bar then 2 bars.

CONCLUSION

GSM signal strength has been investigated and recorded in Mubi town Adamawa State Nigeria 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 3 bars and 4 bars appeared more frequent; however this is fair but not sufficient to meet up with customer's requirement in Mubi town. 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.

Recommendation

i. GSM Operators should have adequate clearance (considerable BSTs height).
ii. Expand their cells to accommodate reasonable number of subscribers
iii. Increase number of BSTs as the number of subscribers increases
iv. GSM Operators should employ more skillful personnel to maintain and address technical problems that occurs on frequent basis
v. GSM Operators should adapt technique of cell sectorization in other to increases number of cells

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Figure 5: Nokia L600 (signal strength detector)