
MONITORING AND EVALUATION OF GSM SIGNAL STRENGTH ALONG WARRI - BENIN HIGHWAY

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ABSTRACT

The presence of good GSM signal strength of all the GSM service providers in Nigeria for every spot along Warri-Benin Highway has been a major problem. Three service providers Airtel, GLO and MTN were chosen for analyses. Geographical locations of the various towns, villages and settlements along the highway were selected. Signal strength measurements were taken at these spots using the Net-Monitor software in an Android phone. Data were collated for five different times within five months and Microsoft Excel software was employed in the analytical evaluation of the strength of the signals. The results revealed that GLO had the best signal strength followed by MTN and then Airtel. Recommendations for improvement were put forward for implementation by the service providers.

KEYWORD: Propagation, Signal Strength, Measurement, Coverage, Traffic**INTRODUCTION**

The ability to communicate over cellular networks distinguishes cell phones from other types of handheld devices. As the name implies, cellular networks provide coverage based on dividing a large geographical service area into smaller areas of coverage called cells (Adegoke & Babalola, 2008). Cells play an important role in reuse of radio frequencies in the limited radio spectrum available to allow more calls to occur than otherwise would be possible. As mobile phone moves from one cell to another, a cellular arrangement requires active connections to be monitored and effectively passed along between cells to maintain the connection. Within Nigeria, different types of digital cellular networks abound that follow distinct, incongruous sets of standards. One of the most dominant type of digital cellular network in Nigeria is known as Global System for Mobile Communications

(GSM) network (Attah, 1998). Cellular networks are also characterized by generation. First generation or 1G refers to analog technology on which cellular networks originated. Analog cellular networks are no longer supported by the major cellular carriers and perhaps only a few small carriers in rural areas continue to support them. Second generation or 2G designates the original fully digital networks mentioned above that offered greater efficiency, performance, and services than 1G analog technology. Third generation or 3G network standards exist, which offer even higher data rates. Sometime fractional designations such as 2.5G are used to designate incremental improvements between two generations (Adegoke & Babalola, 2008). GSM is a cellular system used worldwide that was designed in Europe, primarily by Ericsson and Nokia. Cingular and T-Mobile operate nationwide networks in the U.S. GSM uses the Time Division Multiple Access

(Mark,1990) technology. Time-division multiple access (TDMA) refers to a digital link technology where by multiple phones share a single-carrier radio-frequency channel by taking turns-using the channel exclusively for an allocated time slice, then releasing it and waiting briefly while other phones use it (Emagbetere & Edeko, 2007).

RADIO WAVE PROPAGATION

Radio wave propagation as defined in (Ngala, 2012), is the motion of radio wave when they are travel from one point of the earth to another or various parts of the atmosphere. A good knowledge of propagation phenomenon is very useful in network design, deployment, and management. In effect, it is in the propagation channel that the complexities that distinguish wireless network from the guided or wired network lies.

Radio propagation according to Zhang (2000) depends largely on the site involved and can significantly vary among other factors with the terrain, frequency, interference, and velocity when the mobile device is moving, interference. Characterization radio channel is key in predicting level of signal coverage, interference analysis, and ascertaining the best alternatives before installation.

MULTIPATH PROPAGATION

Multipath phenomenon occurs when transmitted signal arrives at the receiving antenna through multiple paths (say two or more paths). The presence of obstacles such as reflectors and mobile scatterers along propagating path creates a constant change in the channel resulting in loss signal energy. To this end, there is time and spatial displacement of the multiple transmitted signal at the receiver antenna. This results to unstable signal strength, and consequently, small-scale fading, signal distortion or both. The effects of multipath include: signal phase shift, 'constructive

interference and destructive interferences' (Olatu, 2015).

Signal reflectors and scatters such as vegetation, hills and mountains, in rural settings, while for urban environments we have buildings, and vehicles, and for indoor environments it is walls and doors. The signal then arrives at the receiving antenna through multiple parts. This multipath issue results in, difference in: phase shifts, attenuation, and time delays. The output of receiving antenna is gotten by summing the antenna gain weighting of the multiple signal that arrived.

Though characterization of multipath propagation is a very difficult process, a common method is by treating the received multi signal to be a spatial-temporal random process. To obtain the statistics of this random process we use measurements held in selected environments of operation (Olatu, 2015). Since multipath environment largely, determines the received-signal property, two-step process is often used for characterizing the received signal. First, assumed a fixed multipath environment while measurements of varying received signal are taken for the environment. Since statistics is obtained from a small area it is called a small-scale variation (Olatu, 2015). In the second step, small-scale statistics are obtained by taken measurements in different multipath environments. In this case, large-scale variations result because measurements taken span over a large area at various and at different locations.

SIGNAL FADING

Signal fading is defined as the rapid change in the signal strength received over a small distance of travel or interval of time. It is peculiar with environments prone to multipath propagation, the mobile receives signal received consisting of large number of plane waves of randomly distributed amplitudes, delays, angles of arrival and phases. These multipath components combine vectorally at the receiver antenna.

Their combination could be constructively or destructively at different points causing signal strength at receiving antenna to vary from place to place. When objects (scatterers) are considered stationary, and mobile station is moving, fading becomes purely a spatial phenomenon. At high speed motion receiver may within a short time, pass through several fades. If the mobile station is stationary or moving slowly, a deep fade may result at the receiver for a longer period of time. Deep fades can result to unreliable communication because it amounts to a very low signal-to-noise ratio.

Mobile Networks in Nigeria

Over the years, the major GSM network operators in Nigeria are AIRTEL, MTN, GLOBACOM and ETISALAT.

Airtel: Formerly known as Zain which was previously Celtel Nigeria. It was established in 2000, by a group of institutional and private investors as well as three state governments (www.airtel.com). Celtel was previously V mobile which was first Econet. Bharti Airtel, Asia's leading telecommunications service provider, has acquired Airtel Africa's mobile operations. The One Network service is aimed at providing a borderless mobile phone network across the Airtel Group and pan African community.

MTN Nigeria. This is a member of the MTN group, an acknowledged GSM Market leader. Africa's leading cellular telecommunications company. On May 16, 2001, MTN became the first GSM network to make a call following the globally lauded Nigerian GSM auction conducted by the Nigerian Communication Commission earlier in the year. Thereafter, the company launched full commercial operations beginning with Lagos, Abuja and Port Harcourt (www.mtnonline.com).

Globacom. Launched in Nigeria in 2003, with a vision to be the market leading service provider in Nigeria and also aspire to build Africa's biggest and best telecommunications network. Globacom stands out as the first single company to build an \$800 million high capacity fibre optics cable known as GLO 1. It also is the first submarine cable from the UK to Nigeria thus providing sufficient bandwidth to all the cities connected to the cable (www.gloworld.com).

METHODOLOGY

GSM services along Warri-Benin highway has not met the total requirement of customers as there are problems of poor services such as frequent call drops, echo during conversation (noises), crosstalk, network congestion, no network coverage etc. which may be attributed to poor quality of GSM signal strength. Hence, the need to evaluate and analyze the quality of GSM received signals of three selected networks namely MTN, GLOBACOM, and AIRTEL at selected locations along Warri-Benin highway. The steps taken and the methods adapted to carry out this project is as presented below.

1. Field work that involves traveling to collate data from Warri to Benin, a 100km road that stress from Delta to Edo States in Nigeria for four times in four months.
2. Measurement of data was carried out by using a software called NETMONITOR in a Nokia X2 mobile phone (Fig 1).
3. The NETMONITOR gives the GSM signal strength of the networks in decibel milliwatts (dBm),
4. Three network providers MTN, GLO, and AIRTEL were analyzed.



Fig 1: Net-Monitor software environment (on-air mode).

The average signal strength measured along Benin-Warri Highway as tabulated in tables 1 to 6 below using the model shown in equation 3.

$$P_{Average} = \frac{\sum_{Day 1}^{Day 4} P}{4} \tag{3}$$

Table 1: Average signal strength between Effurun Roundabout and Okuovo Junction.

NETWORK/DAY	MTN (dBm)	GLO (dBm)	AIRTEL (dBm)
Day 1	-66.6	-66.4	-84.2
Day 2	-80.6	-71.4	-97.0
Day 3	-87.4	-70.0	-79.2
Day 4	-95.4	-93.6	-107.4
Average	-82.5	-75.35	-91.95

Table 2: Average signal strength between Okwejeba and Ibadan Elume Junction.

NETWORK/DAY	MTN (dBm)	GLO (dBm)	AIRTEL (dBm)
Day 1	-91.8	-92.6	-91.4
Day 2	-98.2	-89.0	-102.6
Day 3	-88.2	-74.0	-80.4
Day 4	-89.4	-91.2	-85.6
Average	-91.9	-86.7	-90.0

Table 3: Average signal strength between Ikwegwu and Mosogar Town

NETWORK/DAY	MTN (dBm)	GLO (dBm)	AIRTEL (dBm)
Day 1	-89.8	-97.4	-101.8
Day 2	-70.2	-88.8	-94.0
Day 3	-91.0	-89.8	-101.8
Day 4	-67.0	-72.2	-80.4
Average	79.5	-87.05	-94.5

Table 4: Average signal strength between Oghara Junction and Ologbo

NETWORK/DAY	MTN (dBm)	GLO (dBm)	AIRTEL (dBm)
Day 1	-75.4	-90.0	-100.4
Day 2	-94.6	-67.0	-108.6
Day 3	-82.2	-88.6	-101.2
Day 4	-94.8	-61.0	-83.8
Average	-86.75	-76.65	-98.5

Table 5: Average signal strength between Obayantor and Okha Communities.

NETWORK/DAY	MTN (dBm)	GLO (dBm)	AIRTEL (dBm)
Day 1	-92.8	-83.2	-100.8
Day 2	-90.0	-72.0	-91.0
Day 3	-102.6	-80.4	-101.0
Day 4	-89.4	-85.6	-78.6
Average	-93.7	-80.3	-92.85

Table 6: Average signal strength between Benin Bypass and Agip.

NETWORK/DAY	MTN (dBm)	GLO (dBm)	AIRTEL (dBm)
Day 1	-99.8	-72.0	-94.0
Day 2	-93.6	-79.4	-108.4
Day 3	-87.8	-76.0	-85.0
Day 4	-103.0	-72.0	-74.6
Average	-96.05	-74.85	-90.5

From the values in tables 1-6, the total average signal strength from Warri to Benin City is computed in chart Fig 2.



Fig2: Chart of average signal strength from Warri-Benin.

DISCUSSION OF RESULTS

Generally, for GSM, dBm ranges from the following -50 to -60 (very strong, near a cell tower), -60 to -79 (good), -80 to -89 (ok/ shouldn't have problem but maybe), -90 to -99 (getting bad/ signal may breakup) and -100 and above (bad, hard to stay connected/ basically no usable signal /call drop). The closer the number is to zero (0), the stronger the signal e.g -70dBm is a stronger signal than -90dBm (Shalangwa & Jerome, 2010).

From the result analyzed in Tables 25-30 and Charts 4-9, it is observed that GLO had the best network coverage with an average signal strength of -75.35dBm for DOFEGT motor par Keffurun rounda bout-Okuovo, Warri sapele road, followed by MTN with an average signal strength of -82.5dBm and AIRTEL with an average signal strength of -91.95dBm. Similarly, for Okuejeba Junction - Ibadan Enume Town along Warri - Sapele road, it was observed that GLO had the best network coverage with an average signal strength of -86.7dBm, followed by AIRTEL having signal strength of -90dBm and MTN with an average signal strength of -91dBm respectively. Atlkwegwu town -Mosogar town, it was observed that MTN had the best network coverage with

an average signal strength of -79.5dBm followed by GLO having an average signal strength of -87.05dBm and AIRTEL having an average of -94.5dBm. For Oghara Junction-Ologbo, it was observed that GLO had the best network average with an average signal strength of -76.65dBm, followed by MTN having -86.75dBm and AIRTEL having -98.5dBm. Observing OBAYANTOR - OKHA communities, GLO had a better network coverage with an average signal strength of -80.3dBm followed by AIRTEL having -92.85dBm and MTN having -93.7dBm. At Benin Bypass- Agip Benin-Sapele Road, Glo network has the best network coverage with an average signal strength of -74.85dBm followed by AIRTEL having -90.5dbm and MTN having -96.05dBm.

Generally, Table 6 and Chart 2, shows the average signal strength for the three networks from Warri-Benin Highway. GLO had the best signal strength with an average value of -80.15dBm followed by MTN having an average signal strength of -88.4dBm and AIRTEL with an average of -93.05dBm.

CONCLUSION AND RECOMMENDATION

Network performance is the most important parameter for measurement of quality of service. Poor

performance of a telecommunication network would induce customer complaints and faults, thereby leading to customer dissatisfaction towards the operator. It is evidence from this presentation that the quality of services rendered by these operators is far below expectation. So, urgent and proactive actions should be taken by the operators towards improving network performance. If this is done, customers could enjoy the best quality of service in terms of call success rate, voice quality, network availability, dead spot and topology. In order to improve on the situations enumerated, the following recommendations are paramount.

1. Network operators should upgrade and optimized all existing base stations. If this is done, it will stem call set up failures due to rise in traffic volumes.
2. Network operators should install additional base stations across the studied area. This would create room for network to handle more traffic.
3. The Nigerian Communication Commission (NCC) should inspect GSM network operators regularly, to ensure that the standards for the country's quality of service delivered are met.

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