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ASSESSMENT OF SIGNAL STRENGTH OF MOBILE COMMUNICATION NETWORKS WITHIN THE SCHOOL OF ENGINEERING FEDERAL POLYTECHNIC, ADO EKITI

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ABSTRACT

This paper assesse d the Signal Strength (SS) of Global System Mobile Network Service Providers (NSP) in the School of Engineering, Federal Polytechnic Ado Ekiti. The latitude and longitude of the reference locations where the study was carried out were determined with the Global Positioning System (GPS). The first location was at the Mast Base identified as Field A (Sports Complex) - (7.6^0 N and 5.3^0 E). Measurements were taken at different locations from the base station with 50m intervals up to the New Engineering Complex - (7.4^0N and 5.2^0E) respectively. The Signal Strength(s) of MTN, GLO, and AIRTEL networks were measured using Network Signal Info App installed in Android Mobile Receiver (TECNO K7, Itel P33 Plus) from the Base Transceiver Station (BTS), covering 1000 metres in all. The measured data were analysed graphically and compared with each other to see the performance of each of the GSM network operators in the study area. The results revealed that the performances of these network providers are yet to be deemed satisfactory. Hence, approaches to monitor and optimize the QoS as the network continuously changes in response to changes in offered traffic were considerably recommended.

KEYWORDS: BTS; Decibel; Network provider; Signal tracker; Signal strength

INTRODUCTION

The advent of the Global System of Communication has brought a tremendous impact on the sphere of communication industries. The wireless telephone system which is a breakthrough in Communication comes either in fixed wireless lines or the Global System for Mobile Communication (GSM) (Wojuade, 2003). However, Statistics have shown that in many countries the use of mobile phones is already higher than the fixed ones (Mitra, 2009; Idim & Anyasi, 2014). During the second half of 2016, Americans reached an important milestone in the history of cellular communications: It was the first time that the majority of homes owned only wireless phones. According to the Centers for Disease Control, 51 percent of American homes owned at least one cell phone and did not use a landline. Therefore, Mobile penetration in particular, being easier and cheaper to supply than fixed telephony can be expected to play a crucial role in the economic growth of Africa and other developing countries (Sridhar, 2004). Even in Nigeria, the rollout of GSM services across states and Nigeria at large has positively altered the socioeconomic landscape of the country and brought huge revenues to the operators as well as the government through tax and license fees (Popoola et al., 2009). More so, technological advancement has boosted the role of communication in human life than before. New generations of communication devices have been invented, with the use of Mobile Phones becoming the most common tool and indispensable part of our daily lives in recent years (Begüm & Çetin, 2016). Almost everybody in every place today owns a mobile phone and desires to be connected to communicate with Friends, Families, Business partners, and associates. The digital data produced in areas using these technologies continue to grow exponentially over time; as a result, the number of mobile communication technology users is increasing day by day (Sectoral Research and Strategies Department, 2011).

As of 2017, a study shows that 95 percent of the U.S. population owned a cellular phone and 77 percent owned a smartphone. U.S. consumers spend an average of five hours per day on mobile devices. No nation of the world can over-emphasize the role of the global system of communication, yet the challenge of poor signal is frustrating. The quest for better reception in homes, offices, and our institutions of learning is yet high. The problem of poor signal across nations is alarming. Despite additional towers being erected, expanded coverage area, and other measures taken by network operators in developed countries of the world, bad reception is yet to be completely eradicated. A survey shows that 72 Percent of Americans experience some form of dropped calls, and 32 percent experience dropped calls at least a few times per week. Dropped calls, network access failure, low data rate, and dead zones are problems associated with bad reception, which is caused by a weak signal; low-quality signal, and congestion on the cell network. The experiences narrated above are typical examples of what we are facing currently in our institution of learning.

Poor signal is a major complaint of the users. Particularly in the School of Engineering, almost all mobile users lament bitterly the situation of dropped calls, slow internet speed, and dead zones. In some offices, it is completely a dead zone. A situation where the signal from the Cell tower that facilitates your cell phone communication is not reaching your phone or is not able to send a strong signal to your device. It was so bad that, if you received a call, you had to come outside your office because you could not just connect to the caller. However, some factors could be responsible for the problem of dead zones which is beyond what the cell provider can handle. They are the distance from the nearest cell tower, how many people are accessing the tower, weather, obstructions from trees, and various building materials that have the potential to interfere with the signal. That is why you rarely get service in places like tunnels and elevators. This paper is therefore focused on the measurement of signal strengths of different GSM Networks from the Mast location, Stadium (Field A) where we have the array of cell sites, towards the School of Engineering and its surroundings. The rest of the article is organized as follows; the Literature review, material and method of the study, data presentation, and analysis, discussion of findings, conclusion, and recommendations.

Literature review

A mobile phone network is made up of a large number of signal areas called Cells. These cells join or overlap each other to form a large coverage area and users on the network can cross into different cells without losing connection. Within each cell, you will find a base station that is connected to a digital exchange where the communication is sent to other telephone or Data networks. As the number of users increases, the cells become smaller in size (Molisch, 2011a). Therefore, with the growth in the capacity of Mobile users, the size of a cell is becoming smaller and smaller from the macro cell to the microcell and Picocell (Molisch, 2011b).

Oftentimes, most users use the number of bars on their phones to determine the level or strength of their signal. The bars represent two major things: the signal strength and signal quality shown in Figure 1.

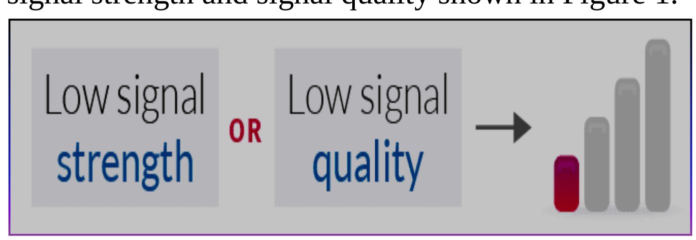


Figure 1. Signal bars (http://pewinternet.org/Report/2012/Mobile-phone-problems/main-findings)

We place a lot of weight on the signal bars we see on our phones, but in reality, there's no standard for what those bars mean. Furthermore, the number of bars can vary widely based on how a person holds their phone, or based on the phone's manufacturer (retrieved September, 2019). Therefore, using those bars may not be accurate in determining the quality of the signal, rather the exact reading of signal strength must be measured either by putting your phone into service mode or downloading a signal application (retrieved September, 2019). However, using a signal meter is the most effective way to test for signal frequency, bandwidth, and strength down to the decibel-milliwatt (dBm), not the "bar." Signal meters read the signal level for all frequency ranges. It is important to stress that signal bars do not always mean you can make a call. Users will sometimes have signal bars, but cannot place a call due to network congestion. As we have progressed from GSM, 3G and now 4G, the quality of the signal has become just as important as the signal strength level in determining your quality of service. Users with five bars may have a low signal strength reading but have excellent signal quality (retrieved March, 2014). Several measurements determine the quality of your mobile signal: Signal Strength – GSM & 3G/HSPA (RSSI) Applicable to GSM and 3G networks. Signal Strength – 4G/LTE (RSRP) LTE signal strength is measured on a different scale than 3G/HSPA, it is measured in Reference Signal Received Power (RSRP). This often ends up being around -20dBm lower than RSSI, so - 100dBm (RSSI) would equate to around -120dbm (RSRP). RSRP = RSSI + Ec/Io RSRP does a much more accurate job of measuring signal strength than RSSI, as it excludes noise and interference on the network, measuring just the usable portion of the signal (retrieved March, 2014). Therefore, signal strength is defined as a Received Signal Strength Indicator (RSSI). It is a measure of the strength of the Cellular signal when it reaches your Phone. It is measured in dBm (decibel milliwatt) while signal quality is the ratio of the actual source signal to the noise and interference received by your Phone. It is measured in dB (decibels) (retrieved April, 2020). The Received Signal Strength of mobile subscribers (MS) from the base Station determines the quality of reception (Nsikan et al., 2016). The Received signal strength Indicator measures both the usable signal and the noise in a single figure. The dBm scale is roughly between -50 and -120dBm, with – 50dBm meaning perfect signal while – 120dBm means when you fall off the network. The signal strength (Akram & Khalid, 2011) is shown in Table 1.

Table 1: Signal strength equivalent table (Akram & Khalid, 2011)

Signal Strength (in dBm)	**Practical Signal Strength**
Greater than -60	Excellent signal, no chance of dropped calls, optimal voice quality, and data transmission speed.
-60 to -75	Very good signal, unlikely to experience dropped calls or quality issues that affect performance. (This is usually the best available unless you're directly next to a cell tower)
-76 to -90	Good signal, while reliability and quality are generally adequate, interruption by building materials or other obstructions could make the difference.
-91 to -100	Fair signal, voice quality, and data transfer speed are noticeably affected, and dropped calls are more common.
-101 to -110	Poor signal, dropped calls and extremely slow data transfer are a constant problem.
Less than -110	No signal, for all intents and purposes, there is no connectivity possible without a signal booster.

The other related works on the measurement of signal strength are as follows: Savas and Topaloglu (2011) worked on Performance analysis of GSM networks with a data mining method. The emphasis of the study is that the signal strength performance evaluation is one of the very important subjects for users (Savaş & Topaloğlu, 2011).

Bakare et al. (2018) carried out a work on comparative Analysis of Signal Strength of some cellular Networks. They used Radio Frequency

Signal Tracker (RFST); an application installed in a Techno Y4 Mobile device that measures and displays the generated signal strength for each cellular network operator. The measurement was recorded at every distance of 100 meters for a given route of 2000 meters. Salawu (2014) worked on the analysis of mobile network signal strength for GSM networks. They opined that network performance and service quality evaluation are essential steps for mobile operators. A driving test was conducted within Canaan Land with a Network Signal Info Professional, an application which was used to measure the signal strength for GSM Networks during SHILOH, an annual program in Canaan Land, Ogun State, where about 250000 people congregated. The test was taken immediately after the end of each meeting session when people were eager to reach out to families and friends at different places. Begum et al. (2016) did a work on comparison of signal strengths of 2G/3G/4G Services on a University campus. They determined the signal strengths of the three cellular system operators based on drive test measurements that were conducted twice on a specific route on the campus. An android operating System and a "Net monitor" Application were used during the synchronized measurements. Salawu (2014) worked on the practical assessment of signal strength of GSM network service providers. TECHNO D3 Android mobile receivers were used to measure the signal strength of MTN, GLO, AIRTEL, and ETISALAT Networks from the Base Transceiver Station (BST) at intervals of 100 meters. The measured data were analyzed graphically and compared with each other to see the performance of each operator in the study area. The results showed that the Network operators are yet to be adjudged satisfactory.

MATERIALS AND METHOD

In this study, the measurements of signal strengths of three GSM Networks (MTN, AIRTEL, and GLO Networks) were carried out on the 9th of November, 2020. Sets of readings were taken in the Morning, Afternoon, and Evening at different points from the Transmitter Base Stations (TBS) toward the School of Engineering and Environment. The different locations were measured using a 100 m Tape Rule and Twenty positions were determined and marked at intervals of 50m from each other. The linear distance covered from the array of cell sites to the School of Engineering was 1000 m. Those points are shown in the Figure 2.

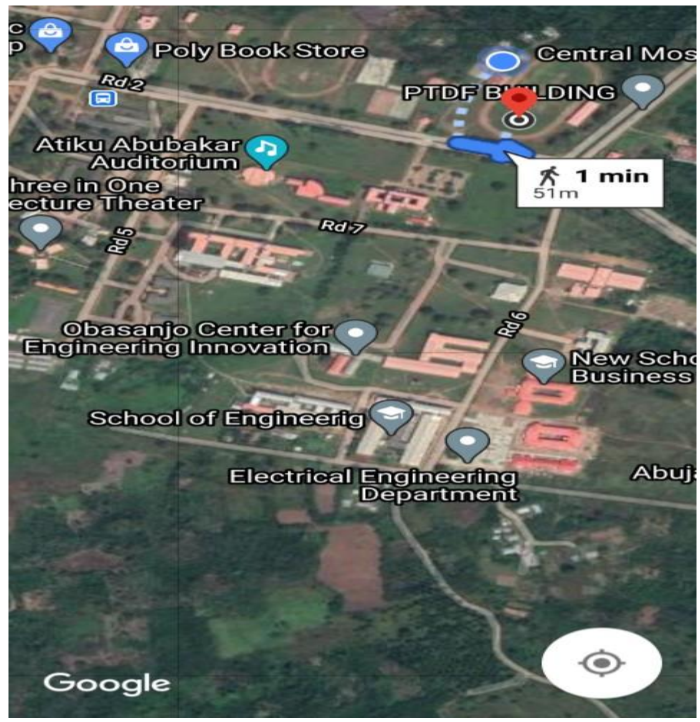


Figure 2. Linear distances of the coverage area

Figure 3 shows the reference base station of all the network providers domicile in the Federal Polytechnic, Ado Ekiti Campus.

Figure 3. Base Transceiver Station (BTS) of the Service Providers

In the measurement, "the Network Signal Information App" which is an Android-based network software was installed on three Smartphones, each consist a different SIM (Subscriber Identification Module) of separate networks, with an Android operating system to measure the exact reading of the signals. The GPS of the three phones was also turned on to determine the GPS of the site location.

The "Network Signal Info App" displays the Local Area Code, (Lac) Cell Identity and Reception Transmission Level, the Received Signal Strength Indicators (RSSI) in dB/m, Cell Location using Google, and (Latitude and Longitude) in Degrees. The School of Engineering is on 7 35| 24.6 N AND 5 17 51.9 E. Mobile Country Code (MCC) and Mobile Network Code (MNC). MCC for all networks is 621 while MNC is 30 for MTN, 20 for AIRTEL, and 50 for GLOBACOM as shown in the Figures 4. The signal strength of each operator was measured in terms of dBm of the current determined points. The primary data obtained were analyzed graphically and their performances were compared.

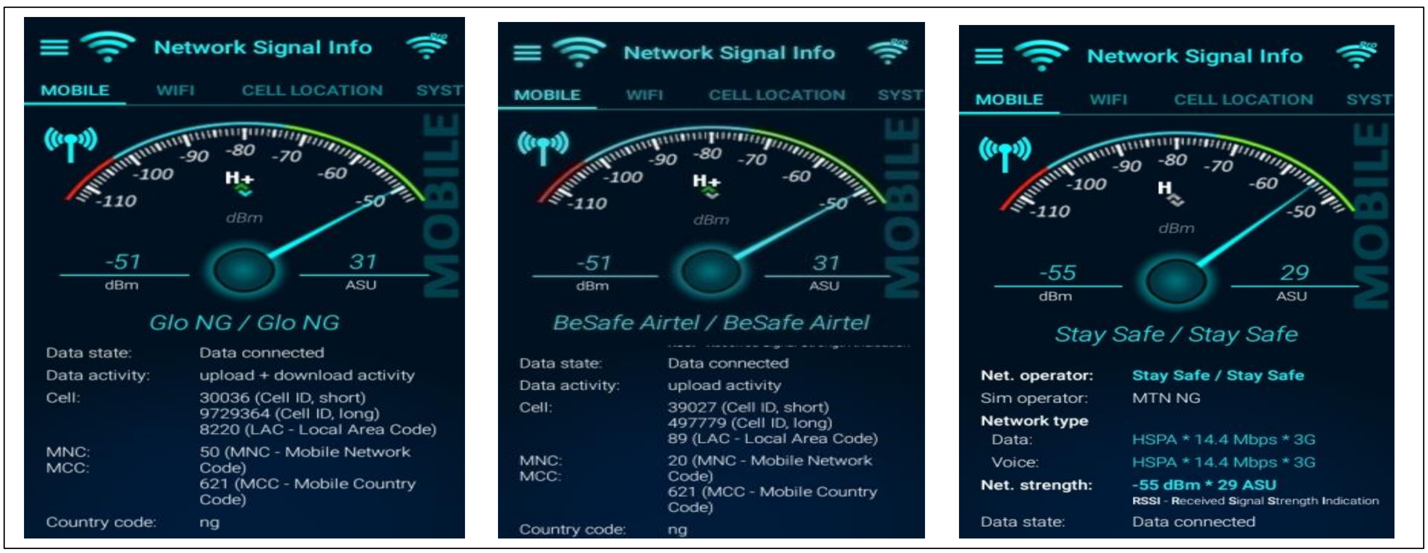


Figure 4. Signal information for MTN, GLO, and Airtel

RESULTS AND DISCUSSION

The plot of signal strength in dBm against distance in metres for MTN is shown in Figure 5. The maximum and minimum signal strength recorded for MTN is -65,-97. Therefore, comparing with the Global System Mobile signal strength (Table 1), it indicates an excellent signal, no signal loss, optimal voice quality, and good data transmission speed when above 60dBm The implication is that at the base of Transmitter, the signal strength is very good at -65dBm, but as we move further away from the Base Station, the signal strength start to fade gradually until -97dBm was recorded which means the users at the far end will experience fair reliability, fair signal, voice quality, and low data transmission speed and dropped calls.

The plot of signal strength in dBm against distance in metres for the AIRTEL network is presented in Figure 6. The maximum and minimum signal strength recorded is -51 and -89. Therefore, the Global System Mobile signal strength presented by Akram and Khalid (2011) indicates an excellent signal, no signal loss, optimal voice quality, and good data transmission speed when above 60dBm The implication is that at the base of Transmitter, the signal strength is very good at -51dBm, but as we move further away from the Base Station, the signal strength start to fade gradually until -89dBm was recorded which means the users at the far end will experience fair reliability, fair signal, voice quality, and low data transmission speed and dropped calls.

The plot of signal strength in dBm against distance in metres for the GLO network is presented in Figure 7. The maximum and minimum signal strength recorded is -51 and -93. Therefore, from the Table 1 of the Global System Mobile signal strength reported by Akram and Khalid (2011) indicates an excellent signal, no signal loss, optimal voice quality, and good data transmission speed when above 60dBm The implication is that at the base of Transmitter, the signal strength is very good at -51dBm, but as we move further away from the Base Station, the signal strength start to fade gradually until -93dBm was recorded which means the users at the far end will experience fair reliability, fair signal, voice quality, and low data transmission speed and dropped calls.

The comparison of each of the network providers in the study area, School of Engineering is shown in Figure 8. The geographical terrain of the study area could be responsible for any network hitch. Ionospheric reflections, refractions, and reflections from terrestrial objects like hills, mountains, and vegetation, uplink transmitting power of the transmitters of the Service Providers could be a determining factor to bad network experienced.

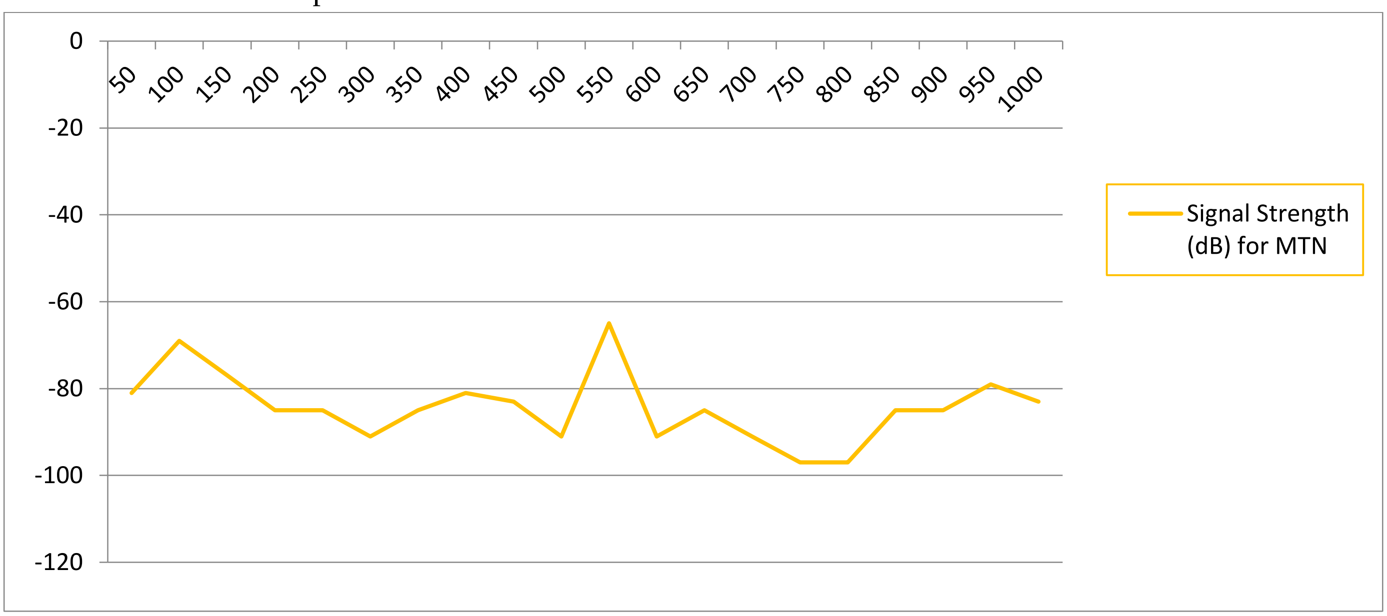


Figure 5. Signal Strength (dBm) against Distance (m) for MTN network

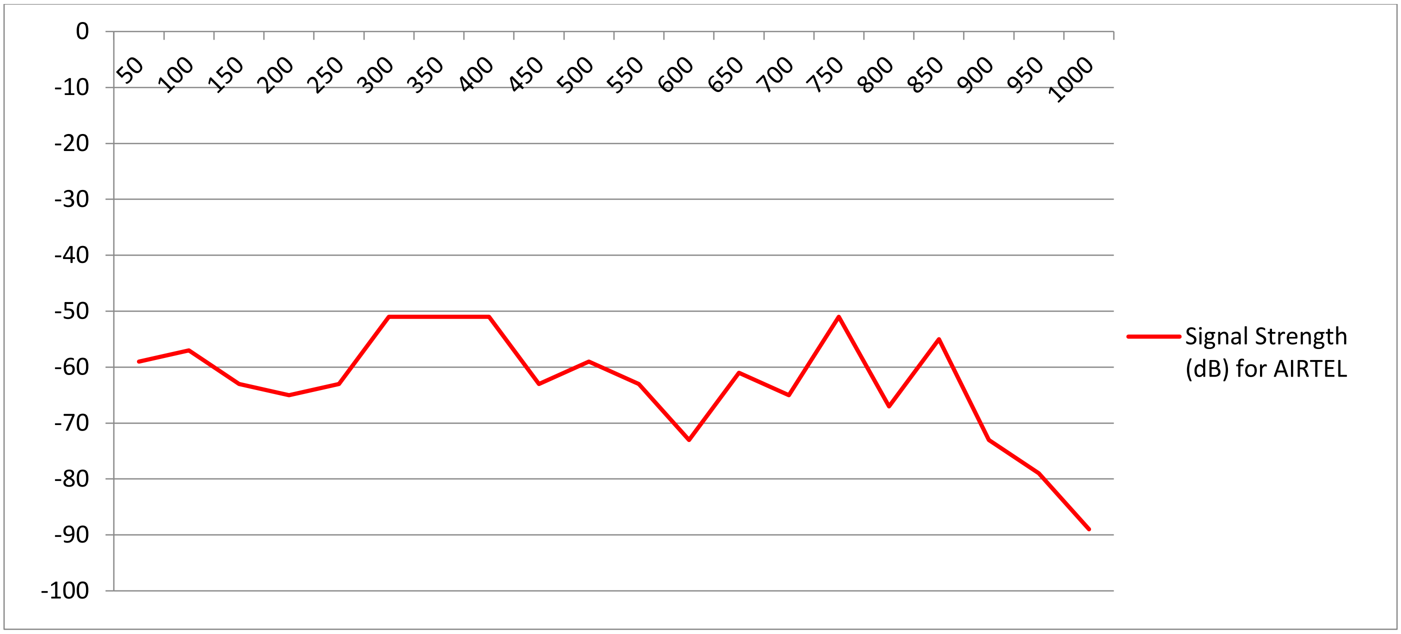


Figure 6. Signal Strength (dBm) against Distance (m) for Airtel network

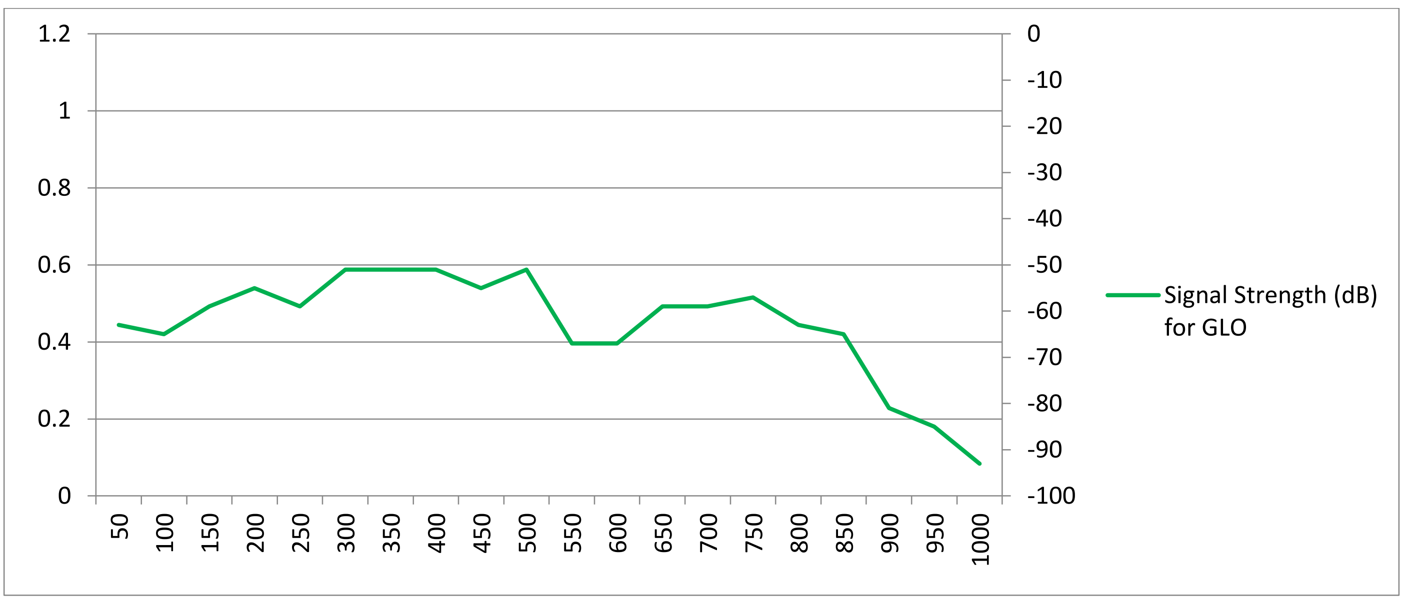
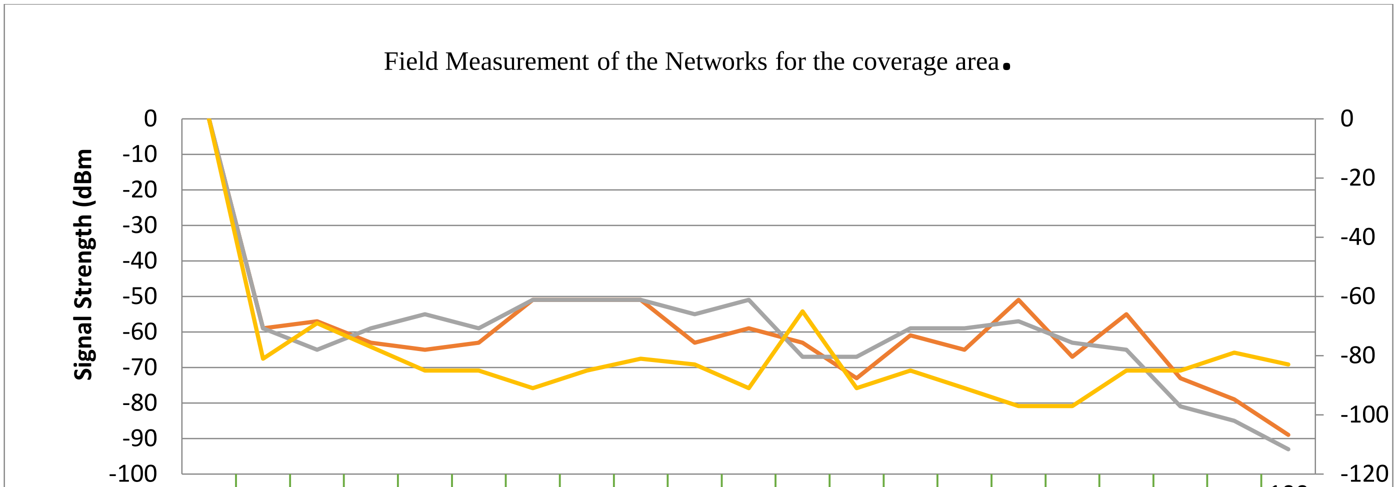


Figure 7. Signal Strength (dBm) against Distance (m) for GLO network



		50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000
AIRTEL	0	-59	-57	-63	-65	-63	-51	-51	-51	-63	-59	-63	-73	-61	-65	-51	-67	-55	-73	-79	-89
GLO	0	-59	-65	-59	-55	-59	-51	-51	-51	-55	-51	-67	-67	-59	-59	-57	-63	-65	-81	-85	-93
MTN	0	-81	-69	-77	-85	-85	-91	-85	-81	-83	-91	-65	-91	-85	-91	-97	-97	-85	-85	-79	-83

Figure 8. Signal Strength (dBm) against Distance (m) for MTN, GLO and AIRTEL network

CONCLUSIONS AND RECOMMENDATIONS

Based on the study carried out, the Paper showed that as the mobile equipment (receiver) was moved away from the Base Transceiver Station the signal strength was observed to be reducing. In all the measurements, the results were analyzed. This work has informed subscribers of the network choice to use at various locations to reduce the challenge of network failure or lack of signal for effective communication. In this research, it has been established that transmitted signals get weak as they are propagated through the air space, buildings, and other physical obstructions. Also, path loss increases with measurement distance from the BTS. Therefore, an approach should be developed to monitor and optimize the QoS as the network continuously changes in response to changes in offered traffic. Mobile phone conversations in buildings are often difficult, if not impossible. This is due to the signal attenuation through walls, window panes, and ceiling. Hence, the application of a GSM repeater, being a two-way amplifier of a window GSM signal, significantly improves the quality of data transmission in our institution. A distributed antenna could be employed by installing such into buildings, this will help to access the network available, boost, and redistribute to meet the needs of the subscriber.

REFERENCES

Akram, A., & Khalid, A. (2011). Q meter tools for quality measurement in telecommunication network. *International Journal of Distributed and Parallel Systems,.2* (4), 103 - 112. doi: 10.5121/ijdps.2011.2409

Bakare, B. I., Ngeri, T. E., & Sunny, O. (2018). Comparative analysis of signal strength of some cellular networks in Port Harcourt, Nigeria. *European Journal of Electrical and Computer Engineering,2* (6), 1 – 6.

Begüm, K. E., & Çetin, K. (2016). Comparison of signal strengths of 2G/3G/4G services on a University campus. *International Journal of Applied Mathematics, Electronics and Computers, 4,* 37 – 42.

Idim, A. I., & Anyasi, F. I. (2014). Determination of building penetration loss of GSM signals. *IOSR Journal of Electronics and Communication Engineering*, 9 (5), 1- 5.

Mitra, A. (2009). *Lecture notes on mobile communication*. Department of Electronics and Communication Engineering, Indian Institute of Technology, Guwahati, India, 4 - 29.

Molisch, A. F. (2011). *Wireless communications.* (2nd ed.). West Sussex, United Kingdom: John Wiley & Sons.

Nsikan, N., Francis, I., Ibinabo, B., & Oluyinka, O. (2016) Analysis of mobile network signal strength for GSM networks. *Proceedings of the World Congress on Engineering and Computer Science, Volume 1*, October 19 – 21, San Francisco, USA, 90 – 93.

Popoola, J. J., Megbowon, I. O., & Adeloye, V. S. A. (2009). Performance evaluation and improvement on quality of service of global system for mobile communications in Nigeria. *Journal of Information Technology Impact*, 9, 91 - 106.

Salawu, M. (2014). On the practical assessment of signal strength of GSM network service providers. *Global Journal of Science Frontier Research, 14* (1), 13 – 18.

Savaş, S., & Topaloğlu, N. (2011). Performance analysis of GSM networks with data mining method. *Journal of the Faculty of Engineering and Architecture of Gazi University*, *26* (4), 741 - 751.

Sectoral Research and Strategies Department (2011). *Three-month market data report.* Information and Communication Technology Authority 2010, Year 4. Quarter N: 12, Ankara, 36 - 59.

Sridhar, V. (2004). *Telecommunications infrastructure and economic growth: Evidence from developing countries*. Retrieved from http://ideas.repec.org.

Wojuade, J. I. (2003). Impact of global system for mobile telecommunication in Nigerian economy: A case of some selected local areas in Oyo State, Nigeria. *Journal of Educational and Social Research*, *4* (7), 79 - 87

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