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QUALITY OF SERVICE (QOS) EVALUATION OF MOBILE NETWORK SERVICES: A CASE STUDY ON THE FEDERAL POLYTECHNIC BIDA, NIGERIA

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ABSTRACT

The requisite for an assurance of telecommunication services is imperative as it establishes the relationship between perceptions and expectations of service delivered by a service provider. Mobile networks need to be under continues monitoring and control in order to maintain and improve the performance of services. In this paper, we examine and evaluate the quality of service of mobile network operators within the Federal Polytechnic Bida campus. This evaluation was undertaken using some KPIs of mobile network services. These KPIs are: Call Setup Time (CST), Call Setup Failure Rate (CSFR), Call Dropped Rate (CDR) and Call Completion Rate (CCSR). For the purpose of this study Drive test was performed using the Mobile Station (MS) software package called MyMobileCoverage Pro (MMC Pro). The result of the study revealed that the QoS provided by mobile network operators for mobile users is not sufficient, unreliable and unsatisfactory. The study also indicated that network accessibility and network retainability in the area being considered is poor. The study presents recommendations on how to improve the QoS of mobile network operators in the campus.

Keywords: *Quality of service, mobile network operators, telecommunication system, key performance indicators (KPIs), drive test.*

1. INTRODUCTION

Before the liberalization of Telecommunication system in Nigeria, the Nigerian Communication Commission (NCC) disclosed that Nigeria had a very limited telephone network for many years which made communication difficult and inaccessible. Over ten (10) million subscribers applied to be connected to the Telecommunication system, (NITEL), for services. Today, the story has changed dramatically with the lunched of

global system for mobile communication (GSM) in Nigeria in 2001 [8]. During its launching in 2001, the core objectives was to provide effective telecommunication services that will support good speech quality, roaming, spectral efficiency, minimized crosstalk, maximum handoff, minimum drop call and good interconnectivity [1]. Since then, the number of Mobile subscribers continues to grow in Nigeria; it grew from 400 lines in 2001 to 231.525 million lines of subscribers with the current active lines stand at 154.12 millions represent 66.57% and inactive subscribers at 77.41 million subscribers or 33.43% [11, 9, and 15]. Currently, there are four major wireless Mobile operators in Nigeria competing for mobile subscribers for Telecom services namely; Airtel, 9mobile, Globalcom and MTN. However, the unprecedented number of subscribers witnessed by the telecommunication industries has not help the situation as the subscribers are faced with one problem or the others among which is poor quality of service been provided by the mobile service providers. Telecommunication Subscribers in Nigeria have been complaining and suffering from bad quality of service (QoS), ranging from problem of network congestion, incessant dropped calls, failed calls, poor voice clarity, and failed handover, among others [3, 2]. How can we maintain a good, secure, uninterruptible wireless mobile network for disaster responses, military control, public health, safety, and law enforcement command in the face of Call Setup Failure, dropped call and poor voice clarity? How can the failed or dropped calls be minimized for everyone to enjoy the use of mobile communication effectively? Thus the need to tackle the problem of QoS on the mobile network is important, as this will both be of advantage to the operators and users [5].

Quality of Service (QoS) is defined as the degree and direction of difference between the customer (mobile users) perceptions and expectations of service delivered by a service provider [4, 12]. In telecommunication system, Network coverage, accessibility, retain-ability and connection quality are the four major factors used in evaluating quality of service (QoS) of a Mobile Network operator. Therefore, Mobile networks needs to be under continues monitoring and control in order to maintain and improve the performance of services. In finding the lasting solution to the problem of poor QoS, the NCC, an organization responsible for the regulation of Mobile services in Nigeria, on 6th July 2007 issued out the threshold levels on the key performance indicators (KPIs) for ascertaining QoS of all the Mobile Networks in the country [10]. For the purpose of this research focus is on Network accessibility and Network retainability.

2. REVIEW OF RELATED LITERATURE

Many research works had been carried out on quality of service (QoS) measurement, evaluation and performance on various KPI parameters of mobile network operators, causes and how to improve on such QoS. However, most papers focus on statistical network data collected from Network Operating Centre (NOC), administering of questionnaires on subscribers for analysis with few researches works on Drive Test models. [13] Presented Outgoing call quality evaluation of GSM services in Epe, Lagos

State. The researchers obtained data from the Network Operating Centre (NOC) for three GSM services operators, providing mobile services in Epe town, for a period of twenty three weeks. A model of service quality and a set of dimensions for comparative evaluation, which could provide useful directions to regulators and service providers, were developed. [14] Worked on determining the Drop call Rate, Failed Call Rate and Signal Strength of Celcom Mobile Network in the Universiti Tenaga National Putrajaya Campus. The Mobile Station application called MyMobileCoverage was used for the drive test which enables the mobile user to view current network coverage with the signal strength mapping with drop and fail calls information. It was concluded from the research that the QoS in the area was poor and need an improvement and recommendations were made by the researchers. The Mobile subscribers of mobile network all over the world as well as in Nigeria continues to face series of problem and poor QoS been provided by the mobile network operators in telecommunication industry. Besiege with the problem of poor QoS been faced by the subscribers gave rise to this study. Area where mobile services are mostly needed and useful for academic, economic and businesses purposes was selected. For the purpose of this research the Federal Polytechnic Bida, was chosen. The Federal Polytechnic Bida is located along Bida- Doko Road in Bida Local Government Area of Niger State, Nigeria and covers a land area of about 2 kilometer square.

3. QUALITY OF SERVICE KEY PERFORMANCE INDICATOR (KPI)

The QoS of any mobile network is been access and measure by the KPI. This research considered the following KPI parameters for evaluation; Call Setup Time (CST), Call Setup Success Rate (CSSR), Call Setup Failure Rate (CSFR), Call Drop Rate (CDR), and Call Completion Success Rate (CCSR). The KPI parameters on each network were calculated from the data obtained from the drive test using the following KPI equations defined by NCC. These are:

i. Call Setup Time (CST)

CST can be calculated from the data obtained from drive test using equations 1 and 2

Percentage of CST ($\leq$ 6s/E) = ($\sum$ calls $\leq$ 6s/ Attempted calls) $\times$ 100 (1)

Where CST ($\leq$ 6s/E) mean call setup time completed within six (6) second, E mean easy call

Percentage of CST ($\geq$ 6s/D) = ($\sum$ calls $\geq$ 6s/ Attempted calls) $\times$ 100 (2)

CST ($\geq$ 6s/D) mean call setup time completed after six (6) second, D mean difficult call

ii. Call Setup Success Rate (CSSR)

CSSR was also calculated using equation 3.

$$CSSR = \frac{Numberofunblockedcallattempts}{totalnumberofcallattempts} \quad (3)$$

iii. CALL SETUP FAILURE RATE (CSFR)

CSFR was calculated using the expression below

$$CSFR = \frac{\text{Number of blocked call attempts}}{\text{total number of call attempts}} \times 100 \quad (4)$$

iv. Call Drop Rate (CDR)

CDR was obtained using the equation 5

$$CDR = \frac{\text{Number of dropped call}}{\text{total number of call attempts}} \times 100 \quad (5)$$

v. Call Completion Success Rate (CCSR)

Finally, CCSR was calculated using the equation below.

$$CCSR = \frac{totalNumberofcompletedcalls}{totalnumberofcallattempts} \quad (6)$$

[10, 3]

vi. The NCC Benchmarked on the KPI Parameters

The NCC, body responsible for the regulation of Mobile services in Nigeria, on 6th July 2007 issued out the threshold levels on the key performance indicators (KPIs) for ascertaining QoS of all the Mobile Networks in the country.

Table 1: KPI parameters considered by NCC.

KPI	CST	CSSR	CSFR	CDR	CCSR
NCC	≤ 6s	≥ 98%	≤ 10%	≤ 1%	≥ 97%

[6, 7]

3.1 Quality of Service in The Federal Polytechnic, Bida

The institution currently has all the four major mobile network operators operating in Nigeria. Figure 2:0 shows that there are four Base Stations (BS) installed outside the school main gate serving the polytechnic and its environs; one for each Mobile Service Provider. A Base Station from one Network provider was installed for Data efficiency used for internet facilities in the institution.

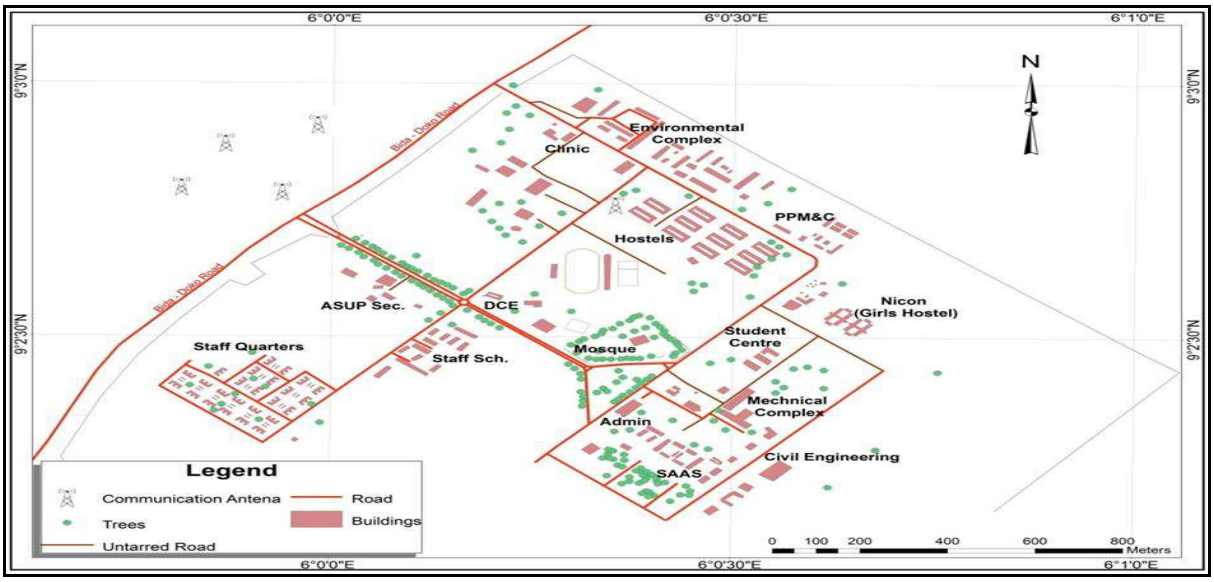

Figure 1.0: The Map of Federal Polytechnic, Bida showing Base Stations.

However, the distance of all the Base Stations with the drive test areas is within 2 km but land slope is a major factor here. Critical surveyed and analysis of the available network facilities in the Institution with over twenty five thousand estimated students showed that during the Busy Hour period the probability that over three to four thousands mobile users may compete for limited services which usually results to congestions and queuing which leads to poor quality of service.

3.2 MATERIALS AND PROCEDURE

This research measurement was conducted within a period of 4 months (August 2017 - November 2017) at the Federal polytechnic, Bida, Niger State, where all the four Mobile networks considered were operating. The Mobile networks studied are Network A, Network B, Network C and Network D. The study was conducted using a Mobile Station (cell phone) software application called MyMobileCoverage Pro (MMC PRO) to perform the drive test under the following metrics; Call Setup Time (CST), Call Setup Success Rate (CSSR), Call Setup Failure Rate (CSFR), Call Drop Rate (CDR), and Call Completion Success Rate (CCSR).The KPI parameters were compared with the NCC benchmarked to see the compliances and also to determine MNO with best quality of service. For the purpose of this Research, the following materials, tools and some definition of terms were used. These materials and tools are: Mobile Stations (MSs), Subscribers Identification Modules (SIMs) Card for all the networks under consideration (Network A, Network B, Network C and Network D), Electronic Stop Watches (4) and a Motor Vehicle.

To perform the drive test, MyMobileCoverage Pro was installed in a Mobile Station(s) (MSs) to take the measurement of the Mobile Network Operators or GSM services. Each

MobileStation has a SIM card installed it depending on the Mobile Network Operator (MNO). Calls were then made on the numbers to carry out the drive tests. The pictorial view of the MMC PRO platform is shown in figure 2.0.

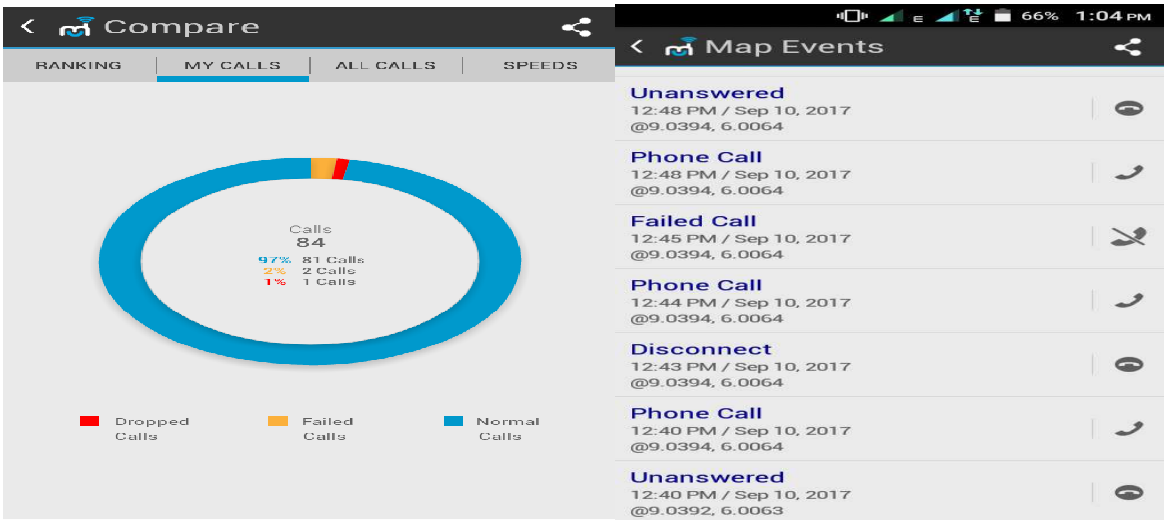

Figure 2.0: MMC PRO Platforms for KPI parameters & their factors.

4. RESULTS AND DISCUSSION

The MMC PRO was able to capture data for each of the Mobile station (MS) on different MNO parameters (either in idle mode or in dedicated mode).The drive test was performed at 8:00pm each day. 8:00pm was selected as it was observed to be the normal busy hour for students when mobile traffic is expected to be at its peak. A total of 4,000 calls were made from the networks under study that is 1000 calls to each network. The KPI values were calculated using the expression earlier defined from equations 1 to 6 on all mobile network providers and results for various KPIs is presented on figure 1 to 5.

4.1 Network Accessibility (NA)

Network accessibility is the ability of mobile station to verify, establish and maintain calls. The KPIs connected to network accessibility are: CST, CSFR and CSSR. The responses on NA from the study are shown in figures 3.0, 4.0 and 5.0.

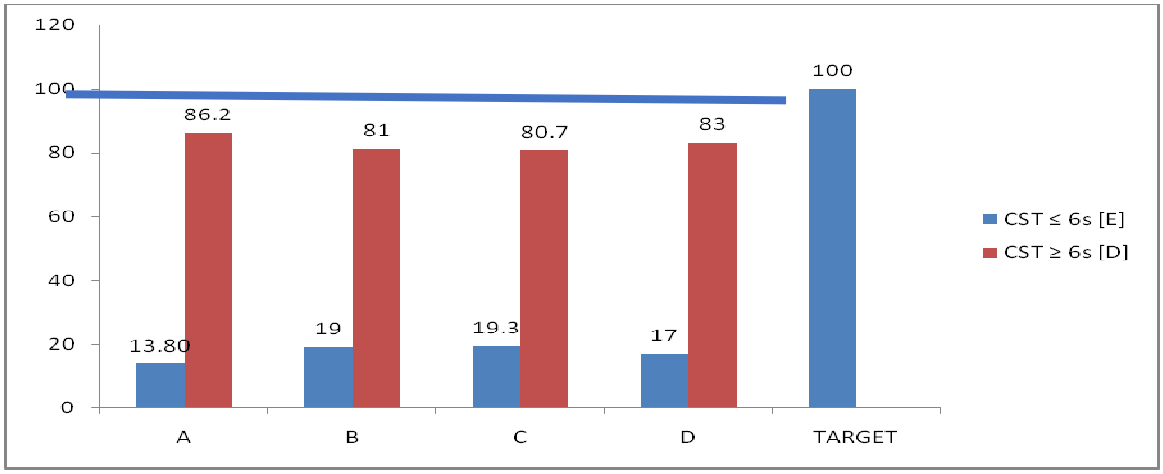

Figure 3.0: Call Setup Time

Fig 3.0 shows the call setup time or call accessibility to each of the Mobile network provider.

CST (≤ 6s/E) means easy call setup time while CST (≥ 6s/D) means difficult call setup time.

Network C has the highest easy call setup time, CST (E/≤ 6s) of 19.3% with call difficult CST (D/≥ 6s) of 80.7% while Network A has the lowest easy call setup time. This simply implies that the accessibility into Network C in terms of call setup time is the easiest. Comparing the KPIs from the graph with NCC benchmarked, all the networks performed below the minimum standard set by NCC of CST≤ 6s.

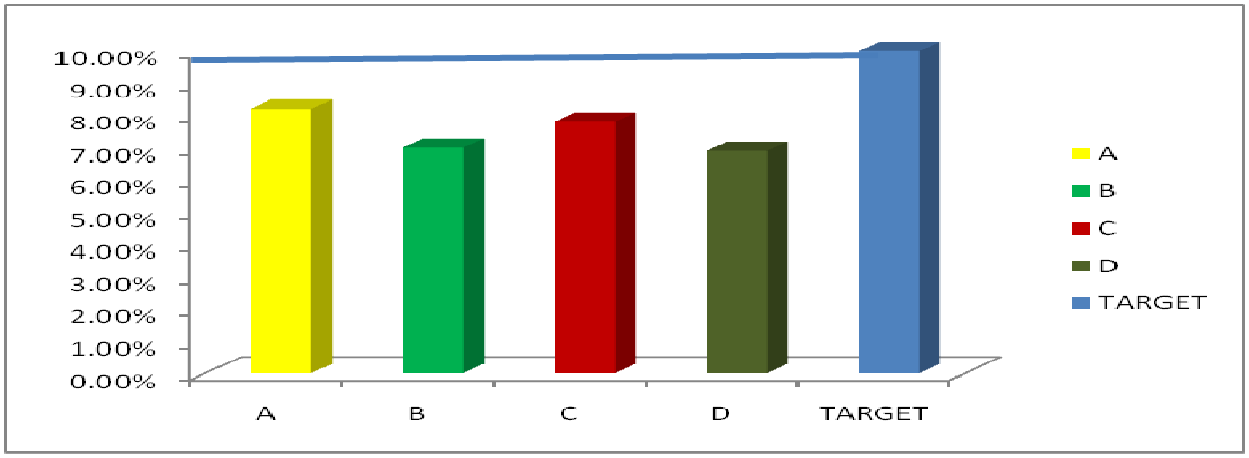

Figure 4.0: Call Setup Failure Rate

Figure 4.0 shows the rate at which call setup failed to each of the mobile networks. The figure shows that the entire mobile networks studied Network D has the best call setup failure rate of 6.9% while Network A has the highest network calls failure. This implies that for every 100 calls made to Network D, 94 calls are likely to be successful without interruption or termination with only 6 calls unsuccessful or blocked

(CSFR).Nevertheless, all the mobile networks studied performed magnificently as the minimum standard (which is Target) of (≤ 10%) benchmark set by the telecom regulatory body the NCC, was not violated.

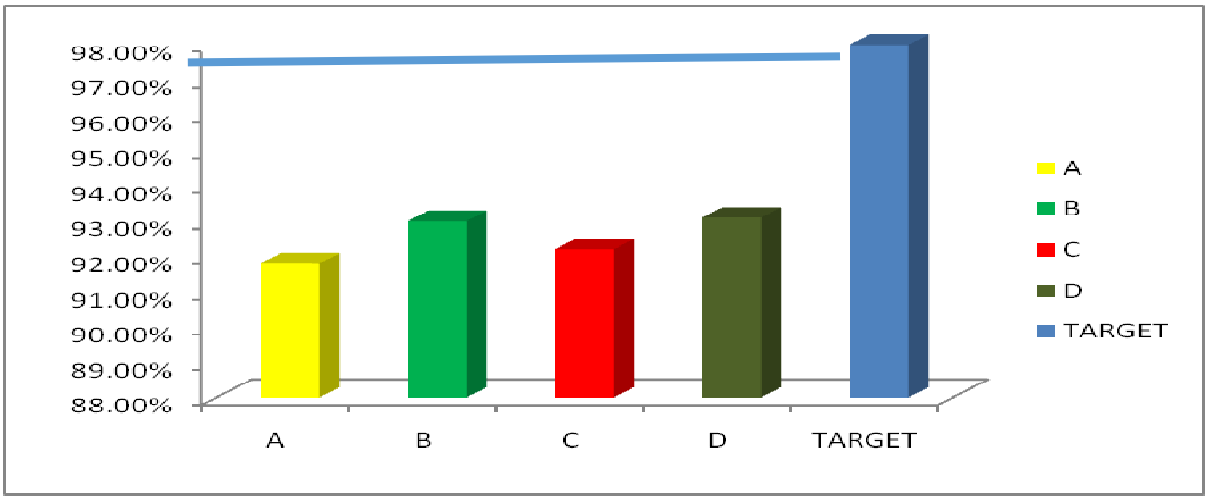

Figure 5.0: Call Setup Success Rate

The degree of accessibility into each network is better shown in figure 3, which indicates the rate at which calls setup were successful. From figure 3 Network D has the best mobile network in establishing calls of 93.1% CSSR while Network A has the poor mobile network of 91.8%. However, all the mobile networks studied slightly performed below the minimum standard (Target) of (≥ 98%) set by the telecom regulatory body the NCC.

4.2 Network Retainability (NR)

Network retainability refers to how long a mobile subscriber stays on a network after the call has been connected or established. The KPIs connected to network retainability are Call Dropped rate and Call Completion Success Rate. The responses of network retainability from the study are shown if figure 6.0 and 7.0 respectively.

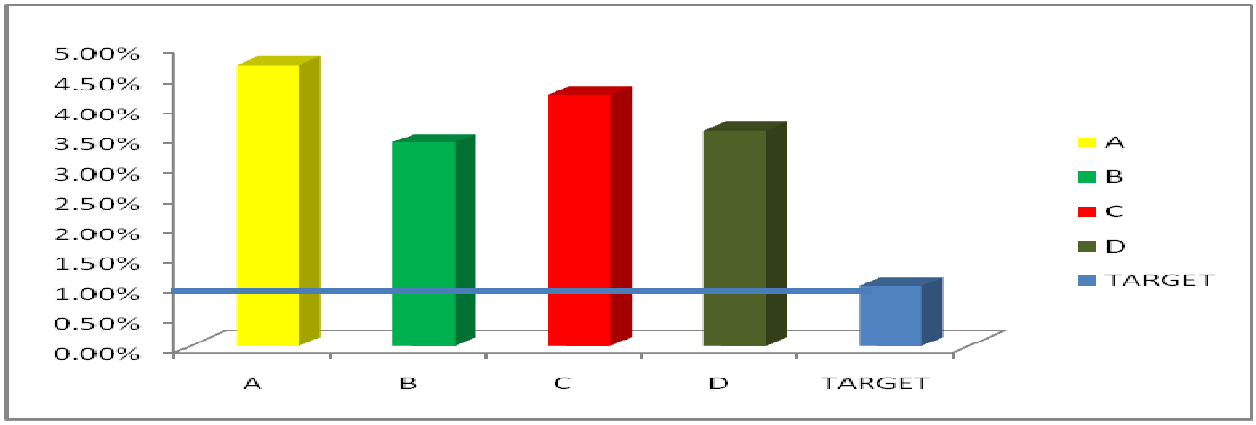

Figure 6.0: Call Dropped Rate

Call dropped rate is said to be among the worst and highest performing metric that affect QoS in Nigeria. The results from figure 6.0 shows that Network A has the highest call dropped rate (CDR) of 4.7% followed by Network C with (CDR) of 4.2%. While Network B has the lowest call drop rate (CDR) of 3.4%, and closely followed by Network D with (CDR) of 3.6%. From figure 4, it shows that majority of the mobile subscribers' experiences call dropped to all the networks while a serious conversation is still ongoing in the institution. On the other hand, all the mobile networks studied performed very poorly as the minimum standard (Target) of (≤ 1%) benchmark set by the telecom regulatory body the NCC, was grossly violated.

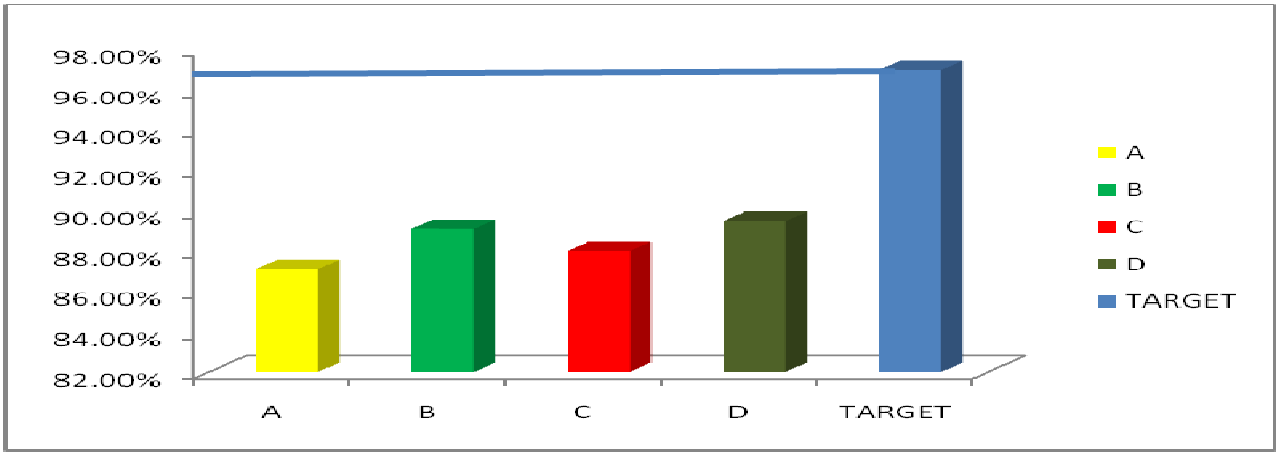

Figure 7.0: Call Completion Success Rate

Meanwhile, the call completion success rate (CCSR) and Call drop rate (CDR) are inversely related. From figure 7.0, with Network A higher in CDR of 4.7% value, it means the CCSR value of (87%) will be lowest. However, Network B that has lowest CDR will have its CCSR highest of 89.6% and follow by Network D with CCSR of 89.4%. This indicates that all mobile subscribers on Network B and Network D have higher probability of finishing their conversation before call terminate when compare with mobile users on Network A and Network C. Nevertheless, all the mobile networks studied performed very poorly and violated the minimum standard (Target) of CCSR (≥ 97%) benchmark set by the telecom regulatory body the NCC for all mobile network operators to complied with.

4.3 The Result for Performance Test and Network Quality

The performance analysis for each of the KPI parameters was done as shown from figure 1 to 5. Generally, these results reveal that poor Quality of Service (QoS) is persistent across all the mobile networks. However, these results only present a comparative study of the networks with the telecom regulatory body NCC benchmarked. Table 2.0 shows the result for performance test and network quality.

Table 2.0 Result for Performance Test and Network Quality

	KPIs	Target	Best Result	Worst Results
	BH Call Setup Time (CST)	≤ 6s	Network C; 19.3%	Network A; 13.8%
	BH Call Setup Failure Rate (CSFR)	≤ 10%	Network D; 6.9%	Network A; 8.2%
	BH Call setup Success Rate (CSSR)	≥ 98%	Network D; 93.1%	Network A; 91.8%
	BH Call Dropped Rate (CDR)	≤ 1%	Network B; 3.4%	Network A; 4.7%
	BH Call Completion Success Rate (CCSR)	≥ 97%	Network B; 89.6%	Network A; 87.1%

From table 2.0, it shows that the overall performance of the mobile network operators is far from being satisfactory. The network accessibility of network C; 19.3% (CST) was better than the rest mobile networks studied. Network D performed better with a minimum 0f 6.9% Call Setup Failure rate and a maximum of 93.1% in Call Setup Success Rate respectively. However, Network B performed wonderfully in network retainability with a minimum Call Dropped rate of 3.4% and Call Completion Success Rate of 89.6%. It further reveals that the entire mobile networks studied Network A has the worst quality of service (QoS) in both network accessibility and network retainability.

5.0 CONCLUSION

This study was undertaken to evaluate the Quality of Service (QoS) of various KPI parameters of mobile network services available at the Federal Polytechnic, Bida. From the results of the study, it is evident and clearly shows that the four mobile network operators studied and operating in Nigeria are far from providing sufficient and reliable services to the subscribers in the study area. From the study undertaken none of the Mobile network operators satisfied the minimum standard set by the telecommunication regulatory organ in Nigeria the NCC.

With these findings, it can be concluded that the QoS evaluation over all the KPIs performance of the mobile network operators in the institution campus and probably in Nigeria at large is poor, unreliable and unsatisfactory and may not be safe for disaster responses, military control, public health, safety, and law enforcement command.

6.0 RECOMMENDATIONS

Frequent call drops, low call setup success rate, high call setup time and high call setup failure rate etc, which affects the quality of service of a mobile networks are indicator of an optimization skull area. The networks need optimization. In order to correct the problem of poor QoS in the country and any other areas with similar situation, suggestions on how to improve the QoS of the Mobile network operators need to be made. It is on this base that the following recommendations are made in order to improve the observed defects:

- All the mobile network operators should ensure a robust optimization of its networks in order to ensure good service delivery to the subscribers.
- Wireless Mobile Operators should constantly carry out proper signaling traffic evaluation to know the capacities of their network equipment so as to meet the expected number of subscribers within the network.
- The mobile network providers/mobile users should install Signal booster to boost the strength of the signal in case of high cost of installing BS/BTS.
- A geographical survey of the area should be carried out before the installation of BS/BTS as presently land slope account for network coverage problem in the Institution.
- The NCC body should always access, monitor, regulate and give timely warning to the mobile operators, and where necessary sanctioned for any contravention if they were not meeting the require standard in the telecommunication industry in order to ensure good quality of service.

It is believed that if the above recommendations are strictly observe and adhered to, the QoS and the overall performance of the Mobile network operation in the area and country at large shall definitely improve.

REFERENCES

Adegoke, A.S and Babalola, I.T. (2011). Quality of service analysis of GSM telephone system in Nigeria,*American Journal of Scientific and Industrial Research.* ISSN: 2153-649X

Alenoghena, C., O and J. O Emagbetere (2012). Base station placement challenges in cellular networks: The Nigerian experience. Proceedings of 4th IEEE International Conference on Adaptive Science &Technology (ICAST) Ghana 25-27th Oct 2012. (Pages 7-11)

Celinus Kiyea (2012). Performance Analysis of Quality of Service of

GSM/CDMA Mobile Networks in Zaria,*International Journal of Science and Research (IJSR)ISSN (Online): 2319-7064Impact Factor (2012): 3.358*

Longe, F.A. 2011. Subscribers' Perception of the Quality of Service (QoS) of the Global System for Mobile Services in Ibadan, Nigeria,*Computing, Information Systems & Development Informatics Journal*

Kuboye, B.M., Alese, B.K and Fajuyigbe, O. 2009. Congestion Analysis on the Nigerian Global System for Mobile Communications (GSM) Network. *The Pacific Journal of Science and Technology* http://www.akamaiuniversity.us/PJST.htm Volume 10

Nigerian Communications Commission, Nigerian Communications Act 2003 Quality of Service Regulations 2011. Arrangement of Regulations (online Retrieved 24/11/2016)

Nigerian Communications Commission, Nigerian Communications Act (No 19 of 2003) (Online Retrieved 24/11/2016) Quality of Service Regulations, 2012

Nnochiri, I.U. 2015. Evaluation of the Quality of Service of Global System for Mobile Telecommunication (Gsm) Operators in Nigeria, *Journal of Multidisciplinary Engineering Science and Technology (JMEST) ISSN: 3159-0040*

National Bureau of Statistics (2016) (online Retrieved 24/01/2017)

Popoola, J.J., Megbowon, I.O. and 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*

Rex Ndubuisi Ali 2015. Handoff and Drop Call Probability: A Case Study of Nigeria's Global System forMobile Communications (GSM) Sector, *Scholars Journal of Engineering and Technology (SJET) ISSN 2321-435X (Online) ISSN 2347-9523 (Print)*

Rajesh, K. Y. and Mr Nishant Dabhade 2013. Impact of Service Quality on Customer Satisfaction of Mobile Users- A Case Study of Airtel, *International journal of Innovative Research Studies ISSN: 2319- 9725*

Shoewu, O and Edeko, F. O. 2011. Outgoing call quality evaluation of GSM network services in Epe, Lagos state, *American Journal of Scientific and Industrial Research ISSN: 2153-649X.*

Sagadevan, S. S.and Nurul, A. B. M. R. 2015. Determining the Drop Call Rate, Failed Call Rate and Signal Strength of Celcom Mobile Network in the Universiti Tenaga National Putrajaya Campus. The 3rd National Graduate Conference (NatGrad2015), Universiti Tenaga Nasional, Putrajaya Campus, 8-9 April 2015*ISBN 978-967-5770-63-0 349*

Zakariyya, A. and Omobayo, A. 2017. Telcos Connect 236m lines in 14years, retrieved from

Daily Trust Newspaper of Monday, January 30, 2017.