© MAR 2026 | IRE Journals | Volume 9 Issue 9 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV9I9-1715475

An Experimental Study of Mobile Networks in Nigeria to Know the Quality of Service.

ELEJE NELSON EMEKA[1], EJIMOFOR IHEKEREMMA A. U.[2]
[1]*Department of Electrical and Electronic Engineering, Madonna University, Nigeria.*
[2]*Department of Computer Engineering, Madonna University, Nigeria*

Abstract- ***This paper focused on the experimental study of mobile networks in Nigeria to know the quality of service/ . The measuring equipment used in collecting data is the QVOICE monitoring equipment as shown in Figure 1. It has four mobile phones which are Nokia 6230i with serial numbers ranging from 85-92 used for channel identification. The measurement drive test was conducted in Lagos State of Nigeria. QVOICE is the measurement tool used to conduct the drive test.. The capability of the measuring equipment QVoice include call statistics i.e connection setup, call drop handover request, received signal level. Before the drive test, planning of the routes to be followed was done using the MapInfo tool integrated in QVoice software. The result gotten indicated that it was noticed that Call Setup advancement of service providers like Mobile Telecommunication network (MTN), Global communication network (GLOBACOM) , and Airtel were very near the starting point (threshold) which is 98% with Airtel having the most reliable performance. The Call drop rate of service providers like Global communication network, 9mobile and Airtel were discovered to be excellently good showing there was a very little congestion as at the period of experiment. In CCR, 9mobile (Etisalat) performed below average.***

KEY WORD: Call Setup Success Rate (CSSR), Call Drop Rate (CDR), Call Handover Successful Rate (CHSR), Call Handover Successful Rate (CHSR): Standalone Dedication Control Channel (SDC

I. INTRODUCTION

The roll out of mobile communication operators (GSM) in the year 200 in Nigeria has developed in a tremendous growth in the number of subscribers, internet users and other telecommunication services as well as various real-time applications (Hardy, 2001). Consequent upon the users's growth, the communication industry has been faced with Quality of Service (QoS) challenges ranging from the problem to initiate calls, call drops, occasioned services interruptions, cross-talks and congestion of netwoks noticed during festive periods such as Sallah, Easter and Christmas celebrations (Ghazani et al,2012).These challenges has caused the GSM users to find the services provided by network operators dissatisfactory due to quality of service degradation battling the communication industry in Nigeria (Osahenvemwen and Emagbetere, 2011),. Some subscribers believe that these challenges were as a result of network expansion without corresponding investment in the area of capacity building.

But, most network operators believe it is as a result of delay in deployment of most vital infrastructures on the empowerment, delay in acquiring sites as well as delay in getting local permit of various state governments (Popoola et al, 2009). This paper focuses on an empirical study of the of Mobile Networks in Nigeria to know their Quality of Service (QoS). The contribution of this work could be applied in network expansion plan especially in the area of dimensioning, to ensure provision of adequate facilities to serve subscribers at different locations. The findings from this study will also make the regulatory agency to reinforce its effort in frequent review of the Key Performance Index(KPI) thresholds and also in developing a robust international acceptable frame work that will meet the satisfaction of GSM users. The paper was able to exploit the concept and potentiality in KPI optimization which has proved that maximization is possible in real cellular network. This paper is structured in such a way that section I deals with the Introduction. Section II comprises the Theoretical analysis. Section III of the paper highlighted the various materials and method used for carrying out the research work. The findings and results are seen in section IV while section V of the paper contained the conclusion.

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II. THEORETICAL ANALYSIS

(A) Quality of Service Parameters

Quality of Service is the collaborative initiative of the service efficiency which establishes the level of fullfilment of any person that uses the service (Kuboye et al,2015).There are several network parameters which can be used to evaluate the QOS delivered to subscribers. These KPI's includes the followings; Call Setup Success Rate (CSSR), Call Completion Rate (CCR),Call Handover Success Rate (CHSR), and Standard Dedicated Control Channel (SDCCH) Call Drop Rate (CDR), (Oyebisi and Abdul-hammed ,2011).The various expressions for these parameters are shown in equation (1)-(5), (Rappaport, 2003).

- Call Setup Success Rate (CSSR): This is the attempted calls per time until traffic routes is assigned to the call smoothly and CSSR is expressed by:

$$CSSR = \frac{\text{No. of successful siezuers of SDCCH} \times 100\%}{\text{Total No.of request for siezuers of SDCCH channel}} \quad (1)$$

- Call Drop Rate (CDR): This is known as the rate of calls not completed smoothly.

$$CDR = \frac{\text{No. of TCH drop rate after assignment} \times 100\%}{\text{Total No. of TCH assignment}} \quad (2)$$

Call Handover Successful Rate (CHSR): This is the rate success handover (intercell and intracell).Call handover success is classified into handover success rate and radio handover success rate.

$$CHSR = \frac{\text{No. of successful (intracell+intercell)handovers} \times 100\%}{\text{Total No. of handover requests}} \quad (3)$$

- Call Completion Rate (CCR): This shows the effective finalization of outgoing call and incoming call per time.

$$CCR = \frac{\text{No. of successful completed inbound or outbound calls} \times 100\%}{\text{Total No. of placed or received calls}} \quad (4)$$

However,note that,CCR is not considering calls that are missed, terminated, or abruptly ended.

- Standalone Dedication Control Channel (SDCCH): This is utilized for granting signal for service that the user needs. It is a carrier signaling data succeeding the connection of the mobile system with base station and just prior to a Traffic Channel (TCH) assignment as authorized by the base station. The interface between MS and BS are maintained by SDCCH. It is really temporary and an in-between channel that takes just finished call from BSC and keeps the traffic on standby for the base station to assign TCH channels.
- SDCCH is applied to send confirmation, alert message and user validation as mobile waits for TCH after synchronizing itself with the frame structure.

- SDCCH is the rate at which the system successfully complete timing advance, validation and authentication.

$$SDCCH = \frac{\text{No. of successful TCH seisures or assigned} * 100\%}{\text{Total No.of TCH request}} \quad (5)$$

Table 1, Table 2 and Table 3 show various KPIs and the standard level set on them by the operators. However, the KPI dataset collated after proper analysis for the months of March and April, 2012 as seen in Table 4. Therefore, benchmarking this dataset 5 with the regulators threshold calls for optimization that was later carried out. Table 1 shows Key Performance Index in their threshold levels of 1%. (Guner,1998)

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Table 1: Key performance Index (KPI)

KPI	Threshold values for some KPIs on %
Call setup rate	>96%
Call drop rate	<2%
Call setup success rate	>98%
Call failed rate	<2%
Call setup time	<5 second
Call handover success rate	
Speech quality index (MOS)	>3.8%
Standalone dedicated control channel	<0.2%

Table 2: Threshold values for Speech Quality Index and remarks

Speech Quality	Mean Opinion Score (MOS)
Excellent	3.5-5
Good	2.7-3.5
Fair	2.1-2.7
Poor	1.5-2.1
Bad	1.5

Table 3: Threshold values for the received signal strength within the investigative coverage area in (dBm)

Coverage	GSM (Rx level)
Excellent	>85 dBm
Good	95dBm<to<-85dBm
Fair	110dBm<to<-95dBm
Poor	<-110dBm

III. MATERIALS AND METHODS

A. Materials

The measuring equipment used in collecting data is the QVOICE monitoring equipment as shown in Figure 1. It has four mobile phones which are Nokia 6230i with serial numbers ranging from 85-92 used for channel identification. Figure 2 shows the interconnection between the various measurement equipment which include Global Positioning System (GPS), nokia phones and the display unit, Graphic User Interface(GUI) and Qvoice data gathering devices.

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Figure 1: QVoice: Monitoring equipment (Data Collection Part)

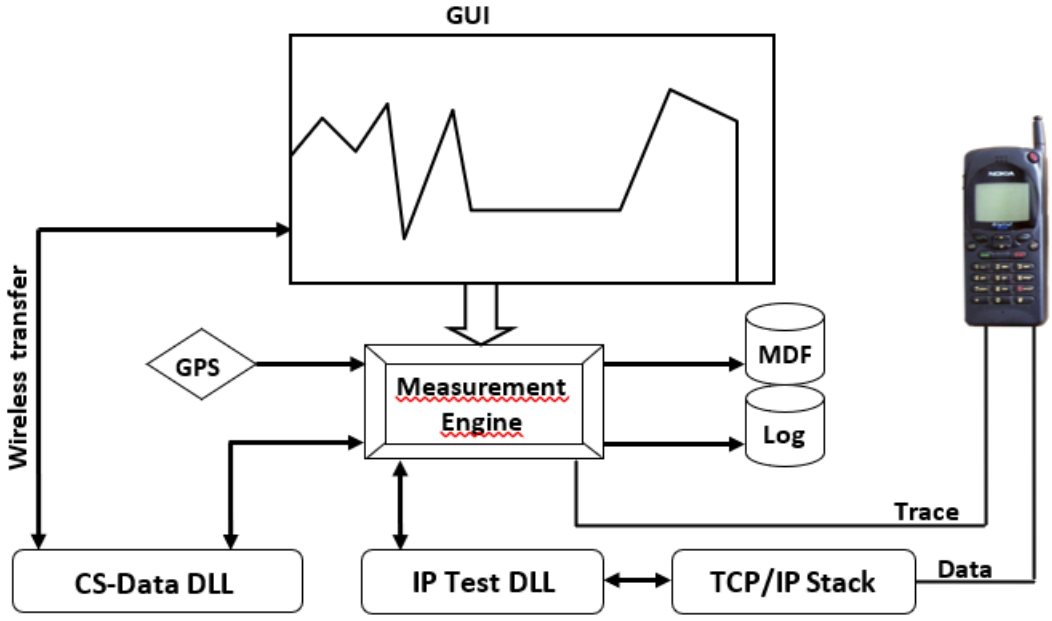

Figure 2: Interconnections of Equipment.

B. Drive Test Measurement Method

The measurement drive test was carried out at Gbagada in Lagos State of Nigeria. QVoice is the measurement tool used to carry out the drive test. This QoS equipment is implemented in a special purpose built vehicle to enable the setup test with least vibration and shock when the vehicle is in motion. The proficiency of the measuring equipment QVoice include call statistics i.e connection setup, call drop handover request, received signal level. Before the drive test, planning of the routes to be followed was done using the MapInfo tool integrated in QVoice software. This helped to spot the areas that have weak coverage .Consequently, an investigation was made on these areas using advanced tools in QVoice software (data observer) and the result indicates that the areas with poorest performance were densely populated areas. After the drive test, the

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raw data from QVM was subsequently integrated into the QVP for output handling in order to track the positions where congestions and weak coverage occurred. The report shows a sample view of the benchmarking and a map view for the four operators.

IV. RESULTS AND DISCUSSION

(A) Results

The result obtained from the unoptimized KPI data from the four networks as shown in Table 4 and Table 5 for the months of March and April while the result of the Chi-Test as shown in table 6 and table 7 are also for months of March and April respectively. Table 8 and 9 show the optimized data. Figure 3 shows the graph of the Optimized KPI data for March, 2012 while Figure 4 reveal the graph of the Optimized KPI data for April, 2012.

(i) Unoptimized Key Performannce Index Data

Table 4: Data of KPI for March, 2012.

Name of operator	CHSR (Target ≥ 96%)	CSSR (Target ≥ 98%)	SDCCH (Target ≥ 0.2%)	CDR (Target ≥ 96%)	CCR (Target ≥ 96%)
MTN	95.14	97.07	0.58	1.13	96
GLO	97.73	97.33	0.39	1.13	96.44
ETISALAT	89.67	94.38	1.64	0.86	93.05
AIRTEL	96.64	97.39	0.58	0.86	96.56

Table 5: Data of KPI for April, 2012

Name of operator	CHSR (Target ≥ 96%)	CSSR (Target ≥ 98%)	SDCCH (Target ≥ 0.2%)	CDR (Target ≥ 96%)	CCR (Target ≥ 96%)
MTN	94.67	96.42	0.61	1.41	95.78
GLO	97.67	97.02	0.39	1.17	96.45
ETISALAT	91.28	96.88	1.36	1.22	95.81
AIRTEL	96.33	97.48	0.47	0.92	96.59

Table 6: The Result of Chi-Test Calculation for March, 2012.

KPI	CHI-TEST OUTPUT PER OPERATOR for Match, 2012			
	MTN	GLO	ETISALAT	AIRTEL
CHSR	39.46*	9.35	67.55*	27.17*
CSSR	18.39	15.29	55.38*	14.46
SDCCH	10.37	3.92	92.74*	10.37
CDR	7.80	11.40	11.40	11.40
CCR	8.99	6.88	85.70*	7.86

Table 7: The Result of Chi-Test Calculation for April, 2012.

KPI	CHI-TEST OUTPUT PER OPERATOR for Match, 2012			
	MTN	GLO	ETISALAT	AIRTEL
CSSR	21.94*	13.65	15.59	7.26
CDR	7.04	9.21	8.79	11.04
CCR	3.68	6.31	2.66	8.29
CHSR	45.83*	4.61	90.85*	23.18*
SDCCH	11.62	3.92	63.34*	6.33

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(ii) Optimized KPI Data set

Table 8: KPI data for March, 2012

Name of operator	CSSR	CDR	CCR	CHSR	SDCCH
MTN	102.054	3.318	97.996	97.136	2.576
GLO	102.314	3.118	98.436	99.726	2.386
ETISALAT	99.364	2.848	95.046	91.666	3.636
AIRTEL	102.374	2.848	98.556	98.636	2.576

Table 9: Data of KPI for April, 2012

Name of operator	CHSR	CSSR	SDCCH	CDR	CCR
MTN	96.666	101.404	2.606	3.398	97.776
GLO	99.666	102.004	2.386	3.158	98.446
ETISALAT	93.276	101.864	3.356	3.208	97.806
AIRTEL	98.326	102.464	2.466	2.908	98.586

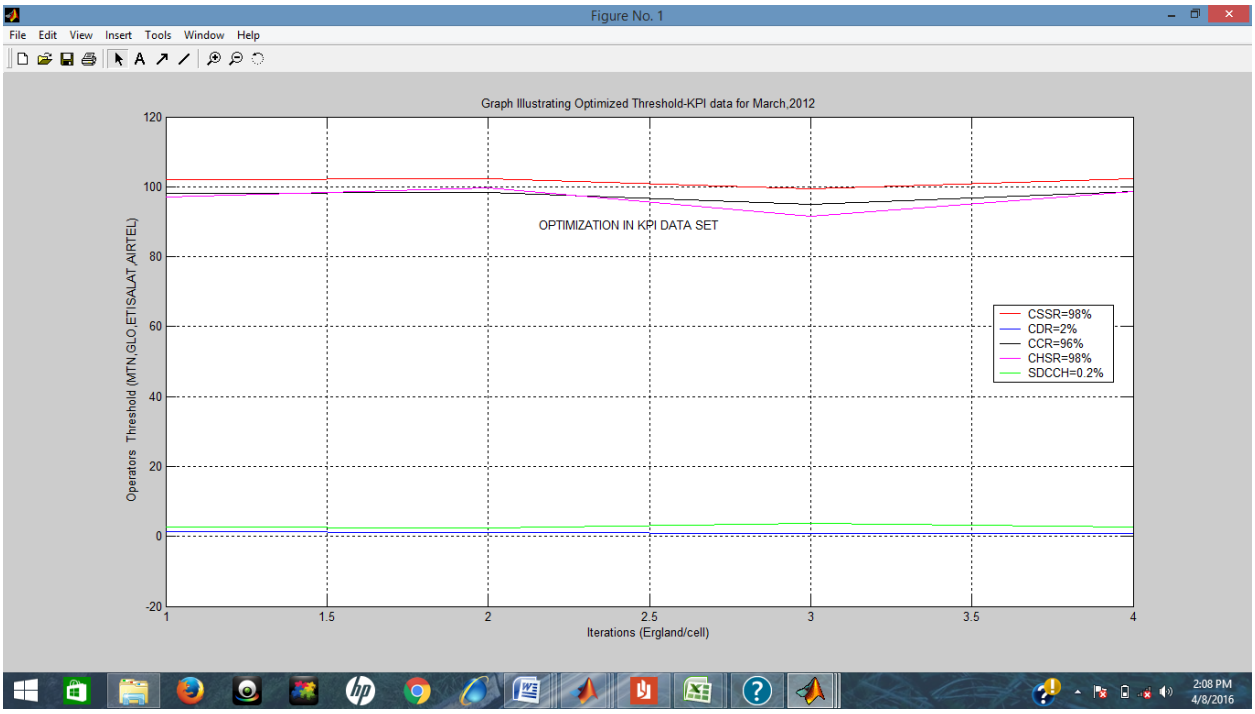

Figure 3: Graph of the Optimized KPI Data for March, 2012.

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DOI: https://doi.org/10.64388/IREV9I9-1715475

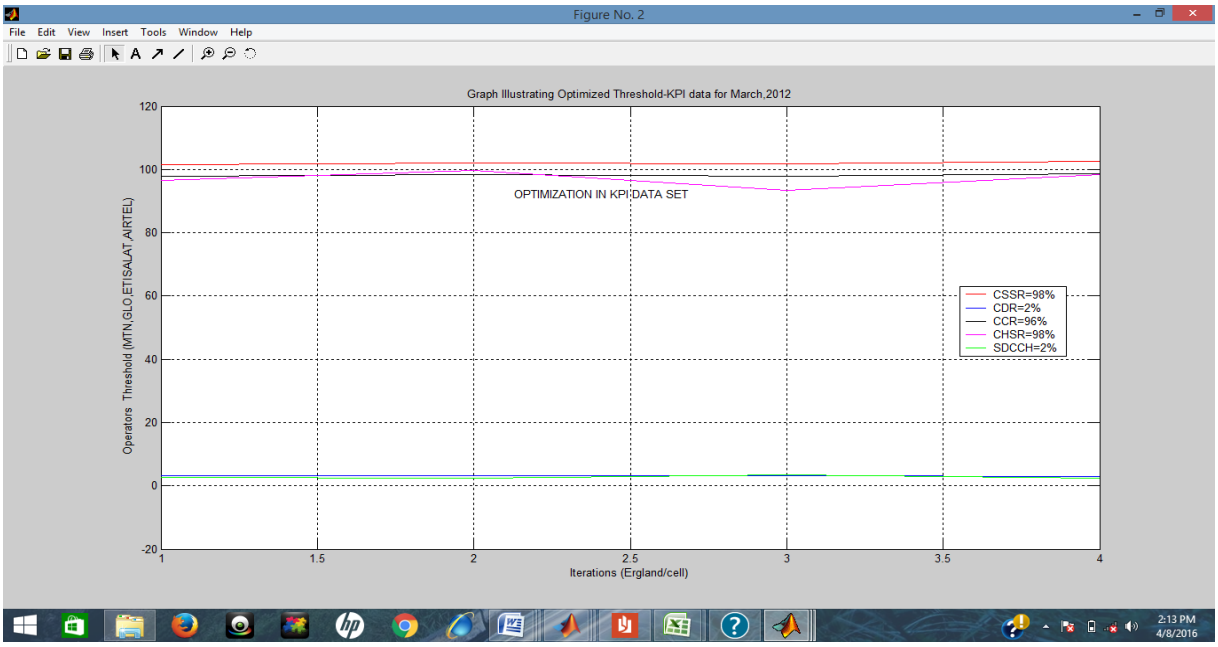

Figure 4: Graph of the Optimized KPI Data for April, 2012.

V. DISCUSSION

The result obtained from the unoptimized KPI data from the four networks in the month of March and April is shown in Table 1 and Table 2 respectively. The tables shows that the efficiency of the network as it varies within the day. It was noted that CSSR of operators like MTN, GLO , and Airtel was very near to the threshold i.e. 98% with Airtel having the highest efficiency. The CDR of operators like GLO,Etisalat and airtel was seen to be excellently good which shows that there was a least overload as at the period of experiment. In CCR, Etisalat performed below average.

In Table 3 and Table 4, For CSSR values, the sampled distribution is approximately distributed as Chi-Square on 2 degrees of freedom with CHI-TEST values of 18.39, 15.29. 55.38 and 14.46 which is less than the critical value of 19.2 at 0.05 levels of significance apart for ETISALAT that has 55.38 labelled with asterisk. This indicates that the perceived CSSR values for different operators did not differed significantly from the regulators threshold. For CDR values, the sample distribution is approximately distributed as Chi-square on 2 degrees of freedom with Chi-Test values of 7.80, 11.40, 11.40 and 11.40 which is less than the critical value of 19.2 at 0.05 levels of significance. This shows that the observed CDR values for distinct operators did not vary significantly from the regulators threshold. Figure 3 and 4 shows the optimized data using the Adaptive Network Based Fuzzy Inferences system and this enhanced the network performance with respect to the network operators.

VI. CONCLUSION

This paper has presented an Experimental Study of the Quality of Service (Qos) of Mobile Networks in Nigeria considering various KPI parameters. Using the Adaptive Network Based fuzzy Inferences optimization technique the KPI's were optimized as such presenting an enhanced network performance with respect to the network operators in Nigeria.

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