

Evaluating the Reliability Indicators of Mobile Network Services in River State, Nigeria

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Abstract

Telecommunication industry is a big market with an active competition among major service providers in Nigeria. Sustaining customers' confidence in a network through achieving a robust Quality of service to increase Quality of end-user Experience is critical for a competitive advantage. Call Setup Success Rate (CSSR) and Dropped Call Rate (DCR) are excellent Quality of Service (QoS) index used to monitor the performance of cellular networks; therefore NCC has placed a performance threshold for the service providers in Nigeria. This analysis employs the use of the data published by the four major mobile network operators through Nigerian Communication Commission to determine the reliability of the networks based on CSSR and CDR for a period of one year (November 2018 – October 2019). We observed from the provided data that globacom have the highest average CSSR (99.79%) followed by MTN (99.69%), Airtel (99.62%) and lastly the 9mobile (99.60%). However, on CDR, MTN had the lowest average CDR (0.12%), followed by Globacom (0.31%), Airtel (0.29%) and 9mobile (0.43%) had the highest.

Keywords: CSSR, CDR, Reliability, Mobile, Network

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1. INTRODUCTION

The selling point of cellular networks is its capacity of enabling communication among individuals irrespective of time and location provided there is viable network coverage. The network coverage area is divided into different cells and sectors. Cellular network organization comprises of several network hardware such as a mobile Station (MS) which is wirelessly linked to the Base Transceiver Station (BTS). The transceiver (TRX) which is located inside the BTS is responsible for the exchange of several radio frequency (RF) signals between the BTS and the end user. BTS is then connected to the base station controller (BSC) via A-bis interface. BSC usually handles radio resource management and handovers of the calls from one BTS (or cell/sector) to the other BTS (or cell/sector) [1]. All GSM operators use Key Performance Indicators (KPIs) to evaluate their network performance and estimate the Quality of Service (QoS). KPIs are becoming increasingly important in the context of network rollouts as well as within mature network optimization cycles [2]. The KPIs are derived with the help of information exchanged between the mobile terminal and the base transceiver using RF drive test. Call Setup Success Rate (CSSR) and Call Drop Rate (CDR) are some one of the most important KPIs used by all mobile operators to measure QoS in Nigeria.

1.1 Drive test

The two fundamental services of wireless mobile network are Voice and Data services. KPIs of such networks are obtained using the RF drive test. Wireless-network drive tests provide a clear insight into the quality of mobile-phone network coverage which includes identification of black spots (areas without reception) and areas of poor signal quality (dropped calls, slow data speed, etc.). According to [16], it's the acquisition and monitoring of information exchanged between the mobile terminal and the base transceiver station (BTS). Drive tests give the 'feel' of the designed network as it is experienced in the field [2][8]. There are 3 types of drive tests which are single Site drive test, Dynamic drive test and Cluster drive test.

Single site verification (SSV or SCFT) drive test

Single site verification or Single cell functionality test is a static test which collects the data for each sector of the cell site such as coverage and quality parameters. The SSV data depends upon the technology in the cellular mobile network [16].

Dynamic drive test (DDT)

Dynamic drive test is a means of collecting the network information of cell sites in terms of coverage and quality by moving around the site. It also involves performing Short and long calls to verify the network strength, stability of the network, Handover between adjacent cell sites, voice and data quality of the mobile network, etc.

MSV or Cluster drive test

Multiple site verification or Cluster drive test is performed to collect the data of network parameter details of more than one cell when the network is in working state. The details of network parameters collected such as Drive Route, Coverage Plot, Download and Upload rate, PCI Plot, Quality plots, etc, is used to optimize the network to deliver service more efficiently. Cluster test is performed for both voice call and data call testing [3].

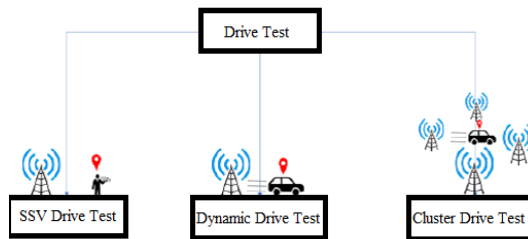


Fig 1: Drive Test

1.2 Call Set Up in Gsm

A call setup is an exchange of signaling information in the call process that leads to Traffic Channel (TCH) seizure [5]. A successful call set up consists of the following parts:

- Successful Immediate assignment procedure (the result is occupation of SDCCH or FACCH in case of Direct TCH assignment)

- Successful authentication and ciphering on SDCCH or FACCH (these procedures can be excluded in case of Direct TCH assignment)
- Successful TCH assignment.

1.3 Performance indicators

The establishment of the connection between the caller and the exchange units and the ability to sustain the active call is a major quality of the service parameter in telecommunication. Excellent Quality of service sustains customers' confidence and is essential for a competitive advantage [14]. Call Setup Success Rate (CSSR) and Dropped Call Rate (DCR) are very important Quality of Service (QoS) index used to censor the performance of cellular networks. The minimization of dropped call probability which births reduced user's DCR is the typical result of many optimization procedures applied to several service aspects as enlisted in [4].

Call Setup Success Rate (CSSR)

The call setup success rate is a major KPI used by the network operators to evaluate the performance of networks. This quality of network, have direct impact on the end user satisfaction with the service provided by the network and its operator. In an ideally situation, a network should have the capacity to accept all call attempts made. The ideal value of CSSR is 100%, unfortunately due to various reasons; CSSR is mostly less than 100%. In telecommunication networks, CSSR is the fraction of all call attempts that successfully connect to the dialled number. This fraction is usually measured as a percentage of all call attempts made. According to [1], if a call is connected successfully but the dialled number is busy then the call is counted as successful. There is no simple formula for calculation of Call Set up Success Rate because the number of channel requests for speech calls cannot be measured [6], therefore different operators measure it differently. However, according to Nigerian Communication Commission (NCC), The Call Setup Success Rate (CSSR) is calculated by taking the number of the unblocked call attempts divided by the total number of call attempts as expressed in equation 1 below [5].

$$CSSR(\%) = \frac{\text{Number of Unblocked Call Attempts}}{\text{Total Number of Call Attempts}} \times 100 \quad (1)$$

Dropped Call Rate (DCR)

A dropped call is a call that is prematurely terminated before being released normally by either the caller or called party (i.e., the call is dropped before the exchange of Released Message "RL_M" and Released Complete Message "RLC_M" in the signaling flow) [9]. Tarkaa, N. S and Pahalsan, C. A. D [7] also defined DCR as the rate of calls which end due to technical reasons. Field studies have revealed that a lot of calls are dropped due to irregular user behavior and abnormal network responses which tend to increase as network expands. The increase in the call drop rates is a serious concern to every network user and researchers in the academic profession. It has delayed businesses, disrupted security management such as military operations, increased the complexity of research activities for the academia, etc. The Dropped Call Rate (DCR) also called Call Drop Rate is the number of dropped calls divided by the total number of call attempts [5].

$$DCR(\%) = \frac{\text{No. of Prematurely Terminated Calls}}{\text{Total Number of Call Attempts}} \times 100 \quad (2)$$

2. RELATED WORKS

V.E.Idigo et al [10] used descriptive statistics to analyse three QoS parameters (Traffic Channel congestion ratio, Call Drop Ratio, and call setup success ratio) of Visafone mobile network on hourly and daily basis. They observed that busy hour TCH Congestion Ratio was 0.0062 which is lower than the NCC stipulated value of $\leq 2\%$. Also the busy hour CDR was 0.7129 and again below the NCC threshold of $\leq 2\%$. Finally the Busy hour CSSR was 98.7267 which is within the expected threshold set by NCC. The satisfaction of Nigerian by the major Mobile Network Operators (MNOs) is still a far cry. This is validated by the study carried out in [11] to analyse the QoS provided by the MNOs in Akure. They obtained their data through drive test and survey questionnaire techniques. The study revealed that in Akure, MTN has the best QoS among other three operators. Notwithstanding, the four MNOs are still far from providing reliable services in Akure. Their

findings are in good terms with the findings of the study in [12], which reported that QoS of GSM system in the Nigeria is unreliable with unsatisfactory GSM network accessibility and retainability.

Lawal et al [13] distinguished two major techniques used for assessing the performance of GSM services: the first is QoS used by service providers and the second is quality of end-user Experience (QoE) determined by reactions from end users. Their work is titled “Quality of Service and Performance Analysis of a GSM Network in Eagle Square, Abuja and Its Environs, Nigeria”. It was carried out at the said place before, during and after PDP presidential primary election from January 10th to 15th, 2011 to assess the GSM QoS provided by only MTN. From the data collected through Network Statistic method, they observed that the worst deviations of the KPIs from the NCC recommended values were worst during the event period. They recommended that antennas with wider coverage area should be deployed so as to boost the overlapping area between the cells. The NCC should continuously retrieve network statistics data for towns, cities and states from operators and carry out network drive test to ensure compliance with their recommended standards.

Beside real time measurements to evaluate QoS of mobile networks, Erunkulu O. O et al [15] proposed an Artificial Neural Network (ANN) model to predict call drop during an initiated call. The data used in the study were acquired using TEMS Investigations software. The measurements were carried out over a period of three months. Post analysis and training of the parameters was done using the Artificial Neural Network to have an output of “0” for no-drop calls and “1” for drop calls. The developed model has an accuracy of 87.5% prediction of drop call. The study clarified that Call dropping was not caused by poor signal strength or failed handover alone, but other network parameters such as Received Signal Level (RxLev), Received Quality (RxQual), Frame Error Rate (FER), Bit Error Rate (BER) can make calls to drop. The developed model is both useful to operators and end users for optimizing the network.

3. METHODOLOGY

To keep track of the contracted QoS, the QoS parameters must be censored, recorded and resources reallocated in response to system

irregularities. The quality of a service can be a differentiator in the business market. Its parameters and measures are necessary to provide an indication of how well a service or product is, and therefore, be an important point when selecting services offered by different vendors (or service providers) [16].

The Quality of Service (QoS) of Nigeria's GSM mobile networks i.e. Airtel, 9mobile (formerly Etisalat), Globacom and MTN, on a nationwide and state-by-state basis were recorded based on the following KPIs: i. Call Setup Success Rate (CSSR). ii. Percentage Call Drop (PDR) or Call Drop Rate (CDR). iii. Dedicated Control Channel (SDCCH). iv. Traffic Control Channels (TCCH) [5]. However, for the purpose of this analysis, only the first two (CSSR and CDR) were considered in this study. We used the CSSR and CDR provided by the MNO's to NCC to rate the performance of their services in River State of Nigeria for a period of one year (November 2018 to October 2019) and finally evaluated the reliability of the network services offered to the public.

Table 1: Call Setup Success Rate (%)

Months	Networks			
	Airtel	9mobile	Globacom	MTN
Nov	99.69	99.65	99.8	99.7
Dec	99.64	99.67	99.76	99.66
Jan	99.64	99.68	99.8	99.7
Feb	99.59	99.66	99.8	99.68
Mar	99.64	99.6	99.74	99.71
Apr	99.67	99.58	99.81	99.7
May	99.54	99.56	99.76	99.64
Jun	99.62	99.58	99.81	99.67
Jul	99.52	99.57	99.82	99.65
Aug	99.58	99.47	99.81	99.67
Sep	99.61	99.58	99.83	99.61
Oct	99.65	99.58	99.73	99.65

Table 2: Network Call Drop Rate (%)

Months	Network			
	Airtel	9mobile	Globacom	MTN
Nov	0.35	0.38	0.36	0.11
Dec	0.37	0.36	0.33	0.1
Jan	0.26	0.37	0.3	0.1
Feb	0.25	0.4	0.31	0.11
Mar	0.37	0.45	0.33	0.1
Apr	0.26	0.46	0.29	0.11
May	0.28	0.5	0.31	0.13
Jun	0.28	0.48	0.3	0.13
Jul	0.28	0.47	0.29	0.17
Aug	0.29	0.48	0.27	0.11
Sep	0.24	0.46	0.26	0.14
Oct	0.27	0.4	0.31	0.13

Table 3: Standard Deviation of CSSR and CDR

Network	CSSR		CDR	
	Avg	Stdev	Avg	Stdev
Airtel	99.62	0.051	0.29	0.046
9mobile	99.6	0.059	0.43	0.049
Globacom	99.79	0.033	0.31	0.027
MTN	99.67	0.03	0.12	0.021

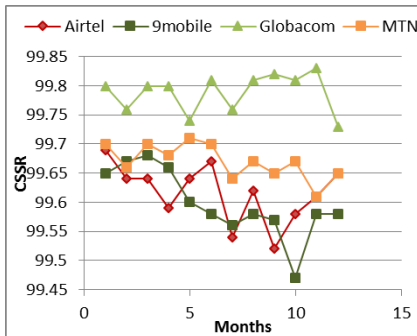


Fig 1: Monthly Variation of CSSR

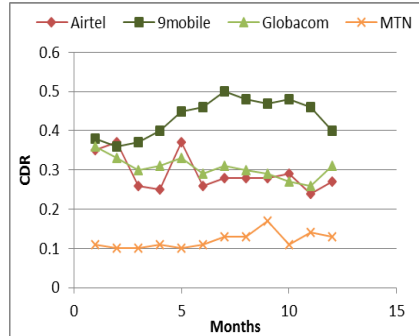


Fig 2: Monthly Variation of CDR

4. RESULTS

The performances of the networks were evaluated based on CSSR and CDR. Furthermore, we determined the reliability of each network based on the STDEV of CSSR and CDR. The data analysis shows that globacom has the highest CSSR of 99.83% in September 2019. On the average, globacom still have the highest CSSR with an average value of 99.79%, having 1.79% above the threshold value of 98% set by NCC. However, 9mobile performed worst in the month of August, having CSSR of 99.47%, and 99.58% on the average. Reliability of the services offered by the service providers is one of the KPIs of the QoE. Table 3 shows that MTN has the lowest standard deviation which indicates that the CSSR of the network in each month is closely clustered around the average value which is an indication of high reliability of the network to end-users on a yearly assessment. Conversely, 9mobile has the highest standard deviation indicating a lower reliability compared to others.

The monthly CDR of the MNOs in Rivers state is presented in table 2; the data shows that the networks had their CDR below the performance threshold of 1% as expected within the time in question.

However, MTN had the lowest CDR of 0.1% in December, January and March and overall average of 0.12% which is well below the performance threshold of 1% set by NCC. This indicates that on the average, MTN network performed better than other network based on CDR evaluation with Airtel (0.29%) coming second, Globacom(0.31) taking third position and 9mobile(0.43) taking the last position. On the QoE, MTN had a STDEV of 0.021 which is a good indicator of MTN being more reliable on a yearly assessment, followed by Globacom with 0.027, Airtel with 0.046 and 9mobile with 0.049.

5. CONCLUSION

Mobile network services offered by MTN, Airtel, Globacom and 9mobile in Rivers State perform within the performance threshold set by NCC. However, globacom network is the best network in Rivers state as from November 2018 to October 2019 as shown by our analysis based on the highest average CSSR of 99.79% followed by MTN (99.67%). However, MTN appears to be more reliable because its STDEV is the lowest (0.03) indicating a very low monthly variation. On CDR MTN has the lowest average call drop rate of (0.12) with the lowest STDEV value of (0.021) followed by Airtel with DRC of 0.29% and STDEV of 0.046 but Airtel shows less reliability than Globacom with CDR of 0.31% and STDEV of 0.027. On the average, mobile network services in Rivers performs above the threshold and are reliable based on the data as at the said time. However some performs better than the others based on our analysis. We recommend that 9mobile should increase their capacity in the state.

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