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Evaluation of QoS in Mobile Communication Networks

Osahenvemwen, O.A.[1] and Ikheba, O.S.[2]

[1]Electrical and Electronic Department, Faculty of Engineering and Technology, Ambrose Alli University, Ekpoma, Edo State Nigeria

[2]Electrical and Electronic Department, National Institute of Construction, Uromi, Edo State Nigeria

[1]Osahenvemwenaustin@ymail.com, [2]steveikheba@gmail.com

***Abstract*– The unprecedented growth in the number of subscribers has led to over stress of limited mobile communication capacity resulted to low quality of service. This study presents the evaluation of QoS in mobile communication network; aim to determine the parameters that affect quality of service and possible solution. Mobile communication network under investigation is called Network D located in Esan west LGA, Ekpoma, was considered in this research work. Data were obtained from Operational and Maintenances Centre (OMC) such parameters were calls drop, block calls, network congestion, sound quality and low signal from network D for period of one year. It is observed that has the number of attempt calls increases also the number of blocks calls increases in a proportional rate. Also, the clear technically differences between block calls and drop calls were highlighted in the mobile communication network and the causes of drop calls with relative percentage were outline. In addition, the signal strength transmitted from the BTS under investigation does not exhibit a linear characteristic. It is observed that block calls increases during the busy hour based on high number of subscribers using the limited capacity of the mobile communication network.**

***Index Terms*– Drop Calls, Quality of Service, Signal Strength and Traffic Congestion**

I. INTRODUCTION

THE twinkling service render by mobile communication network operators has called for researchers to consider the evaluation of Quality of Service (QoS) in mobile communication network has become important based on quality of service demand by the subscribers. Often time, the mobile network has witnessed low quality of service range from drop calls, block calls, network traffic congestion, sound quality and low signal. Therefore, it is imperative to critical considered these areas that affect mobile communication networks. Therefore other factors militating against good quality of service are basically from the government point of view which consists on lack of inadequate infrastructures, huge tax on the industries and the collected tax money not properly utilize to encourage growing industries.

Quality of service (QoS) is the overall performance of a mobile communication network, particularly the performance seen by the users of the mobile network. Quality of service is particularly important for the transport of traffic calls with special requirements and networks for audio (sound) conversations, as well as supporting new applications with even new service demands. (https://en.wikipedia.org/wiki/Quality_of_service).

The Quality of service QoS in mobile communication network is also measured from the perspective of an expert (e.g., teletraffic Engineer). This involves assessing the network to see if it delivers the quality that the network planner has been required to target. Certain tools and methods (protocol analyzers, drive tests and Operation and Maintenance measurements), are used for this QoS measurement. Finally, customer complaints are a vital source of feedback on the QoS, and must not be ignored (https://en.wikipedia.org/wiki/Mobile_QoS).

The quality of service can also be affect by the growing population and government policy on the mobile industries. The mobile communication infrastructures such as bandwidth have been stress by the growing population. Recent report from NCC stated that the total numbers of mobile subscribers are in Nigeria is 147,000,000. The increasing numbers of subscribers against the limited mobile capacity infrastructures as lead to low quality of service experienced by the subscribers. Also, an average subscriber has resulted to possess two or more SIM's for the purpose of redundancy, in view to achieve good quality of service from the mobile communication networks in Nigeria. Subscribers make several calls attempt before their calls call go through the mobile network to the calling party. In addition, other aspect of interest are quality of service are traffic control and effect of traffic calls congest by osahenvemwen et al., 2012, Ostentatious calls (beep calls) effects lead to over usage of signaling channel protocol by osahenvemwen et al., 2012. Also, the Quality of service parameters is considered.

A) QoS Parameters

The following are the parameters or metrics and their definitions for measuring quality of service (QoS).

Call Completion Rate

The ratio of successfully completed calls to the total number of attempt calls in the network. That is, the ratio of the number of completed call attempts to the total number of call attempts. At given point of time in the network. This ratio is typically expressed as either a percentage or a decimal fraction. It is the number of calls of specific duration of successfully completed; measured per 100 calls.

Answer seizure ratio (ASR)

The ratio of the number of successful calls over the total number of outgoing calls from a carrier network (i.e., on a route or a destination point code (DPC)) BASIS, and during a specified time interval, the ratio of the number of seizures that result in an answer signal to the total number of seizures: (ITU-T E600/2.14). ASR in line seizures that are answered by person or device divided by total number of seizures. While seizure is achieved after successful "call setup" It means seizing a truck circuit for conversation or other network services. In GSM network, it refers to seizing traffic Channel (TCH) after a successful "call setup". A successful call is a call that is answered by a called party or machine (e.g., fax machine, answering machine etc).

Call setup success rate (CSSR)

Number of the unblocked call attempts divided by the total number of call attempts.
or (1- blocking probability) x 100%.
A call setup is an exchange of signaling information in the call process that leads to traffic channel (TCH) seizure.

Call Drop Rate

The call drop rate is the number of dropped calls divided by the total number of call attempts or (1- call completion ratio) x 100%. A call drop 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 massage "RL_M" and released complete message "RLC-M" in the signaling flow).

B) Post Dialing Delay Parameters

In GSM network is the average time between pressing send button (after pressing correct digits) and getting a ring back tone. This is also called "call setup time" or time to connect a call.

- Handover success rate
  This is the ratio of the number of successfully completed handovers to the total number of initiated handovers. This ratio can be expresses as a percentage.
- Bit Error Rate (BER) per link
  The link Bit Error Rate (BER) Refers to the average bit error rate on the MSC-PSTN link, inter MSC link, A-interface and Abis-interface. This parameter should not deteriorate above 10^{-9}.
- The end –to-end bit error rate
  This refers to the average end to end bit error rate. This parameter should not deteriorate above 10^{-6}.
- Busy hour traffic channel congestion (%).
  This is the percentage congestion of the TCH measured at the busy hour and is given by:

$$\frac{Busy\ Hour\ TCH\ Traffic(Erlang) - Average\ Tch\ Traffic\ (Erlang)}{Busy\ Hour\ TCH\ Traffic\ \ (Erlang)}\ x\ \% \quad (1)$$

- Percentage of failure for Credit Balance inquiry
  This is the ratio of the number of failure of credit balance inquiry to the total number of credit balance inquiry expressed as a percentage at some instant on the network. This parameter is for a prepaid subscriber.

$$\frac{Number\ of\ failures\ for\ credit\ balance\ inquiry}{Total\ number\ of\ credit\ balance\ enquiry}\ x\ \% \quad (2)$$

- Minimum Data Rate
  This is the minimum TCH encoding rate for data (Half-rate channel.4.8kbps: GSM specification 06.20)
- Minimum Speech Rate

This is the minimum TCH encoding rate for speech (half –rate channel, 6.5kbps; GSM specification 06.20)

- Percentage of SMS-MMS Delivery Failures

This is the ratio of SMS/MMS to the recipients undelivered to the total number of SMS/MMS received at the service centre within specified period of 10 days.

$$\frac{Number\ of \frac{SMS}{MMS}\ to\ recipients\ undelivered}{Total\ Number\ of \frac{SMS}{MMS} received\ at\ Service\ center}\ x\ \% \quad (3)$$

Percentage of SMS/ MMS Incorrect feedback
This is the ratio of the number of SMS/MMS transmitted in which the sender received wrong feedback to the total number of SMS/MMS received at the service centre at same instant on the network.

$$\frac{Number\ of \frac{SMS}{MMS}\ in\ which\ \ the\ senders\ received\ \ wrong\ feedback}{Total\ \ Number\ of\ \frac{SMS}{MMS} received\ \ at\ \ Service\ centre} \quad (4)$$

- Percentage of SMS/MMS multiple Billing

This is the ratio of the number of SMS/ MMS messages in which more than one charges are applied per massage to the total number of SMS/MMS received at the service centre at some instant on the network.

$$\frac{Number\ of \frac{SMS}{MMS} in\ which\ more\ than\ one\ charges\ are\ applied}{Total\ \ Number\ of \frac{SMS}{MMS} received\ at\ Service\ Center}\ x\% \quad (5)$$

- Number of customer's satisfaction index

This is the percentage of the number of customers satisfied with the services of an operator on randomly distributed samples of customers.

C) Speed of Problem Resolution Parameters

- Percentage cleared the same day

This is the percentage of the number of problems resolved on the day they were received.

$$\frac{Number\ resolved\ problems\ \ in\ day\ one}{Total\ \ number\ of\ problems\ received\ on\ that\ day}\ x\ \% \qquad (6)$$

- Percentage in two days

This is the percentage of the number of problems resolved within the second within the day they were received.

$$\frac{Number\ resolved\ problems\ \ in\ day\ one\ and\ \ two}{Total\ \ number\ of\ problems\ received\ on\ day\ one}\ x\ \% \qquad (7)$$

- Percentage cleared in three days and above

This is the percentage of the number of problems resolved within three days and above to the day were received.

$$\frac{Number\ resolved\ problems\ in\ day\ 1,2,3\ and\ above}{Total\ \ number\ of\ problems}\ x\% \qquad (8)$$

D) Billing Integrity Parameters

- Percentage of total bill overcharged

This parameter is the percentage of the number of post paid accounts that are overcharged within a particular month.

- Percentage of incorrect credit balance

This parameter is the percentage of number of pre-paid accounts that suffer incorrect credit balance within a particular month

- Percentage of Failures for Credit Balance Inquiry (CBI)

This is the ratio of the number of failures credit balance inquiry to the total number of credit balance inquiry expressed as a percentage at some instant on the network. This parameter is for prepaid subscribers.

E) Customer Care Accessibility Parameters

- Number of interface points

This is an office where a customer can go to lodge complaints. This is in addition to customer care centers

- Minutes a customer spends on the queen

This is the average time in minutes a customer is expected to spend on customer interface point queue before being attended to by a staff.

F) Recharge Cards Parameters

- Percentage of Recharge Cards Loading Errors

This is the ratio of the number of times recharge card loading failed to the total number of loading attempts at some instant on the network expressed as a percentage.

$$\frac{Number\ resolved\ problems\ in\ day\ one}{Total\ \ number\ of\ problems\ received\ on\ that\ \ day}\ x\ \% \qquad (9)$$

- Percentage of recharge cards loading incorrect feedback

This is the ratio of the number of times an incorrect feedback is received during calling card/ voucher loading to the total number of loading attempts expressed as a percentage.

$$\frac{Number\ \ of\ \ incorrect\ feedback\ received\ during}{Total\ Number\ of\ loading}\ x\ \% \qquad (10)$$

Source [http://ncc.gov.ng/index]

The quality of service parameters is highlighted to determine the performance of mobile communication network (http://ncc.gov.ng/index).

II. METHODOLOGY

This research is on evaluation of QoS in mobile communication network at Esan west Local Government Areas (L.G.A) located in Edo State, Nigeria with the headquarters in Ekpoma and with coordinates of 6°45′N 6°08′E. The Esan west cover the area of 502 km² and a population of 125,842 at the 2006 census. Data such as calls drop, block calls, network congestion, sound quality and low signal were obtained from Operational Maintenance Centre (OMC) in that particular geographical location. This data covered a period of one year from the network D, mobile communication network.

A) Data Analysis, Result and Discussion

The data obtained from OMC mobile communication network D is analysis and presented in Fig. 1 to Fig. 5.

In Fig. 1 shows the various BTS, cell ID number and the respective major types of call in mobile communication networks. These set of calls are used to determine the capacity dimension and quality of service render by the mobile operator in mobile system. The attempt calls, is use to know the total number of subscribers using the mobile transmission channels at particular period. Any increase in the number of attempt calls, the mobile operator should make plan for increase in capacity especially when the number of successful calls are in variance with the attempt calls. Based on Fig. 1 the successful calls are in proportional to attempt calls with small fraction resulting to block calls in the mobile communication system. It is observed that has the number of attempt calls increases the number blocks calls increases in proportional rate.

The issue of block calls cannot be total be eradicated or eliminated from the mobile system, because the mobile operator cannot make available large bandwidth or transmission channels that accommodate all the subscribers in the mobile network. Also, the can economical waste, example building hospital having hospital bed number with same number in the town, knowing that all the people cannot be sick at same time. Moreover all the subscribers cannot be making calls at the same time and the subscribers usage can be characterize as stochastic distribution. Recall, that NCC gave a benchmark of block calls as ratio 2:10. Often time, mobile network operator operates above this benchmark leading to low quality of service. The block calls experienced in Nigeria mobile communication when subscribers are been denied access to make calls, will receiving caller tone of the number you dialer is switch OFF, the number you dial is not available while the caller phone are ON.

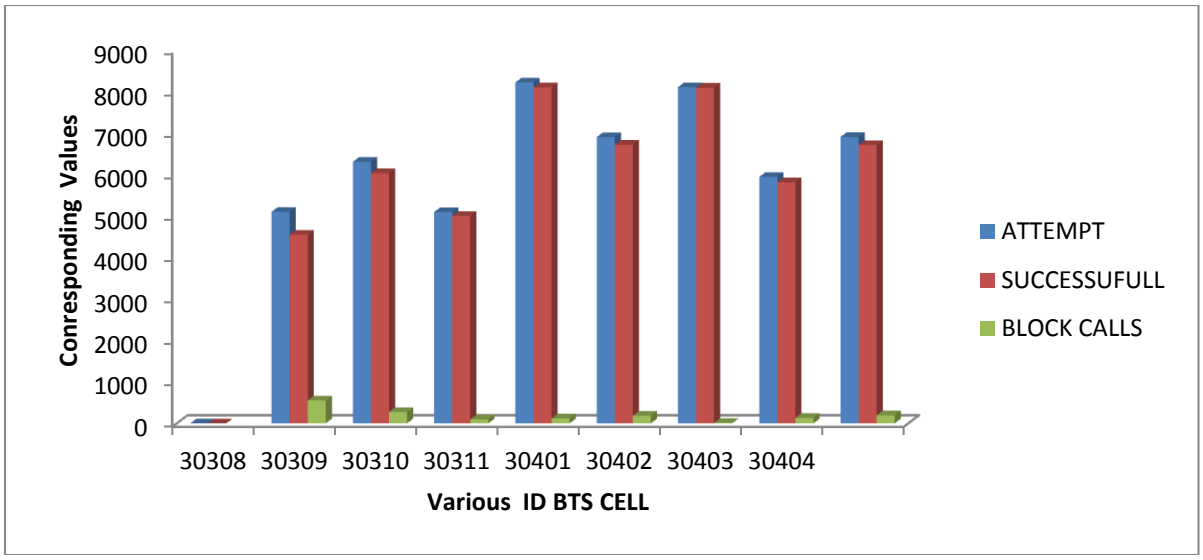

Fig. 1: The various BTS cell ID number with various calls

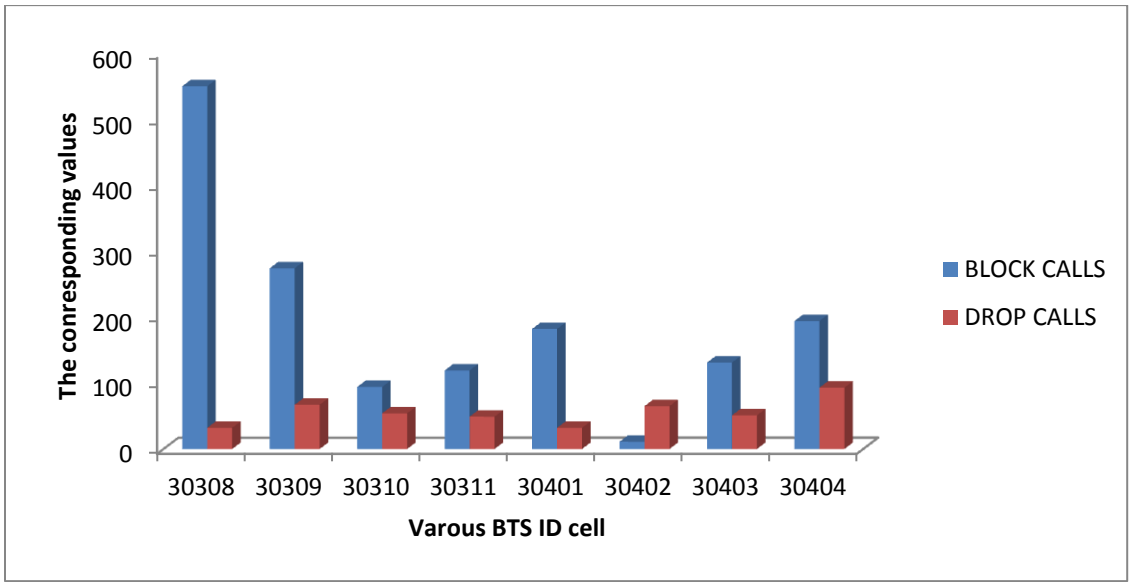

Fig. 2: presentation of Block and Drop calls with the corresponding BTS

Table 1: causes of drop calls in Network D mobile communication network

Drops call causes	Occurrence %
Low Electromagnetic signal strength	21.6
Handover failure process	5.0
Lack of credit (air time)	19.8
Power outage from battery	8.4
Forceful termination of calls due to noise distortion	45.2

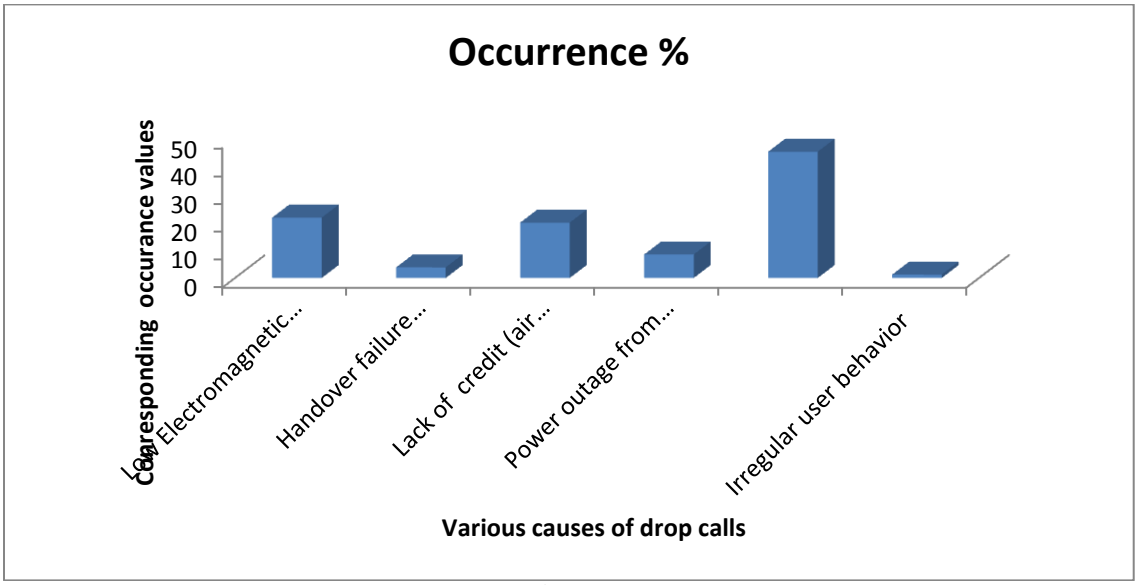

Fig. 3: various causes of drop calls in mobile network

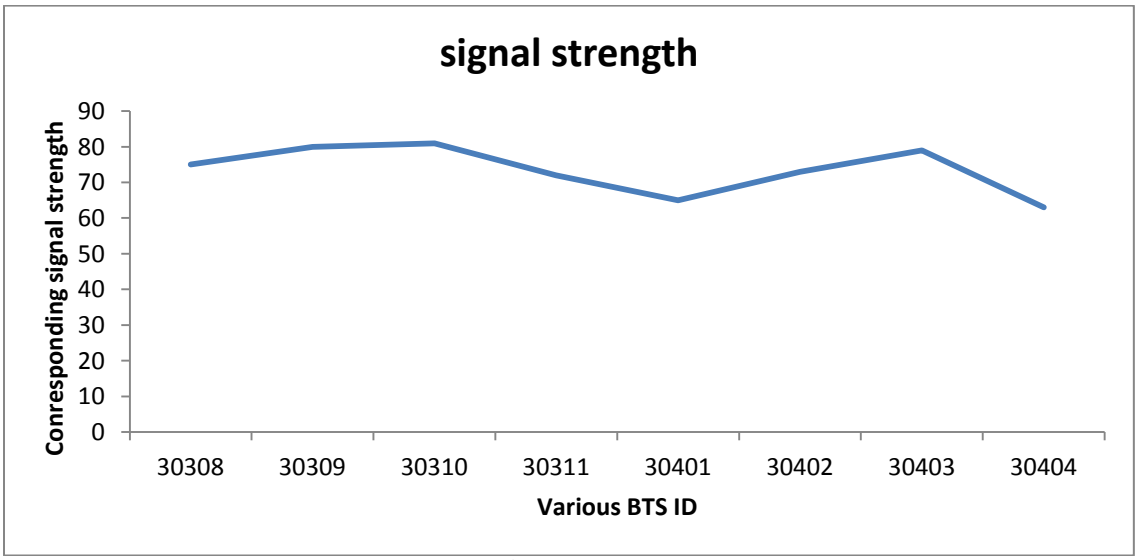

Fig. 4: The signal level from various BTS under investigation

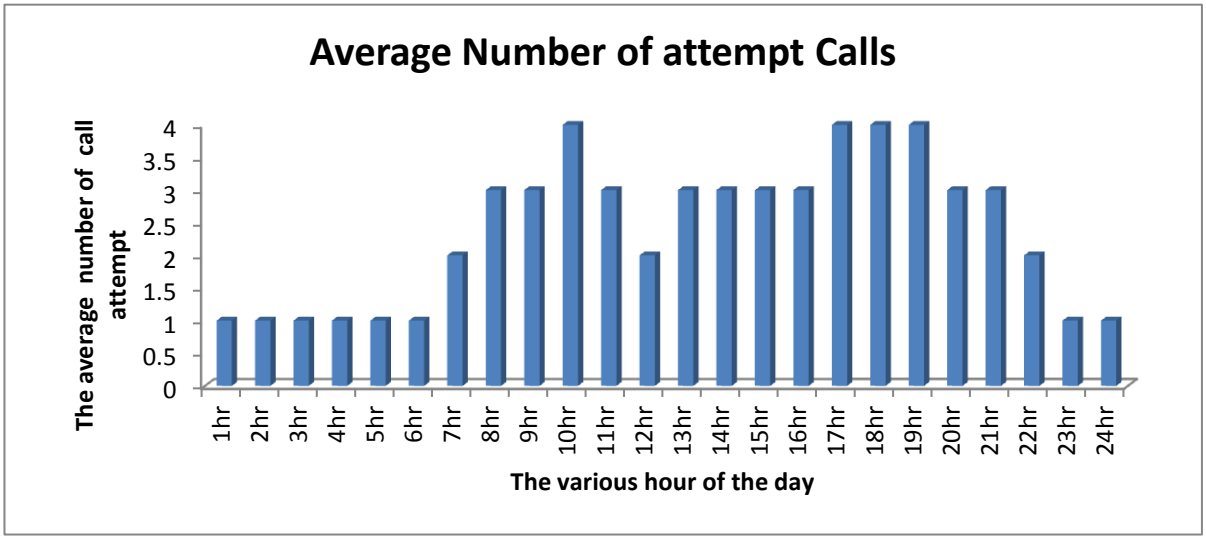

Fig. 5: the average number of attempt calls against the respective hours

In Fig. 2, present the block and drop calls with the corresponding BTS in area under investigation, technically there are differences between block calls and drop calls in mobile communication network. Block calls resulted from lack or limitation of transmission capacity, this are calls that was denied access through the mobile communication system due to traffic congestion at that particular time. Block calls are deduce from the number of successful call from the attempt calls (offer calls), while drop calls, are calls that was original granted access to use the transmission channels, but due to technical reason such as low electromagnetic signal strength, handover failure process, Lack of credit (air time) during conversation, power outage from battery, forceful termination of calls due to noise distortion and irregular user behavior truncate the calls or conversation in progress on the transmission channels. The influencing factors of drop calls were investigated. It was observed that the high number of drop call resulted from forceful termination of calls due to noise distortion or low sound quality with 45.2 percent followed by low Electromagnetic signal strength 18.9 percent. The drop calls in mobile communication network has led to low quality of service, forcing the subscribers to re-establish their calls. In addition, lead to economical waste in mobile communication sector by over using signaling channels in calls setup process. The various drop calls influencing factor are presented with the respective percentages in Table 1 and Fig. 3. It is observed from Fig. 3, that the low Electromagnetic signal strength is the second major causes of drop calls in mobile communication network, therefore the issue of Electromagnetic signal strength as become issue of agent important. The average signal strength obtained from the 10 BTS is presented in Fig. 4. It is observed that there are dead zone and inconstant signal from the BTS's considered within the mobile communication network under investigation, also reliable microwave device should be used to avoid low signal strength. The mobile communication signal protocol process should be upgraded to avoid loss of signal in the mobile network.

Questionnaires were deployed to determine the number of calls attempt made by individual subscribers in mobile communication network and the number of SIMs used by individual subscribers in Nigeria telecommunication**.** It was observed in Fig 5 that during the busy hours, there is more traffic congestion in mobile network; due to this traffic scenario mobile subscribers are subjected to make several calls attempt before their calls can go through the mobile communication network. In addition, individual subscribers in Nigeria possess more than one SIM, in view to achieve quality of service from Nigeria mobile communication sector.

The government should encourage the mobile communication sector with good government policy; provide basic infrastructures such security, good road and stable power supply. Imagine the number of BTS mast own by mobile network operator and the financial implication to deployed security personnel and run all these BTS with generator set. All these draw back can be minimum by good government policy and the over effect on the economical viability. The issue on limited capacity and the relative quality of service has become a bottle neck as the number of subscribers increases in mobile communication networks. Therefore, there must be a balance between available capacity, number of subscribers and quality of service. In addition, technically quality of service such as sound quality, should be improve on, to reduced the number of drop calls presence in mobile communication networks in Nigeria.

III. CONCLUSION

The study is aim to evaluation Quality of Service (QoS) of mobile communication network called "Network D" at Esan West L.G.A, located at Edo State, Nigeria with the headquarters at Ekpoma and with coordinates of 6°45′N 6°08′E, cover the area of 502 km². The network D is considered under this investigation based on quality of service and relative parameters such as the traffic load, congestion, successful calls, attempts calls, traffic congestion and causes of drop calls in mobile communication network were analyzed. Data were obtained for period of one year from Operational and Maintenances Centre (OMC) form network D for analysis. It is observed that has the number of attempt calls increases, the number of blocks calls also increase in proportional rate. Also, clear technically differences between block calls and drop calls was highlighted and Fig 3, shown the causes of drop calls with relative percentage. In addition, the signal strength transmitted from the BTS under investigation does not exhibit a linear characteristic. It is observed that block calls increase during the busy hour due to high traffic situation in mobile communication networks.

REFERENCES

[1]. Osahenvemwen, O.A., Edeko, F.O. and Emagbetere, J. (2012) .The Effects of Ostentatious calls in GSM Networks, International Journal of Computer Applications, (0975 – 888), Vol. 48, No. 9.

[2]. Osahenvemwen, O.A., Edeko, F.O. and Emagbetere, J. ,(2012), Traffic Modeling in Mobile Communication Networks, International Journal of Computer Applications, (0975 – 8887), Vol. 51, No. 9, page. 17-24.

[3]. Osahenvemwen, O.A. and Emagbetere J. ,(2012),Traffic Analysis in Mobile Communication in Nigeria Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS), Vol. 3, No. 2, p. 239-143.

[4]. Osahenvemwen, O.A. and Emagbetere, J. ,(2012), Determination of traffic Load and traffic Performance Parameters in mobile communication in Nigeria, Research Journal of Applied Sciences, Engineering and Technology, Vol. 4, No. 11, p. 1432-1437.

[5]. Mobile QoS, available online https://en.wikipedia.org/wiki/Mobile_QoS [accessed on 2oth September, 2015]

[6]. Quality of service, available online https://en.wikipedia.org/wiki/Quality_of_service [accessed on 23September, 2015]

[7]. Quality of service available online at http://ncc.gov.ng/index. [Accessed on 1st Nov, 2015]

[8]. Quality of Service in telecommunication network available online at http://www.eolss.net/Sample-Chapters/C05/E6-108-14-00.pdf [Accessed on 1st Nov, 2015]

[9]. Telecommunication Measuring Quality Of Service available online at https://www.atkearney.com/documents/10192/178350/telecommunication measuring_quality_of_service.pdf