# Analysis of Drop- Call Probability: A Study of Mobile Telecommunication Network (Apapa Lagos, Nigeria)

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***Abstract*: - Today a number of cellular network subscribers are grappling with the issue of frequent call drops. One of the important parameters as a determinant of quality of service (QoS) of a cellular network system is the drop call rate which defined as the rate of calls which end due to technical reasons and its probability as drop- call probability which we used to provide a measure of performance for failed calls in progress. The objective of the parameter is to provide the subscribers with an expectation of how successful a cellular network will be at retaining the signal throughout the whole duration of call. Both the band limited and interference limited systems have attracted an increase in the number of users that are not given access into the network due to insufficient channels and poor quality of radio channels. The results show that the operator is performing well with regard to drop- call probability as one of the key performance indicator (KPI) therefore, ways to increase not just performance of the indicator but the performance of whole network are suggested. Drop call has been the subject of several network performance studies and a major contributor to service optimization in a well-established cellular network.**

***Keywords:*** **Drop call rate, Quality of service (QoS), cellular network, KPI, traffic and drop call probability**

## I. INTRODUCTION

Today a number of mobile subscribers are grappling with the issue of frequent call disconnections or 'call drop. The dropped-call rate (DCR) can be defined as rate of calls which end due to technical reasons. The probability of such an event is known as drop- call probability (Osunkwor *et al.,* 2003). The dropped-call rate is normally extremely low, such as lesser than 0.01%. However, in mobile communication systems the dropped-call rate is higher which is in between 0.1% and a few percent (Verma *et al*, 2012). There are many reasons that may contribute to the drop calls in mobile network. Among these reasons are physical problems such as lack of radio coverage, radio interference between different subscribers, imperfections in the functioning of the network, overload of the different elements of the network. Service quality will have direct influence on the customer experience and satisfaction with the service provided by the network operator. During network monitoring the quality of service of the network, the dropped call rate is usually included as a key performance indicator. The drop calls may also be influenced by congestion in the mobile network resulting increase in drop call rate ((Verma *et al*, 2012). Drop call probability has been the subject of several network performance studies and a major contributor to service optimization in established cellular (Ekpenyong and Isabona, 2014).

The rural subscribers primarily face call drops because of lack of coverage, while in urban areas; this can be due to the increasing gap between the growth in subscriber base and lack of commensurate growth in investment in augmenting the network infrastructure, including setting up of additional base transceiver station (BTS) and establishing in-building coverage (Adegoke *et al*, 2008).

Transmission problems are also a common cause of dropped calls – resulting from a faulty transceiver (TRX) within the base station. At the receivers' end, calls may be dropped if a mobile phone loses battery power and abruptly stops transmitting. Sun spots and solar flares are rarely blamed for causing interference that leads to dropped calls (Ekpenyong and Isabona, 2014.). The increasing demand of cellular network services constitute another source of dropped calls, when the traffic demands exceed the available capacity (Rappaport, 2002). This capacity related issue has forced network operators to provide stringent QoS. Experiencing frequent dropped calls is one of the most common customer complaints received by wireless service providers. Increased failure to access and engage communications channels, increased dropped calls and general poor quality of service are some of the persistent problems encountered in cellular networks. The effect of these on the level of customer satisfaction and consequently on the generated revenue have necessitated the research into developing techniques for improving the performance of telecommunications networks. These providers have attempted to address the complaint in various ways, including expansion of the customers' network coverage, increased cell capacity, offering compensations to individual dropped calls, etc. Furthermore, studying call dropping behaviors as a function of other network parameters (e.g. traffic load, call duration, etc.) would aid the optimization of the system's performance and guarantee excellent quality of service delivery as well as improved revenue (Joseph *et al*, 2013). The drop call probability is one of the most important Quality of Service (QoS) index in a large scale well-established cellular network, used to monitor

the performance of cellular networks and is to provide a measure performance of fails call in progress.

Dropping calls causes serious challenges to the Nigerian telecommunications system. The number of cellular communication subscribers in Nigeria has continued to grow since its launch in the country in 2001. The number of subscriber grew from 1.57 million in 2002 to 18.56 million in 2005, then to 81.08 million in 2010 (Africa and Middle East Telecom week, 2014). According to the Nigerian Communications Commission (NCC), the current number of active cellular subscribers in Nigeria is 132 million (NCC, 2014). However, the service qualities provided by the cellular operators in Nigeria have remained bad. Basically, every subscriber to the country's cellular networks is affected. Research by (Popoola *et al*, 2009) on the quality of cellular KPIs in Nigeria confirmed that the call drop rate is among the worst performing metric in the country. In most networks, call dropping is viewed as a last resort.

*Quality of Service* (GoS)

The term QoS refers to the capability of a network to provide better service for selected network traffic over various technologies. The primary goal of QoS is to provide priority, including dedicated bandwidth, controlled jitter and latency (required by some real-time and interactive traffic), and improved loss characteristics

*Dropped-Call Probability*

One of the latest drop-call probability models was based on the call dropping phenomenon given by (Boggia *et al*, 2007).

$$P(Y=n)=\frac{(V_d t)^n}{n!}e^{-V_d t} \quad n\geq 0 \qquad (1)$$

Here,$V_d$ = the drop-call rate, t = call duration, and n is the number of confirmed calls dropped. This is a poison probability function with a discrete variable which counts the number of dropped calls (Dajab, *et al*., 2009). The number of dropped call is obtained from the relation

$$\text{Drop call rate}\,(\%)=\frac{\text{no of dropped calls}}{\text{No of call attempts}} \qquad (2)$$

The probability of occurrence of the call dropping event based on the above formula is calculated using Poisson mass probability function (Sanabani, 2007).

*(i) Call Arrival Rate*

Call arrival rate $\lambda_t$, refers to the traffic offered expressed as the number of call attempts per unit time which is given as( Dajab *et al*, 2009)

$$\lambda_t=\frac{Number\ \text{of call attempts/busy hour}}{14400s} \qquad (3)$$

To relate call arrival rate to number performance of a network, the term of grade of service is donated by $P_B$ is used and it is defined in as (Cragin, 2006)

$$P_B=\frac{\text{Traffic lost}}{Traffic\ \text{offered}} \qquad (4)$$

*(ii) Call Duration*

Call duration is another parameter that can affect the quality of service in a cellular network, hence it is considered when planning the network (Mishra, 2004). Call duration or mean call holding time is defined as the time a mobile station takes to complete a call connection. Mathematically, call duration is given by (Lee,1995)

$$h=\frac{A}{\lambda}$$

Where; $A$ = traffic intensity in Erlang, $\lambda$ = call arrival rate

*(iii) Utilization Factor*

Utilization factor is the traffic load in the cellular network traffic load signifies the strength of the offered traffic in the network (A). By definition, the traffic load is the ratio between the arrival rate of calls and the service rate of the calls arriving. Utilization factor gives the product of total traffic offered and the mean service time.

Utilization factor Traffic Load=

Average Traffic Intensity (A) x Mean Holding time (H) (5)

## II. RESEARCH METHODOLOGY

Table 1 provides its raw data and contains the following information: route names, call attempts base in BHT, successful call base in BHT and call durations in seconds. Table 2 thus, show the evaluation of drop call rates, call arrival rate and drop call probability. Traffic measurement is characterized by two major variation components (Moltchanov, 2005) and (Madhumita *et al.*, 2011), are number of calls variation and services times variation. To achieve and maintain a given GoS, the operator must ensure that sufficient network resources are available to meet subscribers demand and continuous optimization is done for effective utilization of the available resource (Jahangir *et al.*, 2000; Alexei B. *et al.*, 2009)

**Table 1:** KPIs data Obtained from OMC for the 10 Base Transceiver Stations for six months

| S/N | Base Station | Call attempt Based on (BHT) | Successful call Based On (BHT) | Call in duration (s) |
|---|---|---|---|---|
| 1 | BTS1 | 7800 | 7796 | 103 |
| 2 | BTS2 | 11104 | 10298 | 119 |
| 3 | BTS3 | 5016 | 4936 | 34 |
| 4 | BTS4 | 11871 | 11647 | 113 |
| 5 | BTS5 | 2830 | 2799 | 22 |
| 6 | BTS6 | 2124 | 2094 | 20 |
| 7 | BTS7 | 928 | 922 | 28 |
| 8 | BTS8 | 1123 | 998 | 103 |
| 9 | BTS9 | 195 | 193 | 15 |
| 10 | BTS10 | 370 | 362 | 114 |

**Table 2:** Evaluation of Drop- Call Rates, Call Arrival Rate and Drop- Call Probability

| Base Station | No. of Call Attempt (BHT) | Call in duration (s) | Number of Channels | Channel Utilization Factor | Drop call rate In BHT (%) | Call Arrival Rate (Call/s) | Drop call probability (%) |
|---|---|---|---|---|---|---|---|
| BTS1 | 7800 | 103 | 238 | 0.94 | 0.05 | 0.54 | $4.46x10^{-5}$ |
| BTS2 | 11104 | 119 | 400 | 0.85 | 7.83 | 0.77 | $1.44x10^{-5}$ |
| BTS3 | 5016 | 34 | 58 | 0.80 | 1.62 | 0.35 | $41.10x10^{-5}$ |
| BTS4 | 11871 | 113 | 400 | 0.91 | 1.92 | 0.82 | $1.77x10^{-5}$ |
| BTS5 | 2830 | 22 | 25 | 0.68 | 1.11 | 0.20 | $20.69x10^{-5}$ |
| BTS6 | 2124 | 20 | 19 | 0.62 | 0.96 | 0.15 | $11.57x10^{-5}$ |
| BTS7 | 928 | 28 | 13 | 0.55 | 0.65 | 0.06 | $1.38x10^{-5}$ |
| BTS8 | 1123 | 103 | 42 | 0.61 | 12.53 | 0.08 | $0.015x10^{-5}$ |
| BTS9 | 195 | 15 | 4 | 0.20 | 1.04 | 0.01 | $9.56x10^{-10}$ |
| BTS10 | 370 | 114 | 19 | 0.76 | 2.21 | 0.03 | $6.08x10^{-5}$ |

## V. RESULT

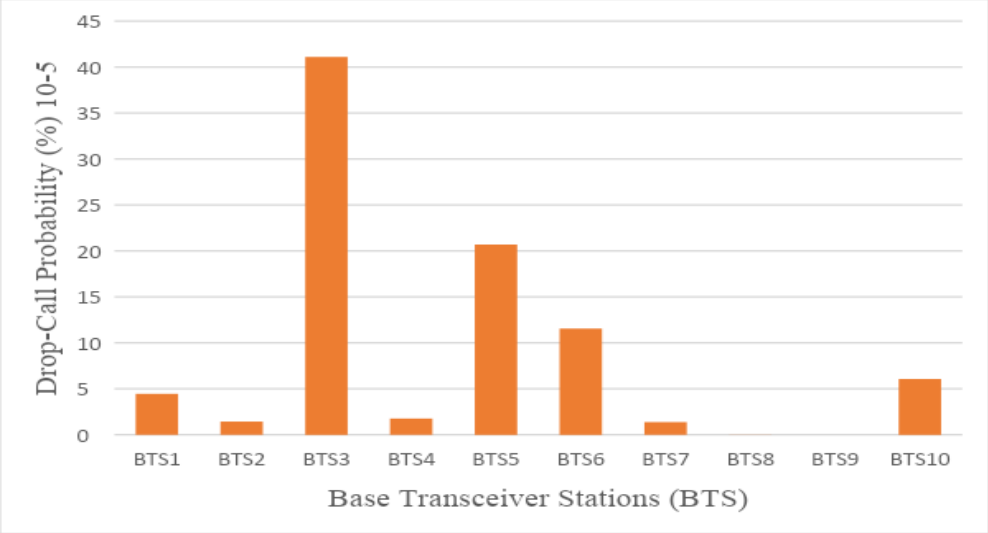


**Figure 1:** Comparison of Drop-Call Probability at Base Transceiver Stations

The drop-call probability is one of the most important parameter for assessing the quality of service (QoS) in a cellular network. Table 3 and Figure 1 confirms that MTN network in Apapa is performing satisfactorily. This is because the estimated values of drop-call probabilities were well below the benchmark at all the 10 base transceiver stations.

## VI. CONCLUSIONS

In any deployed cellular networks, the end users' satisfaction is always a major concern for the operators and regulator. The service quality of cellular network is adequate and reliable.

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