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Assessment of GSM Network Failures, Quality of Service Evaluation and Its Impacts on E-Learning

Caroline O. Ekejiuba[1], Adeola A. Adebayo[2], Oluwatosin S. Adeoye[3]
Department of Electrical/Electronic Engineering,
Federal Polytechnic, Ado-Ekiti

Abstract

This study provides information on GSM network failures and quality of its service evaluation and some of the challenges been faced by e-learning which includes infrastructural provisions in forms of electricity, broadband, computers and inter-connectivity. GSM network performance on the basis of massive data records and application is presented. The available measurements are divided into variable set describing the performance of the different GSM networks in Nigeria. The report also identifies the components of Quality of Service (QoS), locate bottlenecks in network performance and available mechanism to analyze and evaluate them. Statistical analysis and customer complaint were used to identify problems. Finally, the most common QoS shortfalls and possible solutions discussed.

Keywords: *GSM, Quality of Service, Performance, Interconnectivity.*

1. Introduction

The GSM revolution begun in Nigeria in August 2001, under the democratic government and it changed the face of information and communication technology in Nigeria, this heralded the dawn of a new era "the era of GSM technology" which has completely changed the face of doing business in Nigeria and this includes e-learning. The emergency and proliferation of new information and communication technologies (ICT), had introduced an unstoppable revolution into education particularly in the areas of teaching and learning. The internet and web have further raised the revolutionary tempo especially through the enhancement of e-learning. E-learning is one that encompasses a wide set of applications and processes, such as Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivering of content via internet, intranet/extranet (LAN/WAN), audio and video tape, satellite broadcast, interactive TV, and CD-ROM. E-learning according to [1], is the use of electronic technology to deliver education and training applications, monitor learners performance and reports learners progress. The actualization of e-learning depends on the quality of service provided by GSM network operators, hence the importance of this study.

[2] said information technology ICT can generate employment both directly and indirectly, thus reducing the number of unemployment in the nation. It also increases distant learning opportunities thus reducing the illiteracy level in the nation. However, [3] stated that improving the network coverage tends to diminish the network capacity, considering the fact that most valuable and limited resources of the GSM is the available frequency spectrum which limits the system capacity.

Global System for Mobile Communication (GSM) operation in Nigeria has many network failures and this is due to the competition among operators to acquire more subscribers. In Nigeria for instance, MTN provided network coverage to 88.8% of Nigeria land mass, while 86.2% of the population subscribe to the service [4]. Through different marketing strategies, more subscribers are being added to the different networks without considerations to the available infrastructures. Consequently, on the part of the subscribers, the euphoria of owing a phone and accessing the internet is gradually giving way to complaints associated with network failures which includes: drop calls, blocked calls, poor voice clarity, call jamming and network congestions. Some of the network failures are call dropping; congestion.

This paper describes how Quality of Service (QoS) evaluation mechanism and statistical data organization analysis are used to study the failures on GSM network and possible means to mitigate the problem are discussed.

2. History of GSM

Global System of Mobile communication (GSM) originally and formerly known as Global Special Mobile is the most popular standard for mobile telephony system in the world. According to the GSM association, over 93% of the global market uses the standard [5]. Over 4.3 billion people use GSM across more than 212 countries and territories [6].

Cellular telephone commonly known as a cell phone is one of the fastest and most demanding telecommunication applications. It is designed to give the user maximum freedom of movement so because of this freedom, the number of mobile user kept growing at an alarming rate. Cellular system came into existence firstly, in the united

state with the release of the advanced mobile phone service (AMPS) system in 1983.
[7] in a report to GSM association opined that the development of GSM has helped the analog inability to cover more grounds and helped brought modern telecommunication service to under-served communities in Africa, Asia and Latin America and the key to the success of GSM is that it's development was founded from the onset on delivering a specific user benefit i.e. international roaming [4].

2.1 Challenges in Network Service Delivery

The main challenge in network service delivery, is network failures which can be attributed to lack of modernized equipment, non upgrading of the existing network and boosting of its overall capacity for network quality delivering.

2.2 Failures in GSM Network

The following are the failures experienced by subscribers of GSM network: call dropped, call failure, blocked channel request, failed handover, poor voice clarity and call blocking.

2.3 Call Dropping/Dropped

Call dropped can be defined as a mobile phone's call terminated before the mobile subscriber in technical perspective ends it. It can also be described as terminated calls after voice traffic channel used. However, the service may be abnormally interrupted due to several reasons. The following are some of the reasons for call dropping: blank spot, co-channel and adjacent interface, Radio Frequency Loss and handover failure.

2.4 Call Failure

Call failure is the inability of a call to access the trunk usually due to full trunk occupancy. When the trunk has been fully occupied, then majority of the calls made to the GSM network will usually fail. The following can cause call failures on GSM network: Non-availability of trunk is the cause of deficiency in switch to cope with demands and inadequate number of trunks.
Call made in the odd hours of 2330 and 1430, the rate of call failures are outrageously high. These unusually high call failures rates during odd hours are the incidence of signal outages and the irregularity of traffic pattern are manifestation of several congestion attributed to either of the two: Poor network dimensioning or infrastructural inadequacies.

2.5 Block Channel Request

The number of blocked channel request (reject) measures the networks ability to satisfy the demand generated by the network users. Blocking occurs when there are too many users on the network.

2.6 Call Setup Failures

These are failures that occur during the setting of calls. Users request is not served due to problems on the resource allocation of a signaling channel in which the negotiation for the actual traffic is performed.

2.7 Handover Failures

This is the process of transferring outgoing or data session from one channel connected to the core network to another. Handover failures can be cause by the following: interference, hardware faults, location area code and limitation in coverage area.

2.8 Causes of GSM Networks' Congestion in Nigeria

2.8.1 Poor network dimensioning

Poor network dimension, poor traffic prediction can result into poor channel allocation. This naturally has the potential of causing network congestion and its attendant call failure/drop rate.

2.8.2 Infrastructural Inadequacies

Overloading of the base station due to increase in subscriber rate can lead to congestion in the network. The aftermath of this can also lead to breakdown of the existing infrastructure which includes the power supply system. Lack of constant power supply has the potential of resulting into congestion in the following ways. If a transceiver breaks down in a network, there is break in transmission resulting in higher rate of call failure.

2.8.3 Lack of Adequate Base Stations

It has been discovered from research that, the Nigerian network operators do not have adequate base stations to contain enough subscribers on each base station. Number of subscribers increases daily drastically due to a landslide reduction in the price of their network SIM card. It is doubtful if their base station has a matching increase. The present ratio is probably about 10,000 subscribers to one base station.

2.8.4 Lack of Adequate Channels

Since there is no enough base stations, automatically, there will be lack of adequate channel to support the subscribers and the service rolled out by these operators. The channels determine the total number of subscribers that can be allowed to use a base station simultaneously at any point in time. This trend remains the same because any time a base station is added to their network; a high-level of promotion will be rolled out in order to attract more customers.

2.8.5 Competition for Subscribers among Operators

The highest priority of the GSM operators in Nigeria is the total sum of money they will make from the subscriber base and not the overall quality of service. So, they have

catchy advertisements and often make false declarations to attract customers to their network whereas they do not have infrastructures to satisfy customers' demand.

2.8.6 Lack of End-to-End System

The GSM operators in Nigeria are still depending on radio waves to transfer speech and data from base stations to mobile switching centers. Radio wave signals are subject to interference from other electromagnetic waves generating system such as radio and television. When such occurs, it could lead to call setup failures, call drop or other distortions.

2.8.7 Lack of Good Communication Terms between Different Networks

One of the reasons for poor inter-network communication is the inability to agree on the sharing ratio of the revenue between the network operators. As a result the numbers of lines that are open for interconnectivity are small compared to the total number of lines. A situation can occur when there is congestion on the connecting network like when a subscriber from a network A is calling from a network that is less congested to network B, which is filled to capacity. In such a case, the call will not pass through the network.

2.9 Marketing Strategies and Pricing Schemes

This also affects traffic behaviour since this would have increased the number of subscribers on the network.

2.10 Quality of Service Evaluation

The term quality of service QoS is used to designate a set of parameters, which are intended to represent measurable aspects of the subjective "Perceived quality", but not on the causes of this perception. [8] defines, Quality of Service as how happy the telephone company (or other common carrier) is keeping the customer. The transmission engineer calls QoS customer satisfaction, which is commonly measured by how well we can hear the calling party.

The ITU defines the QoS as the collective effect of service performance, which determines the degree of satisfaction of a user of the service. The terminal will also have a strong influence on the subjective perceived quality. It is the obligation of network providers to provide reliable and available networks for their customers. Therefore, the network providers must find mechanisms to protect and detect all defects and errors that might occur during their services in order to maintain their quality of service (QoS) or service capabilities.

2.11Factors Affecting the Quality of Service (QoS)

Currently, quality of service (QoS) is a significant issue for all network providers [9]. The success or failures of QoS are the main responsibility of the network administrator consequently; the network administrators are responsible for a qualified network management policy. For a mobile service, the most significant are call set up delay, probability of blocking and effective bandwidth. These factors can be both network terminal dependent.

i. The Call Set up Delay

This can be defined as the time interval from the instant the user initiates a connection request until the complete message indicating call disposition is received by the calling terminal. The lack of network resources at the user plane as well as the control plane can cause unsuccessful call attempts. The probability of End-to-End blocking can occur at radio link, at the inter-networking units between the mobile and the fixed networks or at the transit network.

The concept of effective bandwidth has been developed over recent yearss to provide a measure of resource usage, which adequately represents the trade-off between sources of different types, taking account of their varying statistical characteristics and the QoS requirement.

ii. Measurements of QoS parameters

The unit for measuring hoe well we can hear a distant party on the telephoe is loudness rating, measured in decibels [8]. From the network and switching viewpoints, the percentage of lost calls (due to blockage or congestion) during the BH certainly constitutes another measure of service quality. Remember, this item is denominated grade of service. One target figure for grade of service is 1 in 100 calls lost during the busy hour. Other elements to be listed under QoS are

iii. Delay before receiving dial tone (dial tone delay);

iv. Availability of service tones (e.g., busy tone, telephone out of order, time out, and all trunks busy (ATB);

v. Correctness of billing;

vi. Reasonable cost of service to the customer;

vii. Responsiveness to servicing requests;

viii. Responsiveness and courtesy of operators; and

ix. Time to installation of a new telephone and, by some, the additional services offered by the telephone company.

QoS parameters are not always directly measurable. The fundamental concept about QoS measurement is based on the traffic over the network. The relative weight of their influence in the user's evaluation depends on the nature of the service.

3. Materials and Method

The data used for this study was obtained through interview of subscribers and use of questionnaires. The survey was carried out by administering a well structured questionnaire to telephone subscribers, GSM operator power team and professionals in the field. A total of one thousand and five hundred questionnaires were distributed at some selected areas in Lagos state and Ekiti state. [10] puts the population of Lagos state to be 21 million and that of Ekiti state by population figure - Ekiti state is 1,750,000. The questionnaires were based on some of the popular network operators. Out of the number administered, 1350 questionnaires were returned by the respondents thus making 90% of the total questionnaire administered. The network covered includes: MTN, GLOBACOM, AIRTEL and ETISALAT.

4. Results and Discussion

In the performance index of service carried out, the findings are presented in tables 1-6. Table 1 shows the performance evaluation from the field of study of some selected networks. The whole assessment being summarized using four major headings: accessibility (A), interconnectivity (B), through switch (C), and service availability (D).

The result on tables 2 and 3 show that MTN, GLO, Airtel and Etisalat networks are averagely good in terms of interconnectivity, accessibility and through switch. From table 6 it can be deduced that MTN has the overall best performance being ranked satisfactory and others fair. This shows that the QoS delivered by the GSM networks operators is averagely under the required quality that should be delivered. But the test results do not just show accidental congestions but enormous percentage failures. This is primarily because the operators proliferated the SIM cards without making sure that the infrastructures can cope with the number of issued or sold SIM cards.

5. Conclusion

In this research, networks service performance; in terms of connectivity, accessibility, through switch and interconnectivity of the four GSM network providers in Ekiti and Lagos State were explored. Analyses were made on the GSM networks failures and QoS.

The result shows that inadequate infrastructure and proliferation of SIM cards by the service providers. The results of the analysis showed that the overall network performance of the four GSM network providers in Nigeria is average and below the standard required for a graded QoS.

6. Recommendations

The following recommendations are hereby presented;

1. The service providers are advised to place adequate infrastructure in prorate to increase in SIM proliferation.
2. Abide by the ITU regulation as it reminds us, we live “in an age that places increasing importance on” ‘any-to-any’ interconnection.
3. Service operators are advised to take regular checks on the systems, upgrade where necessary.
4. The GSM network opeartors are enjoined to try and prepare for 4G/3G evolution that is about to dominate the mobile industry.

References

[1] M. T. Islam, Education Technology for 21st Century. Observer Magazine, Dhaka, 1997, pp. 3-4

[2] O. M. Ogundipe, The Role of Information and Communication Technology (ICT) in the Millenium Development Programme. Proceedings of 2nd Engineering Forum, School of Engineering,The Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria, 2006, Pp 73-77.

[3] L. Pasi and R. Kimmo, “The architect of GSM”. Artech house Inc. 2004

[4] GSM in Nigeria, Wikipedia online Encyclopedia. http://www.wikipedia.com, 2009, Retrieved 03-09-2013

[5] GSM World Statistics http://www.GSMworld.com/newroom, 2010, Retrieved 06-07-2013.

[6] GSM Association www.GSMworld.com/newswire.com, 2010 Retrieved 06-05-2014.

[7] G. Jekins, “History of Telecommunication Systems” vol. 1. 3rd edition. Mir Publishers London, 2010, Pp 234-256.

[8] L. F. Rodger . Fundamentals of Telecommunication. John Wiley and sons, Inc., 1999

[9] NCC, “A Report on Network Quality of Service and Performance of the GSM networks in Nigeria”. The Guardian newspaper, Tuesday, March 22, 2006

[10] Population www.google.com Retrieved 06-07-2010

Table 1: Performance Evaluation from Selected Network

Network	**A**	**B**	**C**	**D**
MTN	90	105	117	105
GLO	54	45	42	39
AIRTEL	54	30	45	36
ETISALAT	27	33	15	27

A = Interconnectivity B = Accessibility
C = Service availability D = through switch

Table 2: Performance Evaluation in Percentage

Network	A%	B%	C%	D%
MTN	30	35	39	35
GLO	18	15	14	13
AIRTEL	18	10	15	12
ETISALAT	9	11	5	9

Table 3: Score table for the Field Assessment of the Networks

Rating%	Score	Remark
81-100	5	Excellent
61-80	4	Very Good
41-60	3	Good
21-40	2	Fair
0-20	1	Poor

Table 4: Field Score of the Performance Evaluation of the Network.

Networks	A	B	C	D	Total Score
MTN	2	2	2	2	8
GLO	1	1	1	1	4
AIRTEL	1	1	1	1	4
ETISALAT	1	1	1	1	4

Table 5: Overall Ranking Table

Ranking	Remark
9-11	Best
6-8	Satisfactory
3-5	Fair
0-2	Poor

Table 6: Comparison of the Network Performance

Network	Remark
MTN	Satisfactory
GLO	Fair
AIRTEL	Fair
ETISALAT	Fair