



Analysis of Congestion of Mobile Network in Offa

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Authors' contributions

This work was carried out in collaboration between all authors. All authors designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript, managed the analyses of the study and managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2019/v22i630108

Editor(s):

(1) Dr. José Alberto Duarte Moller, Center for Advanced Materials Research, Complejo Industrial Chihuahua, Mexico.

Reviewers:

(1) G. H. Raghunandan, BMS Institute of Technology & Management, India.
(2) Hermes José Loschi, The States University the Campinas (UNICAMP), Brazil.

Complete Peer review History: <http://www.sdiarticle3.com/review-history/31575>

Original Research Article

Received 09 January 2017

Accepted 31 March 2017

Published 03 April 2019

ABSTRACT

The study of congestion of mobile network in Offa is necessary as congestion remains a major challenge to telecommunication service provision both to service providers and the subscribers as well, even in developed country. Offa is a renowned city in Kwara State, Nigeria. Cellular wireless systems such as GSM suffer from congestion resulting in overall system degradation and poor service delivery. Obviously, subscribers are susceptible to quite network providers who fail to meet up with the services required of them. In this research, areas on the GSM network where congestion occurred were analyzed including the various causes of congestion on GSM network. This research work also brought to bear recommendation that necessitate the need for service providers to create a mutual benefit between the service providers and subscribers. The tool used for data collection was a Five Point Likert attitude scale questionnaire. The Data collected for this study were analyzed using frequency counts, simple percentage (%) and mean score (x).

Keywords: Congestion; mobile network; GSM; control channel; intra and inter congestion.

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1. INTRODUCTION

In the global trend today the newest phone communication technology is the cellular telephone, which is known as the cell phone or simply mobile phone. A mobile phone is invented to give the user full liberty of movement. It is worth noting that in this regard, the number of mobile users keeps increasing daily and yearly at a reasonable progression. Therefore, the importance of mobile phones soar-up with the improvement in services render, reduction in service cost, and the range of services available. According to Mehrotra [1], mobile or simply cellular systems started in the United States with the release of the advanced mobile phone service (AMPS) system in 1983. Asia, Latin America, and Oceanic countries adopted the AMPS standard and started creating the largest potential market in the world for mobile phone.

Considering the early invented technology of mobile phone in the early 1980s, most mobile telephone systems were analog rather than digital [2]. However, as recently witnessed in the country one can affirm that mobile technology has graduated in expedition from analog to digital. Digital system has a lot of benefits compare to analog type which include but not limited to ease of signaling, lower levels of distortion and interference, integration of transmission and switching, and increased propensity to meet capacity demands. Nowadays the Global System for Mobile communications (GSM) adopted digital systems rather than the obsolete analog systems and uses digital data, which accommodates more subscribers even beyond one would imagine. Along the line, the GSM mobile telephone offers lots of advantages which include high quality voice communications and low bandwidth data connections for fax, short message service (SMS) and full dial-up connection to the Internet.

Also, many people are engrossed to GSM due to its unique mobility features. Thus, it has turned to a means of living for many people across the globe as they are getting involved in mobile phone-related ventures. In a nutshell, a network is a collection of computers, servers, mainframes, network devices, peripherals, or other devices connected to one another to allow the sharing of data [3]. The Mobile depots are now becoming complex entrenched systems, with rigorous real time necessities for signaling and voice processing [4]. Furthermore, the marketing strategies of the GSM network

providers and competition to get many subscribers have lured lots of subscribers to mobile network communication, even though their infrastructures cannot sustain them. Some mobile network providers also complain that they pay an outrageous and huge sum of money to acquire licenses for operation in Nigeria, consequently the need for them to get as many subscribers as they can so as to recover their money. These and many more have led to congestion on the Nigerian GSM telecommunication systems. Congestion occurs when bandwidth is insufficient and network data traffic exceeds capacity" [5]. Also, congestion is the unobtainability of the network to the subscriber at the time of making a call [6]. Network congestion in data networking and queuing theory is the reduced quality of service that occurs when a network node is carrying more data than it can handle [7]. Thus, during network dimensioning process, there are some essential tasks to be well-thought-out. Switches need to be dimensioned in agreement with the projected desired capacity, taking for example, average conversation time, the need for signaling, projected number of handovers, location updates, short message distribution etc. [6].

According to Kuboye et al. [2], the following are areas of congestion in the GSM network: Common Control Channels (CCCH) - it consists of Random Access Channel (RACH), Paging Channels (PCH), and Access Grant Channel. As a matter of fact, on Common Control Channels congestion occur under three conditions, which are: Random Access Channel Congestion (RACHC), Paging Channel Congestion (PCHC) and Grant Channel Congestion (AGCHC). Thus, when any of these three control channels is being congested, there cannot be any call launch between the sender and receiver. This failure is called a "Call Launch or Establishment Failure" [2,8]. Dedicated Control Channel Congestion (DCHC) also occurs when there is failure to allocate Stand-alone Dedicated Control Channel (SDCCH) to provide validation to mobile station, location updating and assignments to traffic channels during idle periods [1]. When making a call or replying to paging message for the sharing of an SDCCH for validation, if there is no vacant SDCCH to use at that time, then the call will be terminated abruptly [2,8]. Traffic channels congestion (TCHC), in this case Traffic channels (TCH) is used to transfer voice, data, and control information and when there is no vacant TCH, the voice communication on the GSM network

cannot be authenticated [2]. Pulse Code Modulation Congestion (PCMC): Pulse Code Modulation (PCM) is the link required to connect together the Base station (BS) and Mobile-switching center (MSC). Meanwhile, each PCM can carry between 1 and 32 calls. When PCM is not vacant to carry the call signals between the BS and MSC, then we have Pulse Code Modulation Congestion (PCMC). This type of congestion can either occur within the network or between networks [2,9].

One of the significances of this study is that it would use a market structure conduct performance context to evaluate the network congestion in Offa, Kwara State. It will also assist network providers to proffer salient solutions to those causes of congestion in the area under study and the entire country as a whole. Moreover, it will be a valuable tool for scholars, institutions and individual that wants to research into the congestion of network in a named city. It will as well serve as a point of reference for further studies. This research work evaluates the congestion of mobile network in Offa, Kwara State, Nigeria, in order to analyze the various causes of network congestion and to examine the factors that cause increase in the number of subscribers in the area under study. However, the study only covers analysis of congestion of mobile network in Offa, Kwara State. It specifically analyzes the location of congestion areas on GSM network in the city under study.

2. LIMITATIONS OF THE STUDY

The limitations of this study therefore includes, the short duration given by the institution authority to cover this research work which does not allow for an in-depth coverage of all issue associated with the topic under study, and gathering of useful correlated information. Self-reliant information required in order to highlight and analyze some statement are not readily available, such as, the actual number of subscriber per network provider in the area under study. Also, funding is additional excruciating limitation to an in-depth study of this topic.

2.1 The Envisaged Causes of Congestion of Mobile Network in Offa are Stated Below

2.1.1 Inadequacy of base stations

Study shows that there is no adequate base stations in Offa presently, compare to the sizable

number of subscribers that are patronizing each of the network operators. The numbers of subscribers to different networks providers has increased drastically because of the landslide reduction in the price of their network SIM card recently experienced in the area. However, the base stations do not had a matching increase as one will expect. The present ratio probably is about 8,000 subscribers to one base station.

2.1.2 Inadequacy of the needed channels

One will definitely expect to experience inadequate channels to support the subscribers and the service rolled out by the different operators in such area, since there are not enough base stations. Meanwhile, the channels usually determine the total number of subscribers that can be allowed to use a base station concurrently at any point in time [10]. This track remains the same because any time a base station is added to their network; a high-level of promotion will be provided in order to lure more consumers.

2.1.3 Competition for subscribers among the operators

Observation shows that the ulterior motive of GSM Providers in Nigeria, of which Offa is not exempted, is the profits they will effectually make from the subscriber base and not the overall quality of service they want to offer. Most of them falsify information and make fallacious advertisements all with the intent of luring customers to their network, whereas they lack basic infrastructure to satisfy subscribers' demands.

2.1.4 Inadequacy of end-to-end system

Most Mobile Network operators in Nigeria are still relying on radio waves to convey speech and data from base stations to mobile switching centers. Usually, as far as microwave region is concern, radio wave signals are subject to certain interference that may emanate from other electromagnetic waves generating systems such as radio and television. It is possible that interference of such could cause call setup failure, call drop, or other impairment.

2.1.5 Absence of good quality phones

According to [11], common to any radio link telecommunication system; it is the radio link between mobile phone and base station that will

be the weakest part of the communication system. However, provided conditions are not favorable, or the user transits into a tunnel during a call, there will be loss of connection.

Mobile Phone with better quality and higher frequency wave intensity will make a call more steady and shrink interference from another caller. This is supported by the parameter of the power control that links power between the terminal and base station. It is highly very necessary to maintain efficient power control so as to hold interference at a lowest.

2.1.6 Inadequacy of good communication terms between different networks

Another colossal reason why there is poor inter-network communication is the incapability to reach a decision on the sharing ratio of the income between the network providers. Owing totally to this, the statistics of lines that are open for interconnectivity are lesser compared to the aggregate number of lines.

Also, condition such as congestion on the linking networks when a subscriber from a network A is calling from a network that is less congested to Network B, which is occupied to capacity; considering situation of such, the call will not definitely pass through the network.

2.1.7 Marketing strategies and pricing schemes

The pricing schemes put in place by individual network providers also affect traffic behavior since this consequently increased the number of subscribers on the network.

2.2 Factors that Favor Increases In the Subscribers in Offa, Kwara State

Study shows that the following factors drastically contribute towards increase in the subscriber base of each network in Offa, Kwara State.

2.2.1 The ease of communication offered by mobile phones

Sizable number of people in Offa cheered the usage of GSM because it has solved the challenge of fading or attenuation during calls. Moreover, mobile phones are light and can be easily carried about from one place to another. In this regard, the noise and distortions caused by wired telephone are a bit eradicated.

2.2.2 Elimination of wired connection

The graduation from wired connection to wireless one, allowed communication to be established in as much as the individual subscriber is within the cell area of his/her operator.

2.2.3 Voice quality service

Observation also shows that the quality of voice service experienced in Offa is far better than the analog wired service as a result of the fact that it is not as vulnerable to distortion and interference as that of wired telephones.

2.2.4 The additional data service

The additional data services available on GSM, such as SMS, browsing make communication easier for people and offer a wider array of options for network subscriber in Offa.

2.2.5 The competitive reduction in the tariff

There are competitions among network providers in Offa and the service rate for service remains the same, even with that of international service also remains the same, without increased tariff charges.

2.2.6 The low acquisition rate

It is noted that the actual amount of money required for procuring a network line and phone is considerably lower than the one user(s) have to pay to have a wired NITEL telephone. Hence, this really attracted many new communication network GSM subscribers in the area.

2.3 Complaints by the Subscribers that are Evident in Offa

Study shows that complaints from subscribers in Nigeria which that of Offa is not an exception include "If I try calling during the day, I often get the same message - 'Network Busy' or 'Error in Network' - even if the mobile phone at the other end is not being used" [12]. However, research exposed the following messages as being regularly declared or displayed to the users by the GSM operators in Offa.

From Etisalat platform:

"Error in connection"

"The number you are calling is not available now"

From MTEL platform:

“Number not responding”
“Network temporary busy”

From MTN platform:

“Error in connection”
“Network busy”
“The number you are calling is unavailable”
“No network”

From AIRTEL platform:

“Error in connection”
“Network busy”

From Globalcom platform:

“Network busy”
“The number you have dialed is not on the Globalcom Network”
“Error in connection”
“No answer”
“Number busy”
“Not reachable at the moment; please try again later”

The above messages show the lack of support of our network operators to their individual subscribers. Those messages were observed to have been programmed into their equipment and it is guessed that they are selected probably randomly and declared to the users.

2.4 An over View of Offa, Kwara State, Nigeria

Offa is an ancient town and at the same time, the Headquarters of Offa Local Government Area of Kwara State, Nigeria. It is the second largest town in the state, and it is located in central Nigeria with geographic coordinates of 8°9N 4°43E.

The city of Offa was founded by Olalomi Olofagan; a crown prince from Oyo, and a direct descendant of king Oranmiyan in Ile-Ife, around 1395. Olalomi was a renowned hunter reputed for his skill as an archer. Offa is known as the traditional headquarters of Ibolo dialect of the Yoruba speaking people of Kwara and Osun States. Offa Local Government Area in its entirety has 5 wards, namely; Essa, Ojomu, Balogun, Shawo and Igbo-Idun. Offa is the home of the legendary Moremi, the one who was said to be responsible for the defeat of the frequent

marauders who stormed Ife, an ancient town and cradle of Yoruba race.

The new Olofa of Offa, a renowned king is Oba Alhaji Mufutau Mohammed Gbadamosi Okikiola Esuwoye II. The prominent knighted chiefs of Offa include Esa, Ojomu, Sawo and Balogun. The popular eulogy of Offa is "Ijakadi Loro Offa", a Yoruba phrase meaning "wrestling is our game". The city's mascot is the peacock bird which is one of the most prominent exotic avian species in the region.

The provincial figure for the population of Offa Local Government Area by the National population Commission [13] is 89,674 comprising of 46,266 males and 43,428 females. Going by reputation, Offa is known as the home of sweet potatoes.

Education is the main industry of Offa people. Tertiary institutions in the town include the Federal Polytechnic, Kwara State College of Health Technology and Nigeria Navy School of Health Science, School of Basic Studies, and National teachers Institute. Two private Universities are also springing up from Offa city.

3. RESEARCH QUESTIONS

The study would examine the following questions:

- i. What have been the causes of network congestion in Offa?
- ii. What do you think are the factors responsible for increase in the subscribers in Offa?

4. FORMULATION OF HYPOTHESES

Based on the objective of this study, following hypotheses were formulated.

HA= Alternative Hypothesis
HN = Null Hypothesis

Hypothesis one

HA: In Offa, there is network congestion
HN: In Offa, there is no network congestion

Hypothesis two

HA: There is ease of communication offered by mobile phones to people in Offa.

HN: There is no ease of communication offered by mobile phones to people in Offa.

Hypothesis three

HA: There is no enough Base Stations in Offa
HN: There is enough Base Stations in Offa

Hypothesis four

HA: The available network channels are not sufficient
HN: The available network channels are sufficient

Hypothesis five

HA: There is competition for subscribers among the network operators:
HN: There is no competition for subscribers among the network operators:

Hypothesis six

HA: There is no enough End-to-End System
HN: There is enough End-to-End System

Hypothesis seven

HA: There are no good communication terms between different networks in Offa.
HN: There are good communication terms between different networks in Offa.

Hypothesis eight

HA: The elimination of wired connection has increased the number of subscribers per network
HN: The elimination of wired connection has not increased the number of subscribers per network

Hypothesis Nine

HA: The voice Quality Service rendered by network providers has increased subscriptions.
HN: The voice Quality Service rendered by network providers has not increased subscriptions.

Hypothesis Ten

HA: The competitive reduction in the tariff plan of each network provider contributed to

increase in subscriptions experienced recently.

HN: The competitive reduction in the tariff plan of each network provider has not contributed to increase in subscriptions experienced recently

5. RESEARCH METHODOLOGY

This research work involves the study of wireless network communications including analog and digital system. Special attention was given to GSM as a digital communication system. A careful study of congestion in GSM was done. The points where congestion occurred on the GSM network were identified through observation of GSM stations such as MTN, Globacom, Airtel Etisalat and Mtel; and through the administering of questionnaires. During the survey of this study, the survey research design was adopted in collecting data. The tool used for data collection was a Five Point Likert attitude scale questionnaire. The Data collected for this study were analyzed using frequency counts, simple percentage (%) and mean score (x). However, a mean score of three (3) and above was used as a basis for successful outcome and regarded as an accepted mean to test research question, while a mean score of 2.99 and below was used as a basis for unsuccessful outcome and regarded as rejection to test the research question.

5.1 Presentation and Analysis of Data

For the sake of this study, questionnaires were distributed. The total number of questionnaires randomly distributed to respondents across five network providers in Offa was 1000, using the simple random sampling method. The network providers that the questionnaires cut across are MTEL, MTN, GLOBACOM, ETISALAT and AIRTEL. The questionnaires were ensured to be evenly distributed among the five network providers. Out of the 1000 questionnaires distributed, 960 were filled and returned which represent 96.0% while 40 questionnaires were not returned, and represent 4.0% of the total administered questionnaires. However, the total working figure for this study is 960.

The total population for this study consists of educational institutions like Federal Polytechnic Offa, Offa, Kwara State, satellite campuses; and members of the general public in Offa.

The outcomes of data collected are as tabulated below:

Table 1. Respondents' response to questionnaire

Variables	SA	A	SD	D	U	Total	Mean (X)
In Offa, there is network congestion	250 26.0%	582 60.6%	62 6.5%	48 5.0%	18 1.9%	3878 100%	4.04
There is ease of communication offered by mobile phones to people in Offa	191 20.0%	658 68.5%	10 1.0%	101 10.5%	-	3819 100%	3.98
There is enough base stations in Offa	-	485 50.5%	-	293 30.5%	182 19.0%	2708 100%	2.82
The available network channels are not sufficient	170 17.7%	652 67.9%	70 7.3%	18 1.9%	50 5.2%	3754 100%	3.91
There is competition for subscribers among the network operators	357 37.2%	562 58.5%	-	25 2.6%	16 1.7%	4099 100%	4.27
There is enough End-to-End System	-	487 50.7%	-	262 27.3%	211 22.0%	2683 100%	2.79
There are good communication terms between different networks in Offa.	72 7.5%	155 16.1%	468 48.8%	169 17.6%	96 10.0%	2818 100%	2.94
The elimination of wired connection has increase the number of subscribers per network	196 20.4%	502 52.3%	140 14.6%	119 12.4%	3 0.3%	3649 100%	3.80
The voice Quality Service rendered by network providers has increased subscriptions.	203 21.1%	590 61.5%	156 16.3%	11 1.1%	-	3865 100%	4.03
The competitive reduction in the tariff plan of each network provider contributed to increase in subscriptions experienced recently	177 18.4%	596 62.1%	118 12.3%	49 5.1%	20 2.1%	3741 100%	3.90

From the above Table 1, "SA" stands for Strongly Agree, "A" stands for Agree, "SD" stands for Strongly Disagree, "D" stands for Disagree and "U" stands for Undecided

5.2 Summary of Findings

Technically, congestion within network is referred to as intra- congestion, while congestion between different networks is referred to as inter-congestion.

The incomplete calls are referred to as call-drop or call-break within networks. Call-drop means the two parties in dialogue were unable to end-up their discussion. This means that the call was brusquely terminated. However, study shows that:

1. In Offa, there is network congestion.
2. There is ease of communication offered by mobile phones to people in Offa.
3. There are no enough base stations in Offa;
4. The available network channels are not sufficient.
5. There is competition for subscribers among the network operators
6. There is no enough End-to-End System

7. There are no good communication terms between different networks in Offa.
8. The elimination of wired connection has increase the number of subscribers per network.
9. The voice Quality Service rendered by network providers has increased subscriptions.
10. The competitive reduction in the tariff plan of each network provider contributed to increase in subscriptions experienced recently.

6. CONCLUSION

Based on this research work, congestion is a menace that has devastated GSM network in Offa, Kwara State, Nigeria. Scholars have been trying their best to ensure that it is brought under control. Mobile Service Switching Center (MSC), Base Station Controller and base station site in order to minimize congestion is needed in Offa. The bench mark created by the international telecommunication union has not been achieved

even in the developed nations, a reason being that service providers are bent on making fabulous gains instead of satisfying their customers. Sequel to this, GSM service provider in the country should ensure they stop pursuing excess money at the detriment of their subscribers. This will go a long way to stabilize good communication system in the area under study and by extension to the entire country.

7. RECOMMENDATION

It is necessary that network providers have reliable goals for the attainment of good quality and high performance network in Offa, Kwara State, Nigeria. There is need for integrated network architecture design that will show how the different services will be implemented as well as what equipment will be needed at each point. Also, a preliminary roll out plan should be included. There should be provision of more Mobile Service Switching Center (MSC), Base Station Controller and base station site in order to minimize congestion. Logistics such as detailed network planning, computer aided design system and tools are to be made available for coverage prediction, interference analysis, frequency planning, microwave link planning and documentation.

Furthermore, there is need for government to be moderate in the area of tax levying network providers in the country in order to enjoy congestion free and good communication system across the country. On this note, the Nigerian government should involve stakeholders, such as, Nigerian Labour Congress and Civil Society Organization officials in matters of importance regarding policy making, design, development and implementation in all areas of governance, most especially, the policy of taxation on foreign investors such as network providers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mehrotra A. GSM system engineering. Artech Home, Inc. Norwood, MA; 1997.
2. Kuboye BM, Alese BK, Fajuyigbe O. Congestion analysis on the Nigerian global system for mobile communications (GSM) network. The Pacific Journal of Science and Technology. 2009;10:262-271.
3. Computer Hope. Definition of network; 2017. Available:<http://www.computerhope.com/jargon/n/network.htm>
4. Scourias J. Overview of the global system for mobile communication; 1997. Available:<http://www.iec.org/online/tutorial>
5. Techopedia. Definition of Congestion; 2017. Available:www.techopedia.com/definition/18506/congestion-networks
6. Ani OJ, Ogbuabor GO. Congestion control of the GSM network in Nigeria. International Journal of Current Research and Academic Review. 2015;6(3):275-285.
7. Wikipedia. Definition of Network Congestion; 2017. Available:en.wikipedia.org/wiki/Network_congestion
8. Boulmalf M, Akhtar S. Performance evaluation of operational GSM Air-Interface (UM); 2003. Available:<http://www.iec.com>
9. Hartel LR, Livingstone G. GSM superphones. McGraw-Hill: New York, NY; 1999.
10. Nigeria Communication Commission (NCC). A report on network quality of service and performance of the GSM networks in Nigeria. The Guardian Newspaper; 2005.
11. Electronic Design. Data over cellular. Brand Communication; 2008. Available:www.elecdesign.com
12. Jonnes GKT. Mobile, Faster, Easier, More Secure; 2005. Available:<http://www.t-mobile.com>
13. FRN Official Gazette. Government Notice. 2007;24.

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Peer-review history:
The peer review history for this paper can be accessed here:
<http://www.sdiarticle3.com/review-history/31575>