Implementing Cloud based IoT GSM RF Signal Monitoring for Quality of Service Determination

[1]Collins N.Udanor, [2]John C Ngwoke, [3]Stephen O. Aneke, [4]Assumpta O Ezugwu & [5]Chikodili H Ugwuishiwu
[1,23,4,5]Department of Computer Science, University of Nigeria, Nsukka,
Nigeria [2]Data Centre, University of Nigeria, Nsukka, Nigeria
E-mail: collins.udanor@unn.edu.ng; john.ngwoke@unn.edu.ng; stephen.aneke@unn.edu.ng;
assumpta.ezugwu@unn.edu.ng; chikodili.ugwuishiwu@unn.edu.ng
Phone: +234803 099 8078, +234806 133 8765, +234803 572 3901; +234805 681 4411; +234803 568 9222

ABSTRACT

The Global System for Mobile communication (GSM) has changed the way we communicate and do business, but not without its own attendant issues. One of the major challenges being the quality of service delivered through its voice and data channels. Quality of service (QoS) is a key performance indicator (KPI) used to determine the effectiveness of a telecommunication infrastructure. Poor GSM quality of service like weak signal strength, drop calls, network congestions and the like seem to have come to stay with us in Nigeria. The inability of regulators and users of GSM to capture real time GSM RF data from diverse locations has made it difficult to effectively monitor GSM QoS. This research therefore, proposed the implementation of an Internet of Things (IoT) based GSM QoS monitoring portal. Through the use of IoT devices, GSM radio signal data was gathered in real time within the University of Nigeria campus and transmitted to a remote repository. The data was mined and analyzed, and network performance and QoS was monitored for different GSM networks. Results from the RF data gathered from three different locations on campus showed that among the three network operators studied that MTN Nigeria showed better performance than the rest. The result of this work is used to advise both network operators and regulators on the key performance indicators that needs to be improved upon, as well as inform user on which network provider performs better in his/her area of residence or office.

Key words: IoT, GSM, QoS, Locations, Networks, KPI, RF and .Monitoring

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1. BACKGROUND TO THE STUDY

The introduction of the Global System for Mobile communication (GSM) in Nigeria in 2001 revolutionized the way we communicate and do business. The technology has been a game-changer within a few years of its advent in many aspects of both our social and business life, though not without its attendant teething problems. One of the major challenges being quality of services delivered through voice and data channels. Quality of service (QoS) is a key performance indicator (KPI) used to determine the effectiveness and efficiency of a telecommunication infrastructure. Poor GSM quality of service like weak signal strength, drop calls, network congestions and the like has bedeviled GSM users in many parts of Nigeria.

The regulatory body seem to be fighting an unending battle with operators, slamming sanctions and fines on the operators. It appears the consumers also have accepted their fate in the hands of telecom operators. Quality of service in telecommunication is defined as a set of specific requirements delivered by a service provider to users, which are necessary in order to achieve the required functionality of an application or service (Carvalho de Gouveia et al, NDP). There are many factors which affect the quality of service in a GSM network and there are standard matrices for measuring them. These include coverage, accessibility and quality of audio signal (Guowang et al, 2016). Our focus in this research work is in the coverage since coverage can be measured by the quality of the signal strength. Signal Strength can run from -51dBm to - 113dBm. Values closer to -51dBm are stronger. A signal beyond -98dBm is not considered strong enough to work properly. For the established connection to be sustained, (Anonymous) recommends a hand over which demands a minimum signal level that is normally between -85dBm and -105dBm for a good quality voice call and provides the table 1 below. There is usually a threshold signal level that initiates hand over. The following factors (Adegoke et al, 2011) were identified as affecting service efficiency in Nigeria: instability in power supply, security of infrastructure, call setup failure, call retention / call drop and congestion. Accessibility, retainability and connection (voice) quality are three major factors used in evaluating quality of service of an operator.

1.1 Statement of Problem

Internet of Things (IoT) seem to be the third wave of information technology after the PC and the Internet (Yaqi et al, 2011). It makes all objects interconnected and is seen as the next technological wave (Kumar et al, 2016). IoT can be viewed as advancement on GSM. In other words, the GSM is one of the providers of platforms upon which IoT thrives. IoT and GSM technologies have been applied in almost all areas of our daily life; such as in anti-theft tracking system in automobiles (Zhigang et al, 2013). Various applications of IoT and GSM are contained in (Yaqi et al, 2011),(Congcong et al, 2014), (Girish et al, 2016), (Kun et al, 2012), Zhang et al, 2011) where different approaches were used to implement the GSM platform but none of the researchers was able to use the cloud technology to implement the GSM service which was what made us to engage in this research.

1.2 OBJECTIVE

The main objective of this study is to implement cloud based Internet of Things GSM RF signal monitoring for quality of service of GSM providers in Nigeria in order to determine the provider whose service is the best in terms of QoS.

2. METHODOLOGY

2.1 The Research Design

The experiment involves using a mobile device as an IoT terminal to capture GSM RF signals, upload the data to a cloud portal developed by the research team and analyze them.

3. DATA PRESENTATION

This architecture shown in fig 3 is implemented by using mobile devices like mobile phones, tablets, etc in which the application, Signal Strength 4.1 for Android is installed shown in fig. 4, to harvest real time RF signal data from the nearest base stations in three different locations on campus for a period of one month. This captured data is then pushed from the mobile portlet to a remote application portal developed during this research work, where it is stored in a repository as an open and Findable, Accessible, Interoperable and Re-usable (FAIR) data.

The Signal Strength app in the mobile device, in addition to picking the RF data also picks the cell and location IDs. The date and time stamp of the data is also stored.
The data was retrieved from the phones and sent to Mysql database for analysis as shown in fig 5 shows.

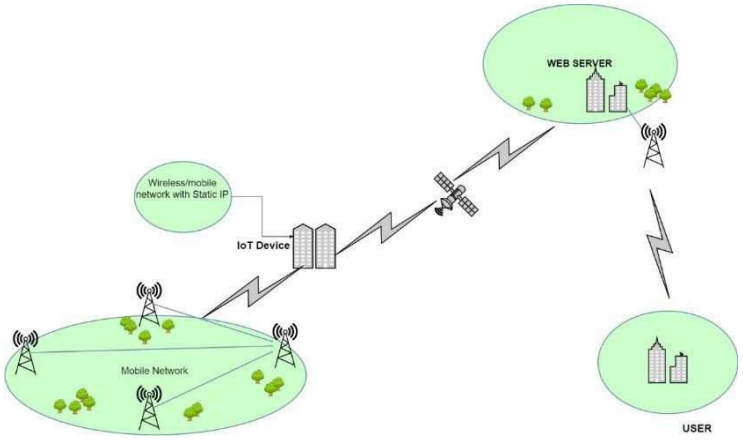

Fig. 1: IoT terminal schematics

Fig 4 shows screen shots of the Laksman Signal Strength 4.1 Tools for Android devices used for the real time GSM RF signal capture from different locations on campus.

Fig 2: Laksman Signal Strength 4.1 Tools for Android

With this app we were able to get a good idea of the Cellular and WiFi signal strength and find out which corners of your office or home are having the best reception.

The features of this app are:-

General User
- Signal meter
- Speed test
- WiFi scan
- Signal widgets

Advanced User
- Signal Logger
- Network info
- Cell towers
- Latency
- Out of service, low signal and roaming alerts.

Date	Time	Signal	Cell ID	LAC	MCCMNA	Network Operator	Location
4-Oct-16	9:03	-97	13142572	957	62120	Airtel	ICT
4-Oct-16	9:18	-91	13142572	957	62120	Airtel	ICT
4-Oct-16	9:32	-95	13142572	957	62120	Airtel	ICT
4-Oct-16	9:47	-99	13142572	957	62120	Airtel	ICT
4-Oct-16	10:03	-93	13142572	957	62120	Airtel	ICT
4-Oct-16	10:18	-95	13142572	957	62120	Airtel	ICT
4-Oct-16	10:33	-99	13142572	957	62120	Airtel	ICT
4-Oct-16	10:49	-99	13142572	957	62120	Airtel	ICT
4-Oct-16	11:03	-99	13142572	957	62120	Airtel	ICT
4-Oct-16	11:19	-95	13142572	957	62120	Airtel	ICT
4-Oct-16	11:34	-91	13142572	957	62120	Airtel	ICT
4-Oct-16	11:49	-91	13142572	957	62120	Airtel	ICT
4-Oct-16	12:03	-91	13142572	957	62120	Airtel	ICT
4-Oct-16	12:18	-91	13142572	957	62120	Airtel	ICT
4-Oct-16	12:35	-93	13142572	957	62120	Airtel	ICT
4-Oct-16	12:52	-91	13142572	957	62120	Airtel	ICT
4-Oct-16	13:07	-93	13142572	957	62120	Airtel	ICT

Fig. 3: Sample GSM RF data captured using Signal Strength mobile app

4. DISCUSSION OF FINDINGS

Table 3 below shows the mean and standard deviation of the signal data captured from three network operators, MTN, Airtel and Etisalat, respectively within the UNN campus over a period of one month during a trial run. While fig. 6 shows a screen shot of the report in bar chart from the IoT cloud-based portal showing how the three networks perform during three time divisions in a day. The result shows a fluctuation among the network operators. For example, from the screen shot we can see that MTN Network signal strength has the best signal strength in the morning, followed by ETISALAT, but in the afternoon it showed that MTN still provided the best signal strength followed by AIRTEL and in the evening it shows that MTN still produced the best signal strength while ETISALAT and AIRTEL have the same signal strengths.

Table 1: Signal strength of Network

Network Providers	Mean Signal Strength (dBm)	N	Std. Deviation
MTN	-80.96	4872	7.425
Airtel	-94.24	4872	4.541
Etisalat	-85.12	4870	10.976
Total	**-86.77**	**14614**	**9.806**

The table shows that MTN has the best mean QoS, while Airtel has the least.

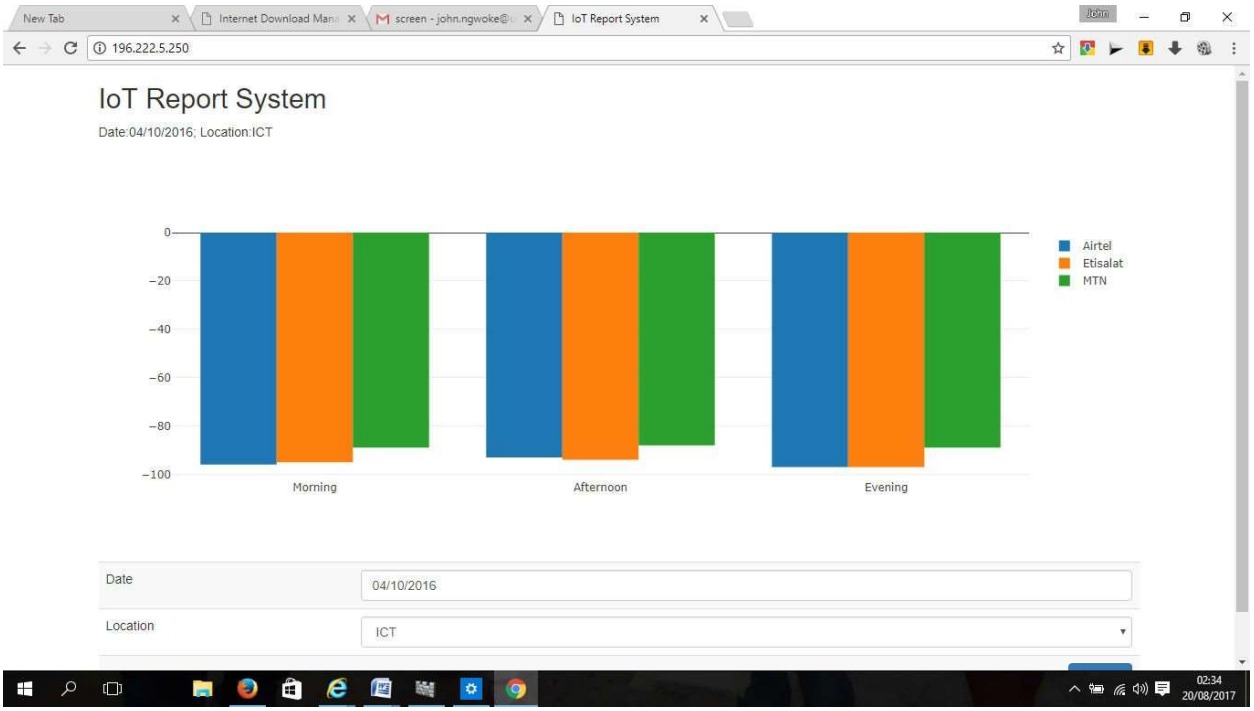

Figure 4: Screen shot of IoT Report System

5. CONCLUDING REMARKS

Finally, the experiment has revealed that MTN has the best QoS among other network providers chosen for this experiment. It also shows that it is possible for any individual, organisation or government establishment seeking to subscribe for the service of any network provider in Nigeria to determine the QoS of any network provider before the subscription if QoS is of paramount importance. This will also enable the Nigerian Communication Commission (NCC), a body that is in charge of monitoring and regulating the services of all the network providers in Nigeria to monitor and regulate the QoS being provided to ensure that each provider does not operate below certain levels of quality so that consumers will get satisfaction in the service they have paid for.

5. CONTRIBUTIONS TO KNOWLEDGE

Having done an extensive work in reviewing other related works, cloud technology is a good platform to monitor the quality of service while using GSM to deploy the Internet of Things.

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