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Development of Web Application for Mobile Broadband Performance Measurement

Stella I. Orakwue[1] and Peter O. Asuelinmhen[2]

Department of Electrical / Electronic Engineering, Faculty of Engineering, University of Port Harcourt, Port Harcourt, Nigeria
[1]stella.orakwue@uniport.edu.ng, [2]peter_onuse@yahoo.com

ABSTRACT

Broadband technologies have been available in Nigeria for long time, and have been utilized by over 40% of her population. But most of these consumers are unaware of the measure of the Quality of Service (QoS) received. This paper presents a test on the QoS received by the consumers. The Mobile broadband performance application (ISP-PERF) was developed using Hypertext Pre-processor (PHP), JavaScript, Hypertext Mark-up Language (HTML), Cascaded Style sheets (CSS) and MySQL to measure, collect and store data relating to four quality of service (QoS) metrics – download and upload speeds, ping, jitter and user data such as mobile phone information, distance from server, and network information. Intensive measurements were taken using ISP-PERF and Ookla's speedtest.net through drive and walk test techniques in three major areas of Port Harcourt on three mobile network operators (MNO). The analysed data gave insights into performance offered to customers by the MNOs in these major areas of interest. Based on results of the comparisons, less than 1% performance error was achieved which justifies that the developed application ISP-PERF is valid for mobile broadband measurement.

Key words: Mobile broadband, Model View Controller, Quality of Service metrics, ISP-PERF

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1. INTRODUCTION

Broadband technology such as the internet communication has become a very import part of life. In Nigeria, over 40% of the population make use of this broadband service [1]. This equates to about a 100 million people [2], and that is a lot. It is necessary that a service of such importance has a kind of quality checking system for its accreditation. Consumers' awareness of the quality of service they are receiving is an important market check that keeps the service providers up and doing. The difference between the proposed quality of service (QoS) by the mobile network operators (MNO) and the actually received QoS at the consumers' ends are alarming, especially in Nigeria. According to NCC (2020), Nigeria broadband plans goals to achieve a minimum download speed of 25Mbps in urban areas. The true success of this plan can only be quantified by the consumers. Therefore, there is a need for a consumer centric approach of measuring the performance of the broadband. This consumer centric broadband performance measurement should be through a means easily accessible to the consumers like a mobile application, and should measure the download speed, upload speed, and latency of the broadband.

Many different tests are publicly available to measure QoS parameters for end users, particularly those related with speed and latency. However, after a quick look at the results obtained from such tests, huge differences appear leading to more confusion and uncertainties for end users.

In this work, a web based mobile application called ISP-PERF was developed and used to test the broadband performance of the three major MNO in Nigeria – MTN, Glo, and Airtel at different hours of a day. It measured and recorded the download speed, upload speed, and latency of the available broadband at three different locations in Port Harcourt, Rivers State. The locations are Choba, GRA, and Trans Amadi. These locations were purposely chosen because of how different they are from each other, in order to account for different consumers. Choba is a densely populated area, while GRA is a sparely populated area. Trans Amadi is an industrial area, and these three areas are located in Port Harcourt. An analysis of the results gotten from these tests will serve as a good insight to performance of the broadband and QoS received by the consumers.

2. QUALITY OF SERVICE METRIC

Common metrics that have been employed for measuring broadband performance include upload and download speed, latency (ping), jitter and packet loss.

Data transfer (upload and download) speed

This metric has emerged as the single most commonly cited metric of interest for characterizing the quality of broadband offerings. Data transfer speed (either upload or download) is a measure of the capacity of a user's broadband connection in Mbps, as it indicates the user ability to GET (retrieve) or POST (send) data to the Internet more quickly.

Latency (delay)

Latency also known as ping or delay is the time it takes a packet to get to its destination when sent from a source measured in milliseconds (ms), it indicates how responsive a network is. Latency affects real time applications such as Voice over Internet Protocol (VoIP) and gaming.

Jitter

This is the variability of latency overtime from point to point and it is generally caused by congestion in an IP network.

3. DATA COLLECTION TECHNIQUES

In order to test the data service performance, junk files of 100MB and 20MB for download and upload respectively is transferred from or to a test server located on the Internet using the client front end on mobile devices. In addition, the peak data performance was tested in uplink and downlink directions by assessing the amount of data that was transferred within a 15 seconds time period. All the tests were conducted with the best-performing mobile plan available from each operator.

The various means the app can be used to measure broadband performance are through; drive testing, walk testing and crowd sourced mobile measurements. However, in this work, a walk test was deployed in collecting the data.

4. MODEL VIEW CONTROLLER ARCHTECTURE

Model-View-Controller (MVC) is an architectural pattern that separates an application into three main logical components: the model, the view, and the controller. Each of these components are built to handle specific development aspects of an application. Figure 1 shows how the MVC components of the system are related.

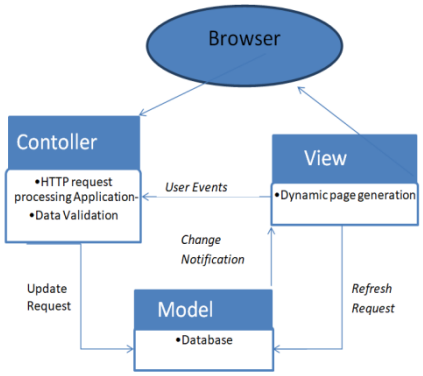

Fig. 1 System Architecture using Model View Control (MVC) pattern

The Model component corresponds to all the data-related logic that the user works with. This can represent either the data that is being transferred between the View and Controller components or any other logic-related data.

The View component is used for all the User Interface logic of the application.

The **Controllers** act as an interface between Model and View components to process all the logic and incoming requests, manipulate data using the Model component and interact with the Views to render the final output.

MVC is one of the most frequently used industry-standard web development frameworks to create scalable and extensible projects. The system is structured into three functional basic performance system which includes the client front end, communication links (web server & URL) and server back end. The client front end module consists of an internet enabled device running on an operating system and the quality of service (QoS) is measured when the user successfully runs a test, an HTTP request is sent to query the MySQL database via the web server for latest information, the result is returned back to the user through the web server (Apache). The application performs data collection and logging of this data to an online database hosted on a web server. The server back end serves as an interface where data sent through the communication links are represented in a database. The communication links are the universal resource locators (URL) and web server that performs accurate transmission of performance data from the front-end module to the server back end.

The client front end is designed in a way that its primary function is to perform test analysis, data collection of performance metrics and logging them to a hosted server database through universal resource locator. The client front end communicates with the server back end through broadband services (2G, 3G, 4G LTE) provided by three major network operators as restricted by this project which includes MTN, GLO, and AIRTEL. The server back end utilizes server APIs and script modules to process all the data from the client front end stores and represent them in a data sheet.

4.1 Use Case Diagram

Use case diagrams are usually referred to as behavior diagrams used to describe a set of actions (use cases) that some system or systems (subject) should or can perform in collaboration with one or more external users of the system (actors). Each use case provides some observable and valuable result to the actors or other stakeholders of the system [5]. The use case diagram of the system is given in figure 2.

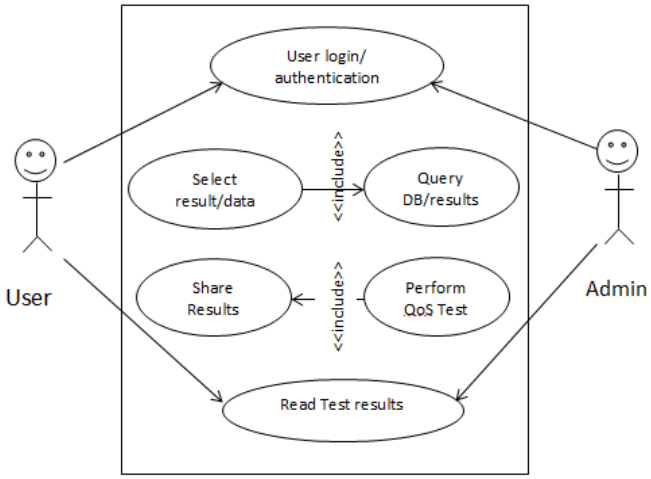

Fig. 2 Use Case Diagram of the system

The steps for a user to use the application are given below;

- **i.** The web-based application is opened.
- **ii.** Press "start" button to run performance test.
- **iii.** After performance test is done, user gets notified of the QoS metrics which is also stored in the database in real-time

5. SYSTEM IMPLEMENTATION

System implementation is the development, installation and testing of system components and delivery of that system into production. The purpose of this section is to build the system and install it, preparing, user documentation and train users.

In developing the web-based platform, various web technologies were used. These web technologies are;

- BOOTSTRAP: This was used to develop the user interface. It is the most popular HTML, CSS, and JS framework for developing responsive, mobile projects on the web.
- VueJs: is a progressive framework for building user interfaces. Unlike other monolithic frameworks, Vue is designed from the ground up to be increment-ally adoptable, vuejs.org (2019).
- APACHE: Apache is the most widely used web server software. Developed and maintained by Apache Software Foundation, Apache is an open-source software available for free. It runs on 67% of all webservers in the world. It is fast, reliable, and secure. It can be highly customized to meet the needs of many different environments by using extensions and modules.
- **MySQL:** MySQL, the most popular Open-Source SQL database management system, is developed, distributed, and supported by Oracle Corporation.

6. RESULTS AND DISCUSSIONS

In order to determine mobile broadband performance measurements: the download speed, upload speed, ping and jitter of the three mobile network operators considered in this project were obtained in Port Harcourt city using both our designed and implemented speed test app and Ookla's speedtest.net for verification. The results of the time analysis carried out on each of the QoS metric revealed the performance pattern of each considered mobile network operator (MNO) of which some results have been published in [4]. The application is able to store each test performance with an identification number, the date and time the test was taken, the host (device) used in taking the test, the MNO used in taking the test, the distance from the server, the hosts IP address and also performance metrics which includes download and upload speeds, ping and jitter in real-time into the database of the system. Note that the highest numbers of upload and download

speeds or the lowest number for ping do not necessarily reflect the best service offered by an MNO, as other factors can affect their performance too.

6.1 Download and Upload Analysis

The mobile network operator with the highest average download speed in all the tested areas using ISP-PERF was MNO-A at 14.49-Mbps. MNO-C had the lowest average broadband download speed at 12.59-Mbps while MNO-B recorded average broadband download speeds of 12.74-Mbps. On the other hand, using Ookla's speedtest.net MNO-A recorded the highest speed at 14.50-Mbps, MNO-C had the lowest average broadband download speed at 12.60-Mbps while MNO-B recorded average broadband download speeds of 12.70-Mbps as shown in figure 3 and figure 4 below.

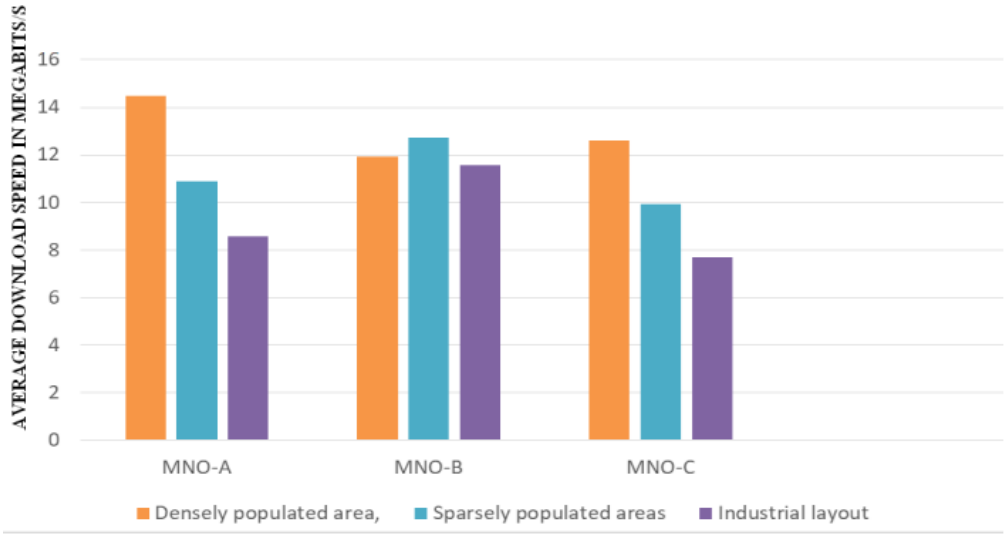

Fig. 3 Average Download Speeds by MNOs in densely populated area, sparsely populated area and industrial layout using ISP PERF

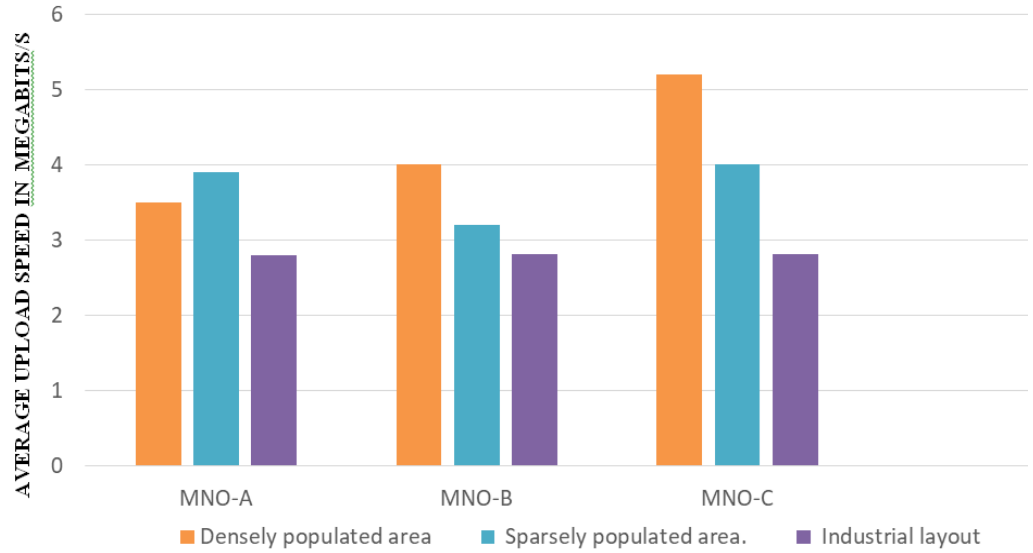

Fig. 4 Average Broadband upload Speeds by MNOs in densely populated area, sparsely populated area and industrial layout using ISP PERF

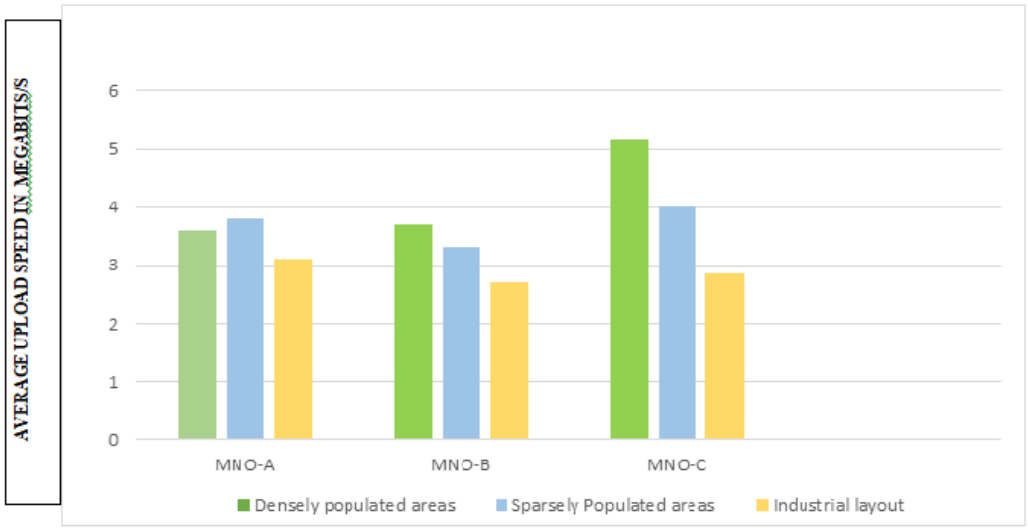

Fig. 5 Average Upload Speeds by MNOs in densely populated area, sparsely populated area and industrial layout using Ookla

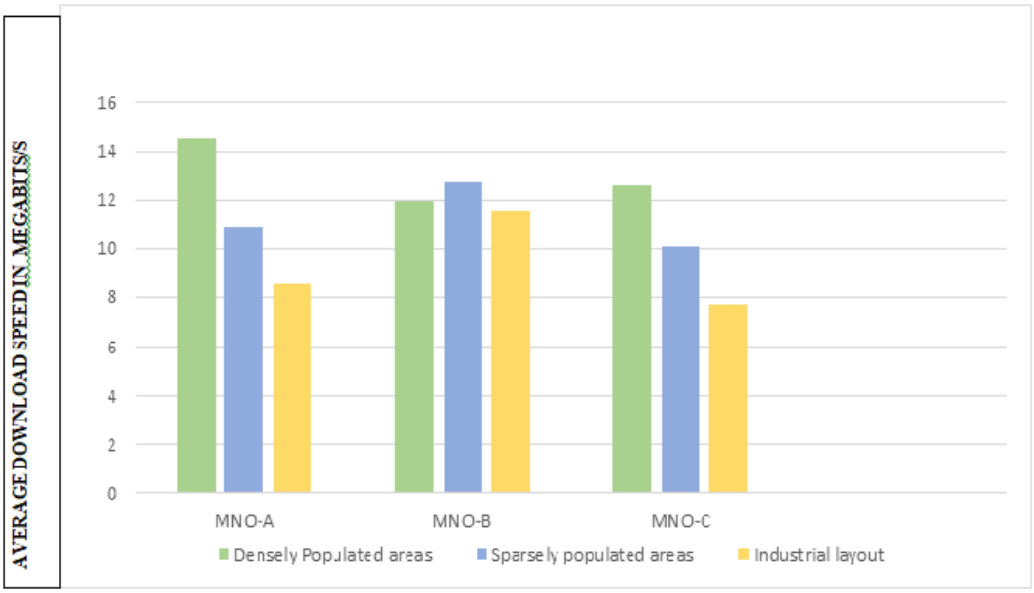

Fig. 6 Average Download Speeds by MNOs in densely populated area, sparsely populated area and industrial layout using Ookla

The mobile network operator with the highest average upload speed in all the tested areas using ISP-PERF was MNO-C of 5.20-Mbps. MNO-A had the lowest average broadband upload speed of 2.80-Mbps while MNO-B recorded average broadband download speeds of 3.20-Mbps. On the other hand, using Ookla's speedtest.net MNO-C recorded the highest speed at 5.15-Mbps, MNO-C had the lowest average broadband upload speed of 2.78-Mbps while MNO-B recorded average broadband download speeds of 3.23-Mbps as shown in figure 5 and figure 6 above.

6.2 Latency Analysis

Figures 7 and 8 are graphs that give a descriptive comparison between the average latency results obtained from three main areas studied in Port Harcourt City. The broadband service provided by the mobile network operators in these areas shows that MNO-B is ranked the most responsive network in all three areas using ISP-PERF with an average latency of 114 ms, followed by MNO-A, at 192 ms, and MNO-C which is least responsive at 342.25 ms.

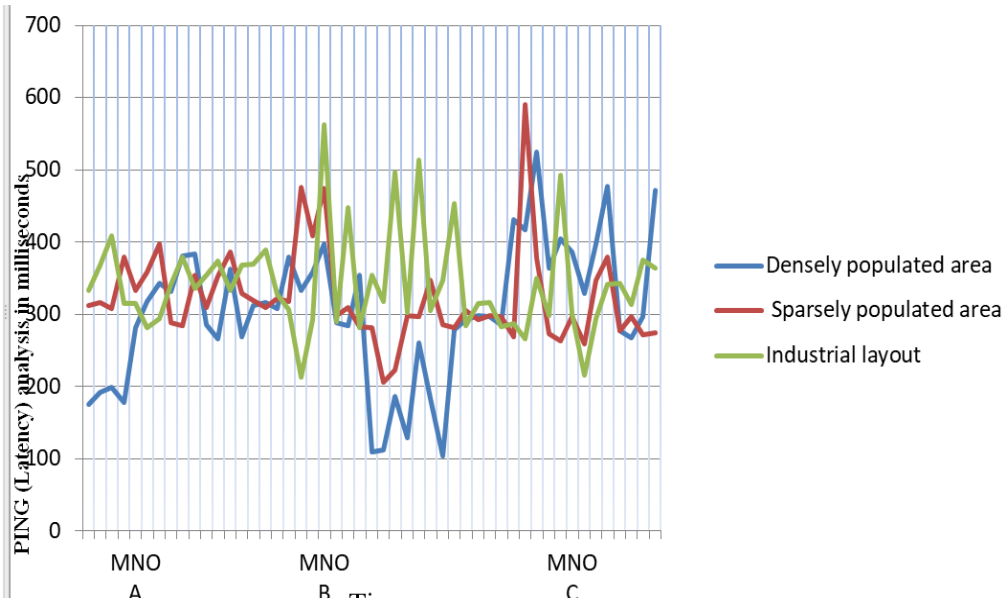

Fig. 7 Average Broadband Ping (Latency) by MNO in the three studied areas in Port Harcourt City using ISP-PERF

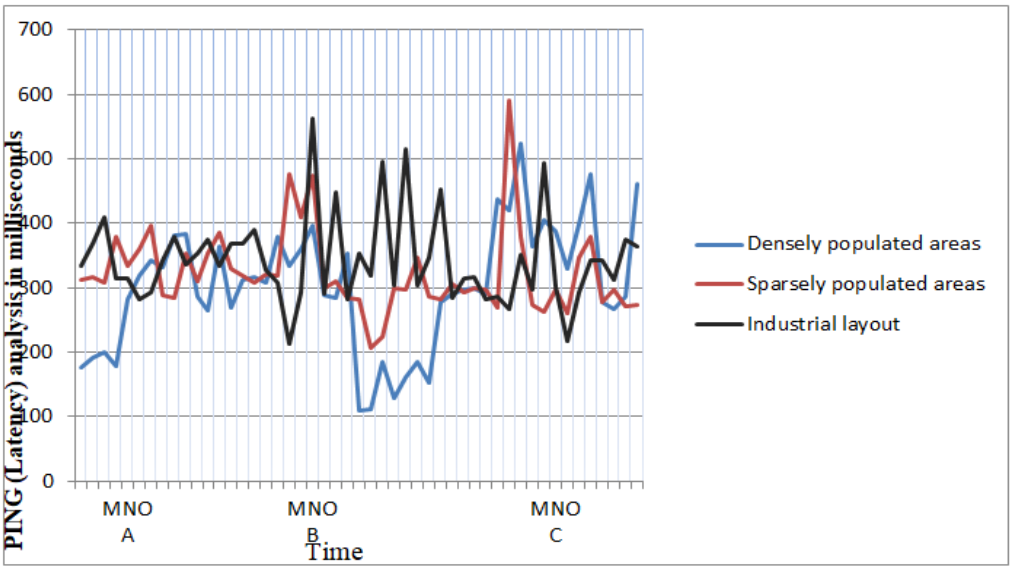

Fig. 8 Average Broadband Ping (Latency) by MNO in the three studied areas in Port Harcourt City using Ookla

Jitter analysis was performed using only ISP PERF because of its extra functional algorithm MNO-A recorded the least variation in latency with 7.91 ms followed by MNO-C with 9.74 ms and MNO-B with the least variation with 15.80 ms. From our latency analysis, the variations are due to some well-known factors which are the distance of the performed test to the closest base transmission station (BTS) and the traffic in the given location i.e. the number of internet users trying to access broadband in a particular location from the same mobile network operator

As the test is taken towards a BTS it is observed that there is a decrease in latency while tests taken away from the BTS tends to increase in latency and reduce download and upload speed. Likewise, the higher the number of users the higher the latency, the lower the upload or download speed and vice versa respectively.

7. CONCUSION

ISP-PERF had been developed and employed in checking mobile broadband QoS performance of three selected mobile network operators; MNO-A, MNO-B and MNO-C. in three major locations in Port Harcourt city. The analysed data gave insights into performance offered to customers by the MNOs in these major areas of Port Harcourt that formed the coverage area of the study. From the results, it was deduced that congestion is an important factor that affect the overall performance the mobile users get and that performance is highly unstable especially during the day and at peak times.

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