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An enhanced mobile-porting model for mobile number portability in Nigeria

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Abstract

Presented in this research, is an enhanced Mobile-Porting model for Mobile network portability in Nigeria geared towards solving the challenges faced by mobile network users. These challenges are in the form of system breakdown, drop calls, high tariff rates, poor service worth, pitiable client concern and unsustainable promotions as well as network congestion. An Apache NetBeans Integrated Development Environment (IDE) platform was used to develop a Mobile Number Visual Sim (MNVSim) suite which allowed application to be developed from a set of modular software components called modules using Object oriented programming. The MNVSim was written with JAVA programming language in Apache NetBeans IDE with My Structured Query Language (MyQSL) XAMPP control panel for the database integration. It was developed as a client in middle tier server application with the selected network service provider's integration on the computing platform. The research successfully developed, simulated and integrated the front end with the backend of the proposed suite. The security and authentication of the suite were equally considered. The approach in this research demonstrates the replacability of the existing Mobile Number Portability (MNP) SIM card Global System for Mobile Communications (GSM) architecture with an adequate trusted software module proposed to demonstrates the functionalities of the network integrations.

Keywords: MNVSim, Apache NetBeans, Drop calls, Mobile-Porting, XAMPP

1. Introduction

Wireless mobile networks in Nigeria today are faced with a lot of challenges. These challenges are in the form of system breakdown, drop calls, high tariff rates, poor service worth, pitiable client concern and unsustainable promotions. Network Congestion is not left out of the observed challenges, (Okonedo, 2018). These factors compel users migrating choice amid service providers. Also, most of the network operators in Nigeria have failed to attain the Key performance Indices (KPI's) benchmark stipulated by Nigerian Communication Commission (NCC). Sequel to the above, this research studies the factors controlling network subscriber's choice to migrate between service providers in the Country, and hence tries to establish the conformity indicator of few cellular service operators. Also, the reasons accountable for service breakdown and develop a Mobile Number Portability (MNP) to position an improvement to the endless quality of service difficulties in the country. Mobile Number Portability (MNP) can be defined as capability of customers to keep their phone lines when migrating from one service provider to another.

This was not possible in Nigeria until the second half of the year 2013. The major reason why the government of the day undertook this exercise was to revive a sector of the Nigerian economy which was still virgin given the fact that multinational telecoms are now inundating the Nigerian market with their services but were also sadly enough, ripping the average Nigerian off with their very poor services. With the implementation of the MNP supervised by the country's National Communications Commission (NCC), the hope was that providers will up their game to ensure that

they are not outdone by their competitors. The real issue is that once a particular Telecom was able to stabilize its services and meet the expectations of customers, it was likely that others will also do everything possible to improve their services else they will give up their customers to their competitors who have better service quality.

It cannot be gainsaid the fact that cellular communications in Nigeria is still in the teething stages and out of a Nigerian population of 170 people, the rate of subscription as reported keeps surging with each passing day. Worldwide, MNP is executed in single of two main ways; namely donor-led porting or receiver-led porting. In donor-led porting, the user commences the process by first contacting the current service provider to demand approval for service transfer. However, in the receiver-led porting, the latest network provider commences the porting process on behalf of the prospective user by informing the user's current service provider. Nigeria opted for the latter which is the more popular system used by most countries globally owing to the fact that it has many advantages to the consumer. Moreover, the NCC further resolved that porting will be free of charge to consumers (Cho, *et al.*, 2019). These notwithstanding, in rolling out the novel technology, the NCC set the following benchmarks for consumers to fulfill before they could port their numbers:

i. Firstly, the prospective applicant's individual information should be equivalent with that in the operator's database.
ii. Secondly, the candidate should not have any type of bond whatsoever with the donor provider and furthermore, the number to be migrated should still be in lively service at the moment of migration.
iii. Thirdly, if the donor network provider is at present having technical issues, the request can be deprived pending to rectification of those technical issues.
iv. Fourthly, the same numbers cannot be ported more than once in 30 days even though there is no restriction over the number of times one can port the same number.
v. Fifthly, if the applicant happens to have any prepaid balance left it will be impossible to transfer it onto the new network.

However, the process of porting itself from the customer's end is very easy. It entails the following three steps:

i. A subscriber walks into the offices of his/her new service provider (Recipient).
ii. The old service provider (Donor) is informed by the beneficiary and the porting procedure commences.
iii. Within 24 hours, the user is informed of the success of the process and he/she starts using the new service. MNP is portrayed as the facility that allows the users customers to toggle network providers whereas maintained their mobile phone numbers. MNP entails porting processes, code of conduct between Donor Operator and Recipient Operator, technology used for porting, competition, and customer standards to decide the achievement or collapse of MNP based on how they are implemented by mobile operators (ICASA, 2018).

As regards to MNP, the network provider which loses a user is called the Donor Operator whilst the one on the gaining side is called the Recipient Operator. As an example, prior the beginning of MNP, all numbers starting with 082 were routed to Vodacom, 083 to MTN and 084 to Cell C, Vodacom, MTN and Cell C are the three mobile network licensees in South Africa. With the establishment of MNP, 082 numbers for example, can now be ported to any network. The centralized database solution adopted in Nigeria though perceived as a long-term target solution for number portability that supports optimal call routing. But it is technically much more complicated to implement and more so involves significant investment.

Nnochiri, *et al.*, (2014) used JAVA programming language to develop the integration front end of MNVSim Suite of mobile network providers in Nigeria, but failed to successfully simulate, developed, and integrate the front end with the backend of the proposed suite. They did not also put into consideration security and authentication of the suite.
The present research will provide a combination of a model architecture that captures the impact of MNP and complementary software that is bound to sharpen the strategy to improving the MNP adoption so that it can become a huge success in Nigeria.

1.1 MNP Research in Developed Country Context

Most literature reviews on MNP in developed countries context can be link to the efforts by researchers to find a way to introduce healthy competition and reduced porting expenses. For instance, (Reinke, 2018) opined that the method by which MNP is deployed may enhance or intimidate healthy competition if it promotes competition in the telecom sector. Also on his own, (Gans and King, 2016) discovered that MNP is helpful and enhances the customers quest for quality services as well as the right to own their mobile phone numbers and to port. Moreover, (Park, *et al.*, 2017) investigated the statistical impact of MNP on the competition and societal benefit. He discovered that MNP has not added much to the societal benefit, but on efficient competition in the telecom sector.

Furthermore, (Buehler and Haucap, 2018) conducted research on the effect of MNP deployment on consumers' welfare. The research entails the impact of MNP on level of information accessible to subscribers. They discovered that callers cannot differentiate between on and off mobile numbers under MNP. This is because number prefix does not have suggestive control. This might result to the customers paying more than normal charges. They also argued that with MNP implementations, the receiver mobile network is to benefits, while the donor network loses. The result of their research proved that MNP will equally improve customers benefit when controlled by telecom's regulatory bodies.

In the USA, (Shin, 2016) investigated subscribers' reception of MNP, they discovered that MNP deployment is going to reduce cost and the subscribers are going to gain. However, the network providers are going to increase customer's lock-in through signing of term agreements which will result in introducing the saddle of hidden charges and rising termination costs. In effect, this adversely affects the effectiveness of MNP; subscribers still feel the high level of switching barriers even after the deployment of MNP. There has been little competition effect in the USA mobile market since the introduction of MNP. Shin and Kim, (2017) investigated subscribers' behavior and acceptability as regards to migration even after the deployment of MNP in Korean market. They found that the customers are yet to comprehend the essence of MNP, thus the merits of MNP have not been harnessed by the customers.

From their results, it could be affirmed that MNP is yet to meet the essence of removing migrating bottleneck which are at large rampant from the customer's view. The results also reviewed that despite the cheap migrating cost of MNP, some other migrating costs could be very expensive. They agreed that MNP has improved migration bottleneck using customer's lock-in method and its strategies. Their results are in tandem with most research conducted on Korean MNP such as (Park, 2018). The importance of MNP have been highlighted by previous researches, however, some inconsistencies are observed in terms of the merits of MNP in many countries.

From review, it could be affirmed that despite the fact that MNP was deployed to add values to the customers, participants might find it difficult due to increase in cost of manufacturing, thus shrinks customers excess. These researches have recommended that the telecom regulating authorities should create more awareness as regards to MNP and not to impose MNP to the operators. This recommendation can be referenced by earlier studies of (Gans and King, 2016). Also, they noted that regulators are challenged with realistic choice of MNP on the on the deployment pattern and how it could be beneficial to the consumers.

1.2. MNP Research in Developing Country Context

Research conducted in South Africa showed that the deployment of MNP has spark up healthy completion among the network providers, (Chweya, 2018). Delays in the migrating method have been identified as one of the hitches of MNP. Odunaike, (2019) researched among students as regards to MNP. He found out that the involvement of students in MNP is very inconsequential. This he said was as a result of the inabilities of MNP to retain customers automatically. He argued that the impact is high on the online connection speed among the students.

Moreover, (Dube, 2016) also found that in South Africa, policy and regulations on MNP had both positive and negative effects. They maintain that although consumers are now able to toggle with network providers while keeping their numbers, prices still remain uncompetitive and quality of service has not been enhanced. Thus, since consumers' expectation has not been meant with MNP implementation in terms of reduced price, the attitude of the intended mobile subscribers' will be affected. And the envisaged advantages of adopting MNP in mobile telecom industry (MTI) in South Africa will be defeated.

Before the deployment of MNP in Nigeria, (Tiamiyu and Mejabi, 2018) studied subscribers' behaviour concerning MNP. Their finding shows that most mobile users are of the opinion of the deployment of the MNP; others insisted that the deployment of MNP will not reduce tariff cost so long as the epileptic power issues persist in the country. Their results further demonstrated that some other factors which include marriage, earnings as well as age also determine customer's mind-sets. Amongst them, age influencing most of the subscriber feelings about MNP in Nigeria.

In Kenya, (Kagwathi, *et al*., 2017) discovered some of the determining factors influencing the adoption of MNP in Kenya market. These factors include amongst others satisfaction, migration bottleneck, delay migration process, customer service, hidden cost Etc.

Similarly, (Ooko, *et al.*, 2014) on their own discovered that following the introduction of MNP in Kenya on April 1st 2011, the migration method has not yielded the expected results citing some factors which coincidented with that identified in (Kagwathi, *et al.*, 2017). In Ghana, previous literature works on MNP only concentrated on the review of MNP and their operational framework.

Odii and Nwokorie, (2020) did research on Predictive Model for Evaluating Mobile Number Portability in Nigeria. The methodologies that were deployed in packaging the model include the statistical methodology, Structured Systems Analysis and design Methodology (SSADM), Object Oriented Design Methodology (OODM) and prototyping. A model called Mobile Number Portability Growth Trend Trajectory Simulator/Predictor (MNPGTTS)was developed using Visual Basic.Net version 10and Microsoft Access as the DBMS engine. The MNPGTTS is capable of forecasting the impact of the MNP restrictions in the next 10-50 years. The MNPGTTS model was test run using the beta coefficients derived from SPSS multiple regressions and ANOVA of collected field data as their indices and later adjusted values of the indices were plugged into the program that enabled them assess the future possibility of MNP expansion. The result demonstrated that if government still allows the existing restrictions, subscribers may not be motivated to port. They opted that if government can remove or improve on most of the restrictions towards the adoption of MNP in Nigeria, MNP will receive a boost in terms of patronage that can range between 50-100%. But they equally warned that should government further stiffen the restrictions, MNP will totally collapse.

Nnochiri, *et al.,* (2014) developed an efficient solution which seeks to improve the current Mobile Number Portability (MNP) scheme in Nigeria from composite operational perspectives. They proposed a network integration framework referred to as Mobile Number Virtual SIM card suit which shows how the limitations of the current MNP architecture could be improved for greater efficiency. The authors used JAVA programming language to develop the integration front end (MNVSim Suite) of the four dominant mobile network providers in Nigeria (MTN, Glo Etisalat and Airtel). They outlined the merits of the proposed system over the existing system. But the authors failed to successfully simulate, developed, and integrate the front end with the backend of the proposed suite. They did not also put into consideration security and authentication of the suite.

Joseph and Joachim (2021) together worked on Switching Cost and Customer Loyalty in the Mobile Phone Market: The Nigerian Experience and are of the opinion that Switching barriers affect significantly the level of customer retention, and also affect the relationship between customer satisfaction and customer retention. They felt that switching costs could be used to predict consumer's behavior in the mobile telecommunication sector.

1.3 Benefits of MNP

a. Quality of service

Competition is the driver of low costs, and quality service and customer attraction and retention among other drivers. Quality of service in this context is based on the consumer's interpretation as it has different meanings. Operators look at the quality of service as the availability of network coverage, upgraded technology and manageable drop calls.

b. Porting information

In South Korea MNP became a success month after it was introduced. Contributory factors were strong positive association with income and awareness of MNP among others. Other countries could not make a positive impact on consumers because of consumer's ignorance on the concept of MNP.

c. Porting times

Previous literature informs us that porting times were one the determining factors in the success or failure of MNP. The researcher has noted however, that research made on the time frames regarding MNP could not conclusively indicate if the short time was an indication of porting success, (Adekunle, 2020).

d. Consumer awareness

When MNP was introduced, many countries conducted *ex ante* and *ex post* assessment to determine if consumers were aware about MNP and investigated if they were ready to embrace it. Customer Education was included in the regulation framework. An *ex-post* study was conducted in South Korea about the effect of MNP and the research results showed that consumers ported because they were aware about MNP.

e. Churn coverage

Churn rate refers to the proportion of contractual customers or subscribers who leave a supplier during a given time period.

f. Value added service

Value added service includes internet data services and video or picture services which are accessible from mobile connection, all bundled together.

This 'triple play' is a competition trend which came as a result of innovation.
Initially these bundled were sold separately. For instance, the 3G card at the beginning was sold separately, but due to competition, different operators began to adopt this trend. These days, whether one is a pre-paid or contract, services are the same. Most handsets and services allow for other value-added services.

g. The switching costs

The switching barrier refers to the difficulty of switching to another provider that is encountered by a customer who is dissatisfied with existing service, or to the financial, social and psychological burden felt by a customer when switching to a new carrier. Essentially if consumers continue to encounter switching barrier, then they will be forced to remain with their existing operator.

1.4 Advantages/Strengths of the Existing System

The existing system of porting in Nigeria has few advantages to its credit and they are outlined below:

a) It shows that Mobile Number Portability can work in Nigeria, and this is a sign of growth in the Nigeria`s telecommunication market.

b) MNP implementation has compelled the various service providers in the country to upgrade their technologies to prevent stagnation and to do network maintenance activities to ensure proper operation of the number portability service.

a) It stirred up a healthy competition among the providers. And for the first time in Nigeria the service providers were afraid of losing subscribers to their rivals through porting.

b) There are numerous flavors and bouquet of value-added services offered by the operators since the implementation of MNP.

c) To some extent there has been a competitive tariff package offered by all service providers.

d) Number portability has given freedom to subscribers to choose any service provider of their choice and at will.

e) The All-call Query framework being used also has less search complexity.

1.5 Weaknesses in the Existing System

Some weaknesses have also been identified in the existing system of porting and call routing in Nigeria and they are as outlined below.

a. A subscriber that intends to port his/her number must be physically present in any of the network provider's outlets in order to declare his/her intention.

b. The intending porting subscriber is meant to manually fill some forms and tender ID cards for proper identification

c. Many subscribers are not motivated to port because of the clumsy administrative procedure in the system.

d. The minimum of 48-hours duration. This is a serious weakness because subscribers would instead prefer to pick up a new SIM and start using almost immediately rather than waiting for 48hours just to port a line.

e. Once a subscriber has been successfully ported to new network, it is mandatory by regulation for the subscriber to stay on that particular network for at least 90days before any other migration. This lock-in period is a major weakness in the existing system because it is possible that the new network provider which the subscriber must have ported-in to is not even better than the old one and as such the subscriber may wish to go back to the donor network almost immediately and that is not possible. The fear of this lock-in period still makes subscribers believe that it is better they stay with the devil they know than to go to the angel they never knew.

c) The Setup cost needed by the network providers to upgrade their technologies and to do network maintenance activities to prevent stagnation and ensure proper operation of the number portability service is very high.

f. Network providers spend more time and money on customer retention programs rather than improving quality of service.

g. The set-up cost for the adopted of All Call Query routing framework is high.

h. The adoption of ACQ alone in re-routing of calls to ported numbers in the existing system makes the whole process sluggish. This is mainly because the ACQ is the most complex to implement as it supports only centralized database which in turn requires considerable national co-ordination.

i. Subscribers don't get benefit of balance / facilities provided by old service provider.

j. There is loss of some specific identity as a result of porting.

k. Involves a number of technical feasibilities as well clerical formalities.

l. Operators not providing up to 3G may not fit in.

m. The centralized database solution adopted in Nigeria though perceived as a long-term target solution for number portability that supports optimal call routing. But it is technically much more complicated to implement and more so involves significant investment.

Figure 1 shows Model for the existing MNVSim in Nigeria.

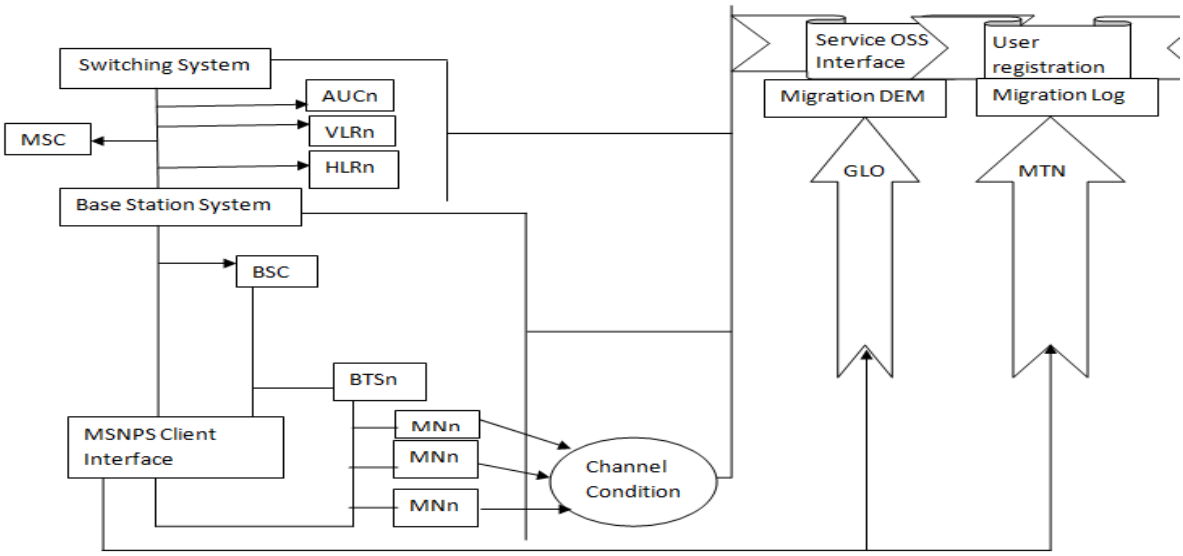


Figure 1: Model for the existing MNVSim in Nigeria

1.6. Mobile Number Portability - How to PORT From Network A to Network B

In this case, any mobile number from any GSM network only can migrate under MNP to induce a drive for excellent service and customer care among the operators.

i. Formulation of MNP Scenario

Now let's analyse a hypothetical scenario of Mr A with phone number 08051327651 who wants to PORT from GLO to MTN. Firstly, Mr A has to go to MTN office to get this done. There, he will be given a new MTN SIM which will still bear his phone number (08051327651). As such the former GLO number now becomes the MTN number completing the porting process.

ii. Scenario Description Terms for the MNP (Porting Process)

Begin ( )

Subscriber: *Mr. A*

Receipt Network: **AIRTEL** Network ➔ Network Which *Mr.A* is Porting into

Donor Network: **GLO** Network➔ Network Which *Mr.A* is porting from

Port In: *Mr.A* is Porting in to **MTN**

Port Out: *Mr.A* is Porting out from **GLO**

Now ( )

To port from **GLO➔MTN**,

Mr.A visits a Customer Service Center of the MTN (Recipient Operator) and Make a request *K*

i. K (Request): Fill a MNP Form

ii. Provide a Valid Proof of Identification with a recent passport

iii. Registered SIM card of Donor network (Must have registered **GLO** Sim with **GLO**) ➔ Porting to **GLO**

iv. GLO Sim *Mr.A* wants to Port must be currently Active

v. Send PORT as SMS to 3232, using the **GLO** Sim that he wants to port

vi. After satisfying this requirement, *Mr.A* will be issued a new MTN Sim which he will insert into his Mobile device, Not Immediately but after a Stipulated period of time by which time the GLO Sim must have deactivated.

vii. The recipient network (**MTN)** will send *Mr.A's* request to **N**umber **P**ortability **C**learing house where the request will be processed.

viii. If the line to be ported, the registered owner of the line and the request are Validated OK, ***Then***

ix. Mr.A's **GLO** Sim will be deactivated and the new **MTN** Sim given to him become **ACTIVE.**

x. Any Credit on his **GLO** Sim will Not be Carried to his new **MTN** Sim

xi. The new Sim will be placed on the recipient network's default tariff plan, or a plan of his preference if applicable.

xii. Mr.A will Not be able to port from MTN to any other network within 90days

Figure 2 shows a Typical MNP Form

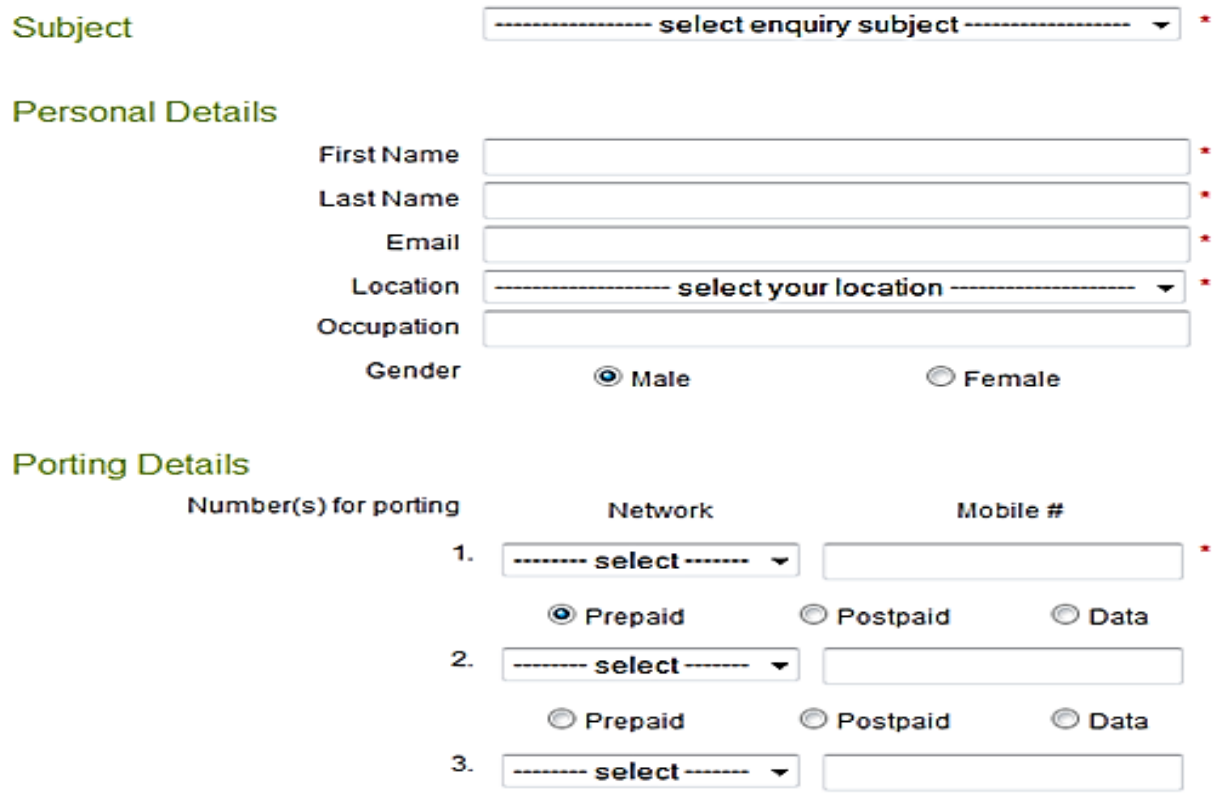


Figure 2: A Typical MNP Form

2.0 Material and methods

2.1 Mathematical model

When a subscriber request for porting service, approval will be given (approval time) J. The service rate, β, which is the frequency of the allocation of C to a subscriber, is the reciprocal of J. Therefore, the average holding time per subscriber is given by:

$$J = 1/\beta \quad (1)$$

Let consider subscribers requesting for porting. The frequency at which these requests arrive at the MSC is known as call arrival rate, α. For the donor network it is denoted λ_1 and λ_2 for the acceptor network. Assuming the number of porting request at the mobile switching centre comes in batches and all the available channels are occupied, any call request is blocked or access to the system is denied. A queue is employed to hold the requesting user until a channel become available. M_1 refer to the size of queue for donor network and M_2 refer to the size of queue for acceptor network. Therefore, at a particular instant the total porting due to donor network is given by:

$$a = (\alpha_1 + \alpha_2)/\beta \quad (2)$$

As a result, the traffic intensity due Donor network is given by:

$$b_1 = \alpha_1/\beta \quad (3)$$

The traffic intensity due Acceptor network is also given by:

$$b_2 = \alpha_2/\beta \quad (4)$$

The probability of a user not having immediate access to porting and the porting getting delayed for any period of time greater than zero is determined by the Erlang C formula given in (Hamad, 2016), as:

$$P_r = [delay > 0] = \frac{A^C}{A^C + C!\left(1 - \frac{A}{C}\right)\sum_{k=0}^{C-1}\frac{A^k}{k!}} \quad (5)$$

Where C is the number of channels, A is the offered traffic.

Assuming all the channels is occupied and the porting is delayed. The probability that the delayed porting is forced to wait more than t seconds is given by the probability that a porting is delayed, multiplied by the conditional probability

that the delay is greater than t seconds. The grade of service of a trunked system where blocked porting is delayed is hence given as:

$$P_r[delay > t] = P_r[delay > 0]P_r[delay > t]delay > 0$$
$$= P_r[delay > 0]e^{\frac{-t(C-A)}{J}(-(C-A)t/J)} \quad (6)$$

The average delay D for all porting in a queue system is given by:

$$D = P_r[delay > 0]\frac{J}{C-A} \quad (7)$$

Where the average delay for those Porting which are queued is given by

$$\frac{J}{C-A} \quad (8)$$

This model characterizes the proposed model and is applied whenever the assumption can be made that the calling rate is independent of the number of calls in progress.

2.2 Materials

The Apache NetBeans IDE platform was used to develop the MNVSim suite. This allowed application to be developed from a set of modular software components called modules using Object oriented programming. The Apache NetBeans IDE is an open-source integrated development environment which supports the development of all Java application types. The MNVSim was written with JAVA programming language in Apache NetBeans IDE with MyQSL XAMPP control panel for the database integration. It was developed as a client in middle tier server application with the selected network service provider's integration on the computing platform.

2.2.1 The proposed MNVsim suite

Number Portability can be in the form of Fixed –to – Fixed Porting, Mobile – to – Fixed Porting, Fixed – to – Mobile Porting- and Mobile – to – Mobile Porting- The proposed MNVSim leverages the Mobile –Mobile-Porting while utilizing a centralized database in which the regulatory authority NCC. In this case, the two service providers considered (MTN and GLO) will have a shared and well-defined interface with a centralized Number Portability administration canter for processing the porting request of a number.

Figure 3 shows the proposed Network Integration with an All-call-query approach for Portability

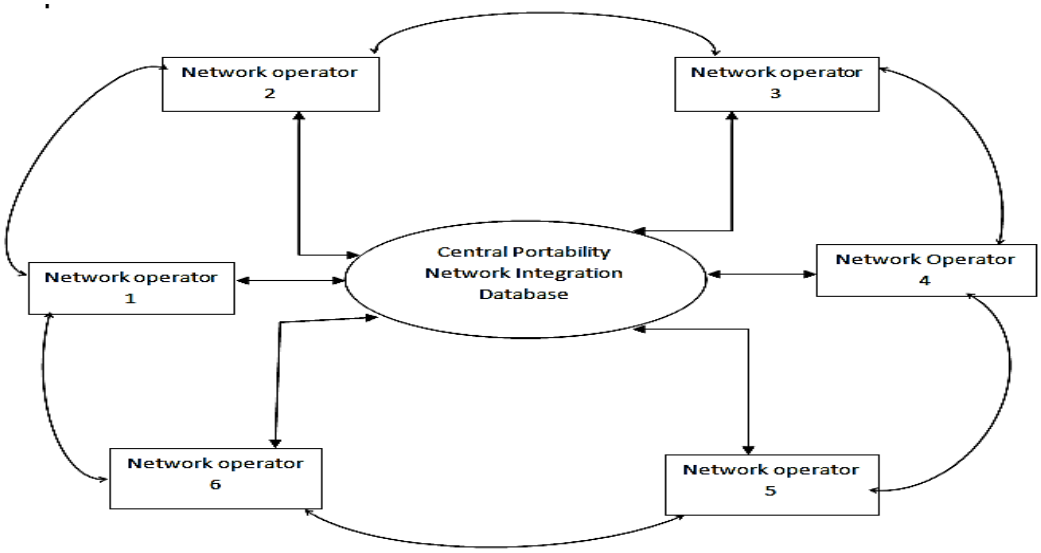


Figure 3: Proposed Network Integration with an All-call-query approach for Portability

2.2.2. Operational Mechanisms

Figure 3 illustrates our methodology which involves the originating network directly requesting the location routing number from a central portability database. This information is then used to route the call to the appropriate ending network's gateway mobile switching centre. In order to establish the call, the gateway mobile switching centre also configures a trunk to the serving mobile switching centre. The donor network routes calls most effectively by utilising network resources without interfering with the call process. Because of this, this strategy is thought to be the most effective routing scheme for big, networked networks with plenty of port numbers. The research has highlighted the shortcomings of the current MNP architecture in the sections above. We'll provide a brand-new QoS architecture that aims to compel network operators to act quickly in order to meet increased QoS demands. The suggested solutions for each of the aforementioned challenges will work with the framework. We discuss the network migration interface in brief, which conveys the stored migration process in the distant NCC centralised data center. The solution for enhancing GSM performance in terms of service quality must be offered by this framework. It first provides a thorough assessment of the network while safely enabling user transfer to any network provider that consistently provides a reasonably efficient KPI. The existing GSM network from GLO or MTN comprises of the switching system (SS), base station system (BSS) and the support system as shown in figure 5. As can be seen in Figure 5, the SS handles all call processing and subscriber-related tasks. It consists of the Home Location Register (HLR), which keeps subscriber data, the Visitor Location Register (VLR), which keeps subscriber data temporarily until the Mobile Services Switching Centre (MSC) needs it, and the Mobile Services Switching Centre (MSC), which handles the system's telephony switching functions, like channel signalling and network interfacing. The Equipment Identity Register (EIR) is a database that holds details on mobile equipment, while the Authentication Centre (AUC) handles encryption and authentication for user identity verification and secrecy. The AUC and EIR systems are operated independently.

Figure 4 shows a Generic GSM System.

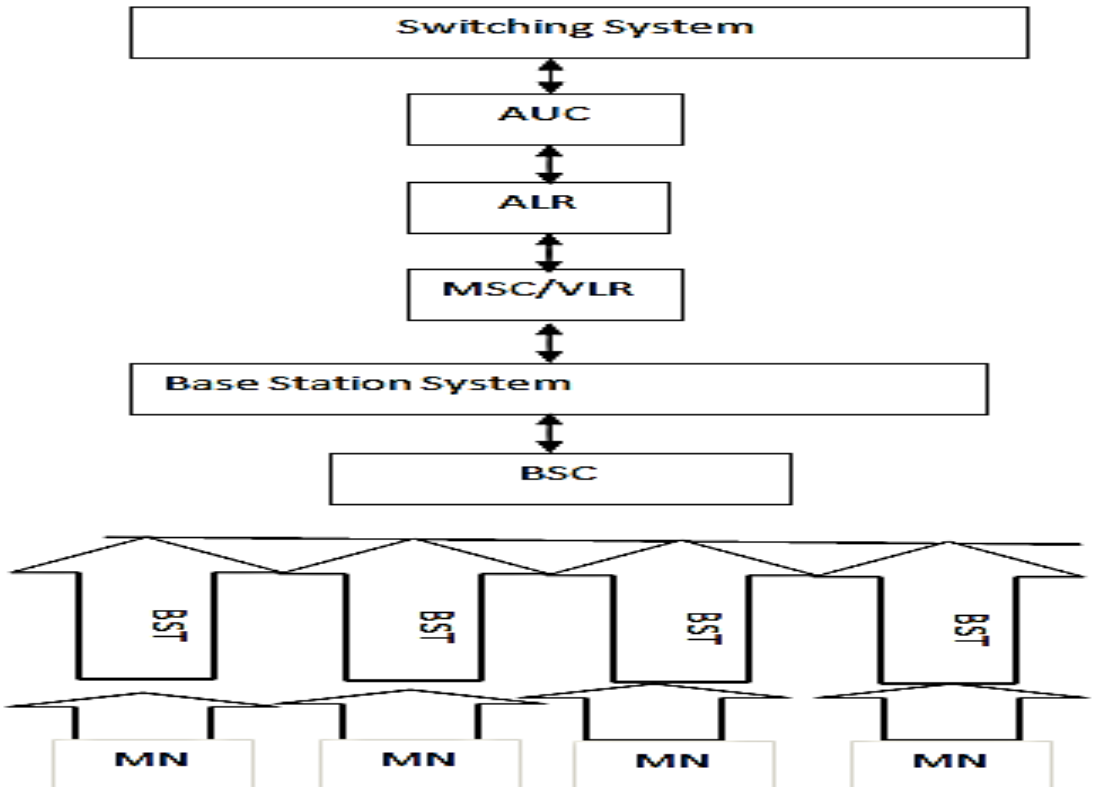


Figure 4: Generic GSM System

The Base Transceiver Stations (BTS) and Base Station Controller (BSC) make up the Base Station System (BSS), which handles all radio-related tasks. The BSC is a large capacity switch that connects the MSC and BTS physically and handles all control functions. Handover, cell configuration information, and radio frequency (RF) power level management in the BTS are a few of these features. An MSC provides services to several BSCs. The mobile station's radio interface is managed by the BTS. It is the radio gear (antennas and transceivers) required to service every network cell. A BSC is in charge of a group of BTS. All equipment connected to the switching system and the BSC is operated and maintained by the OSS.
It is the functional unit from which the system is controlled and monitored by the network operators. Its goal is to provide the client with affordable assistance for local, regional, and centralised operations and maintenance tasks that are necessary for a GSM network.

Figure 5 shows the Conceptual System Model for MNVSim. Figure 5 seeks to remove the bureaucratic processes associated with the scheme so as to make it more attractive to the citizenry. Also, this will encourage infrastructure sharing among the GSM operators thereby reducing cost while improving QoS.

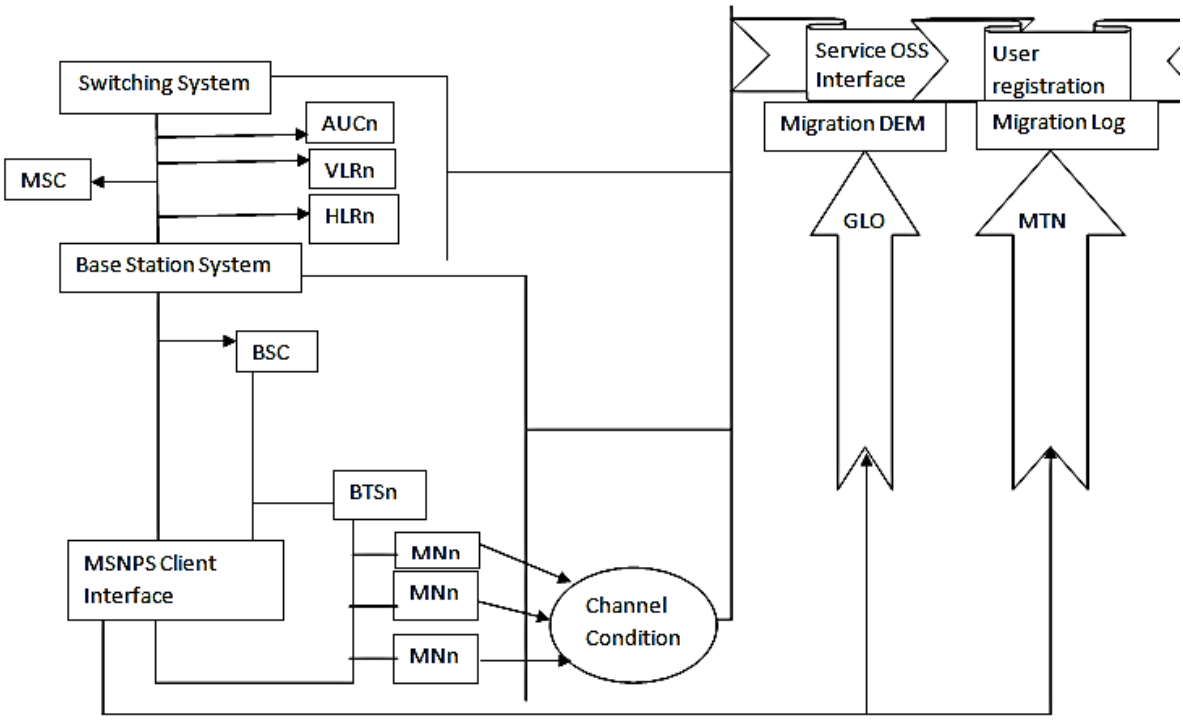


Figure 5: Conceptual System Model for MNVSim

From figure 5, a Java Virtual machine (JVM) which sits on the Mobile Nodes (MN) runs the Mobile SIM Number Portability Suite (MSNPS). All the MNs faces the same channel BER problem, but the MSNPS features two basic migrations for operators with poor KPI thresholds, viz:
- Migration To MTN
- Migration To GLO
In the operating model, every registered user has a high level of encryption running on the mobile device for safe migration to any chosen network. MNVSim provides real time reach and balance checking etc. At the NCC switch, migration sessions and security encryption are stored in a migration database running on the server. All migration operations and other transactions still maintain the assigned mobile number. In essence, the objective of this research is to adjust figure 5 for every GSM network operator with smooth integration with NSS for high availability and reliability of KPI in Nigeria.

3.0 Results and Discussions

The model is a combination of a model architecture that captures the impact of MNP and complementary software that is bound to sharpen the strategy to improving the MNP adoption so that it can become a huge success in Nigeria. When a call is made to a number, the originating network now has the option to either query the central database or liaise with the donor network to query its local database in order to retrieve the routing number with which to route the call. The model combines the functionality of ACQ and Call Drop back models. This routing model ensures less search complexity which in turn ensures faster porting; less network seizures and less volume of dropped calls which are being experienced today even with the MNP in place.

The application is made to be very portable since the approach of implementation ignored the usage of database like Sybase or Oracle, as such there is no drain on the system resources when deployed.

The model developed in this work took into consideration the deficiencies as found in Nnochiri, *et al.*, (2014), and successfully developed, simulated and integrated the front end with the backend of the proposed suite. The security and authentication of the suite were equally developed.

Figure 6 shows a valid XAMPP Control Panel Interface of the suite.

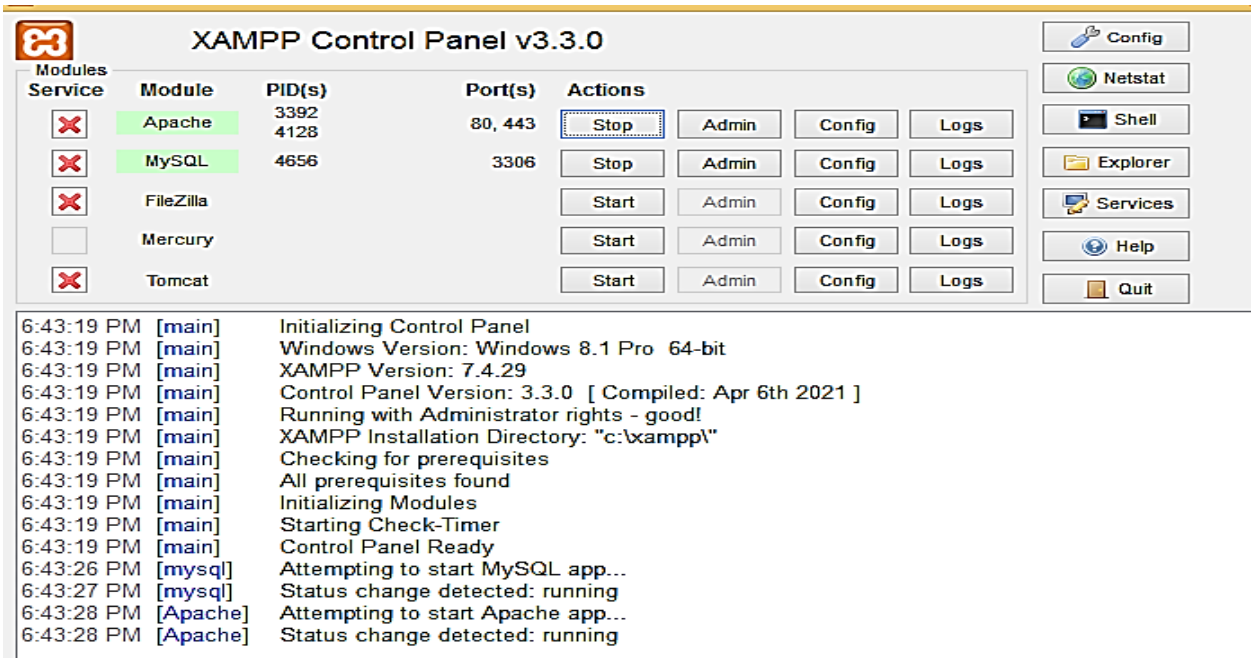


Figure 6: A Valid XAMPP Control Panel Interface

From figure 6, XAMPP Control Panel was used to provide efficient management of the software in the XAMPP package. The Control Panel is use to determine whether Apache and MySQL are currently running and to start or stop them. Before the development environment can be used, Apache and MySQL must be running.

Figure 7 shows a Valid Apache NetBeans IDE Interface

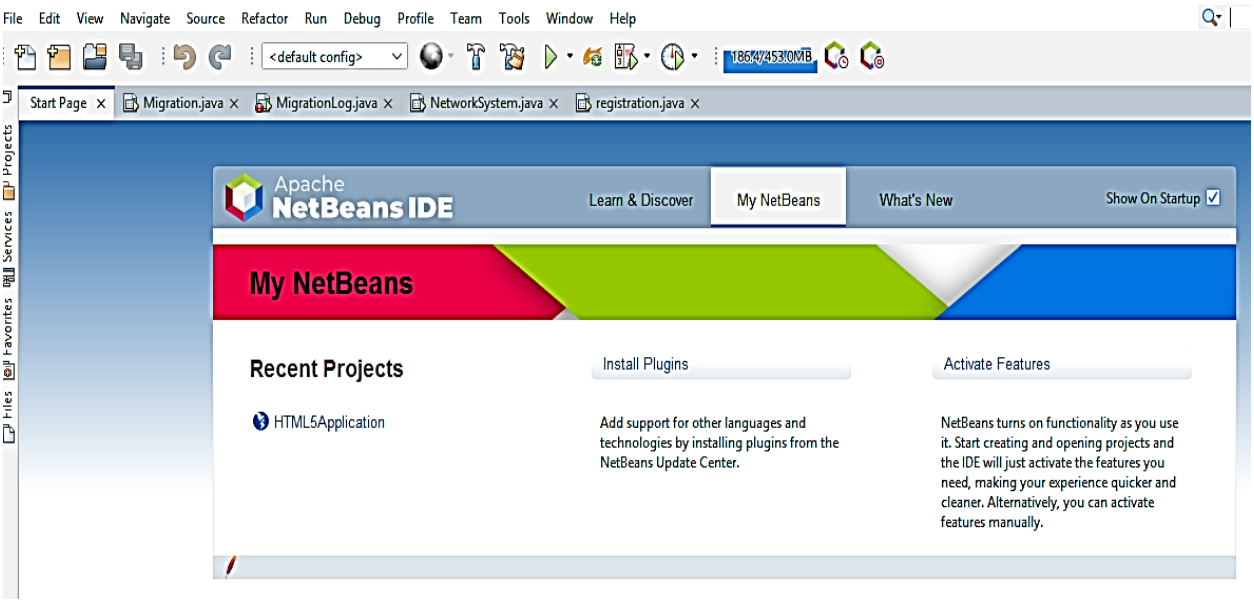


Figure 7: A Valid Apache NetBeans IDE Interface

From figure 7, Apache Netbeans, an open-source Integrated Development Environment (IDE) used to develop applications with Java other programming languages are shown. The applications are developed using modules in Java. It can run on any operating system such as Windows and Linux etc.

Figure 8 shows a valid phpMyAdmin server Interface

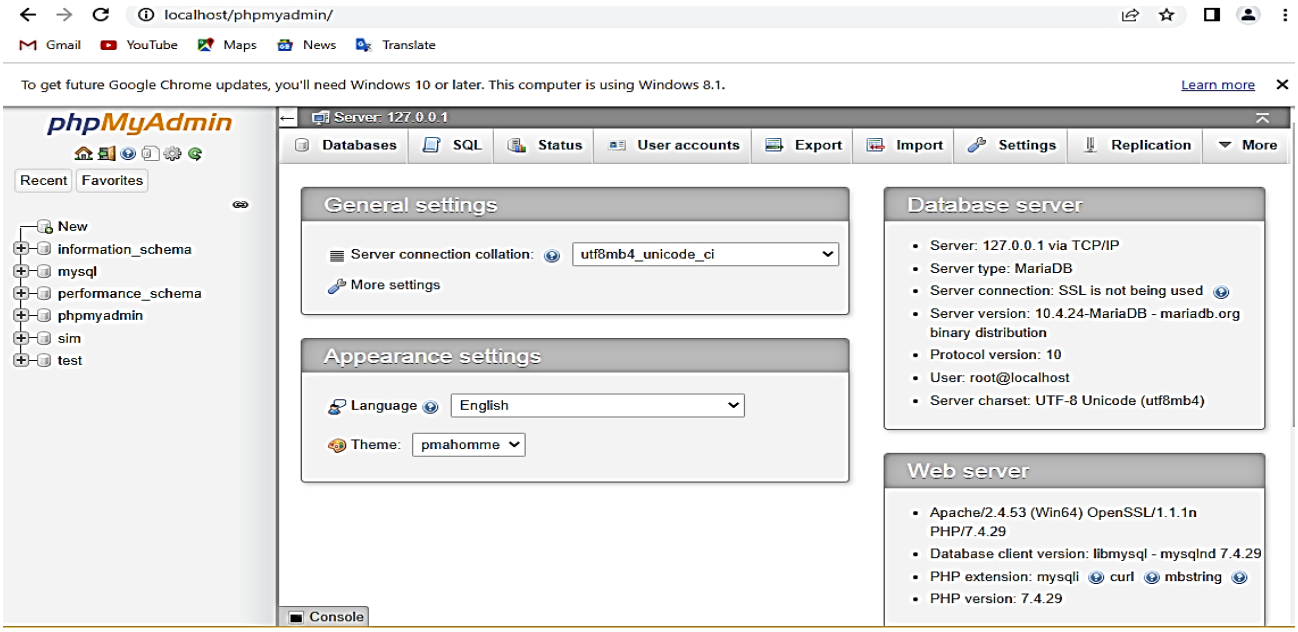


Figure 8: A Valid phpMyAdmin server Interface

phpMyAdmin server Interface shown in Figure 8 is a third-party tool to manage the tables and data inside a database. phpMyAdmin supports various type of operations on MySQL. The main purpose of phpMyAdmin is to handle the administration of MySQL over the web. It is the most popular application for MySQL database management. It can be used to create, update, drop, alter, delete, import, and export MySQL database tables. The operations are performed

via user interface, while still having the ability to execute any SQL statement. It provides a web-based interface and can run on any server. Since it is web-based, it can be accessed from any computer.

Figure 9 shows a Valid User Login Interface. The Login form serves as a security and authentication check.

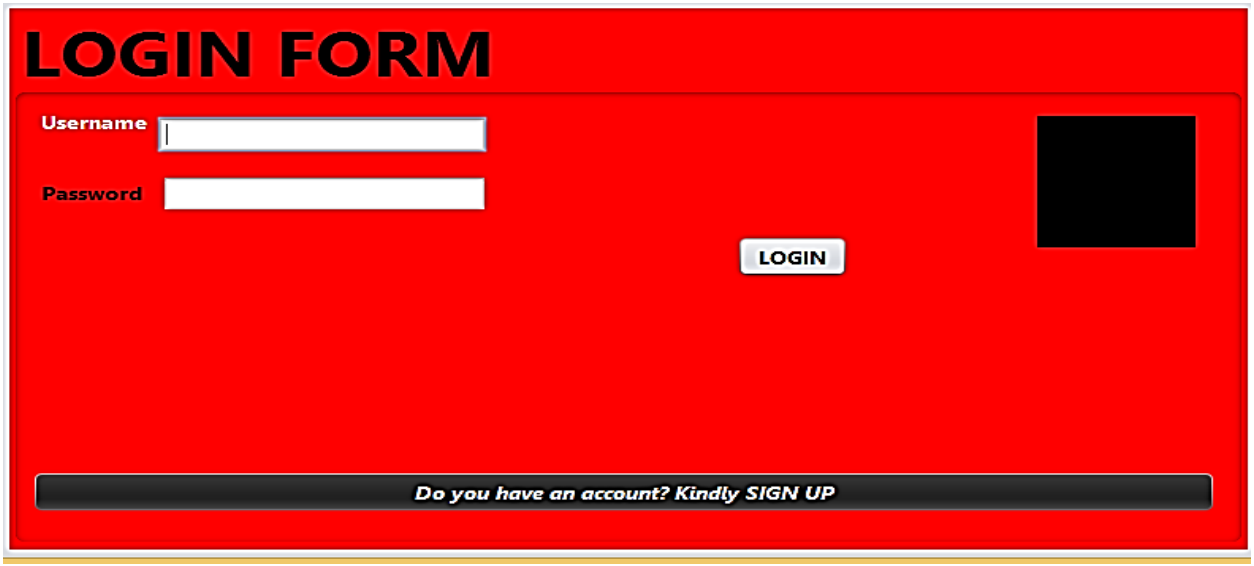


Figure 9: A Valid User Login Interface.

As seen from Figure 9, the Login form serves as a security and authentication check. This is an improvement on what was found in literature, (Nnochiri, *et al.*, 2014)

Figure 10 shows a Valid User Simulation Interface.

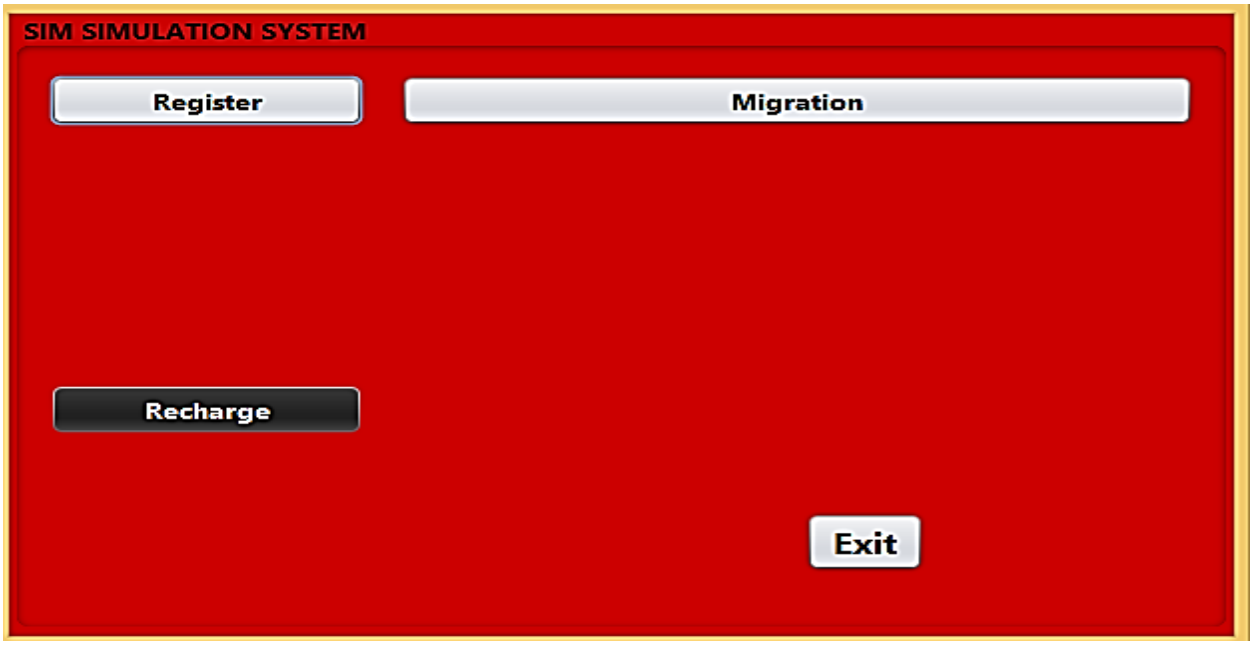


Figure 10: A Valid User Simulation Interface

The user interface as shown Figure 10 is the aggregate of means by which the user interacts with the system and the program. The simulator in this research is constructed based on the simulation model. It is interactive and provides managers with a user interface that allows them to experiment with the model.

Figure 11 shows an implementation of a valid user SIM card registration interface.

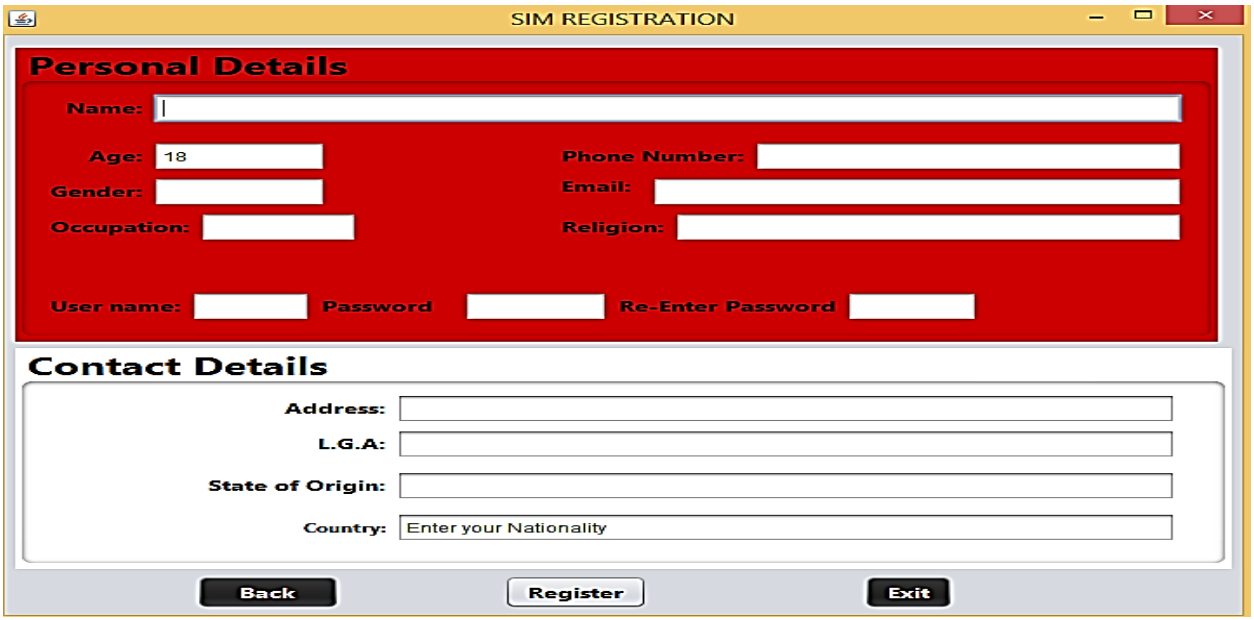


Figure 11: A Valid User Sim card Registration Interface

As sown in Figure 11, by submitting the registration details, the users have by default accepted the service level agreement without many bureaucracies.

Figure 12 shows a Migration Log Interface

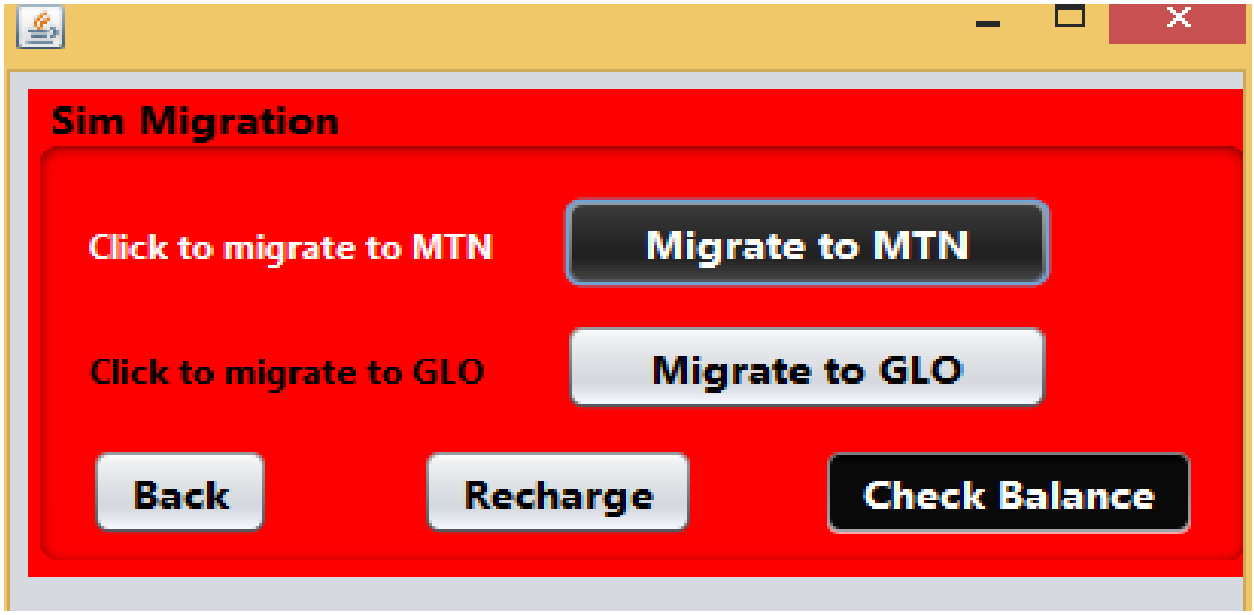


Figure 12: A Migration Log Interface.

As shown in figure 12, the proposed system by default supports the two key networks while only supporting one active migration at any time leveraging the centralized database as shown in figure 3. In figure 12, a valid network user migrates to MTN.

Figure 13 shows how as valid user that have migrated to Glo can explore the MNPSim suite of recharging cards.

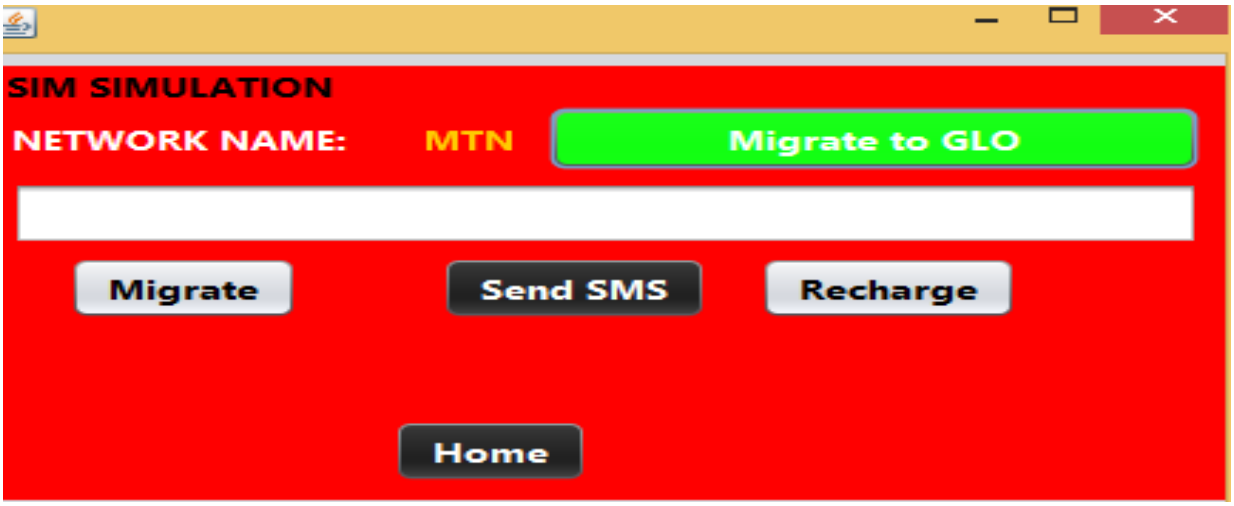


Figure 13: A Valid User Migration to Glo

Figure 14 shows the database capture of the network migrations specifying the id, network, time stamp with its descriptions.

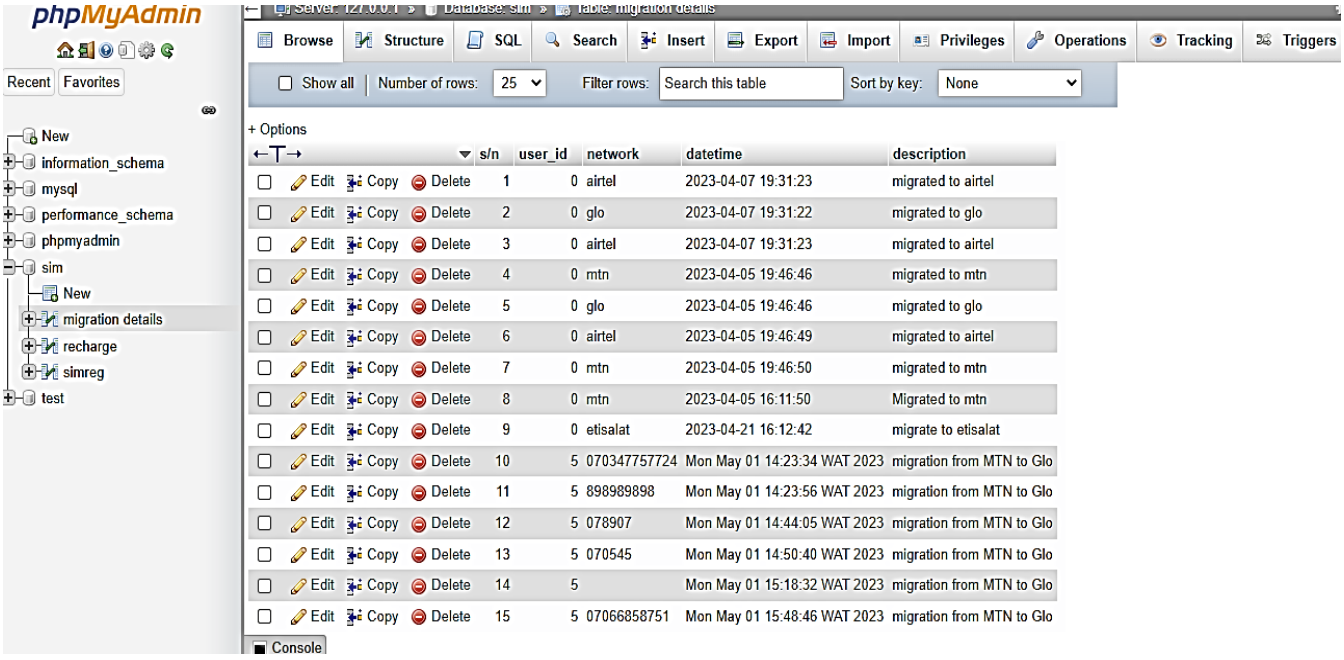


Figure 14: A Valid User Simcard Network Migration Log Interface

Figure 15 shows the database capture of the network recharge cards specifying the network and the card pins.

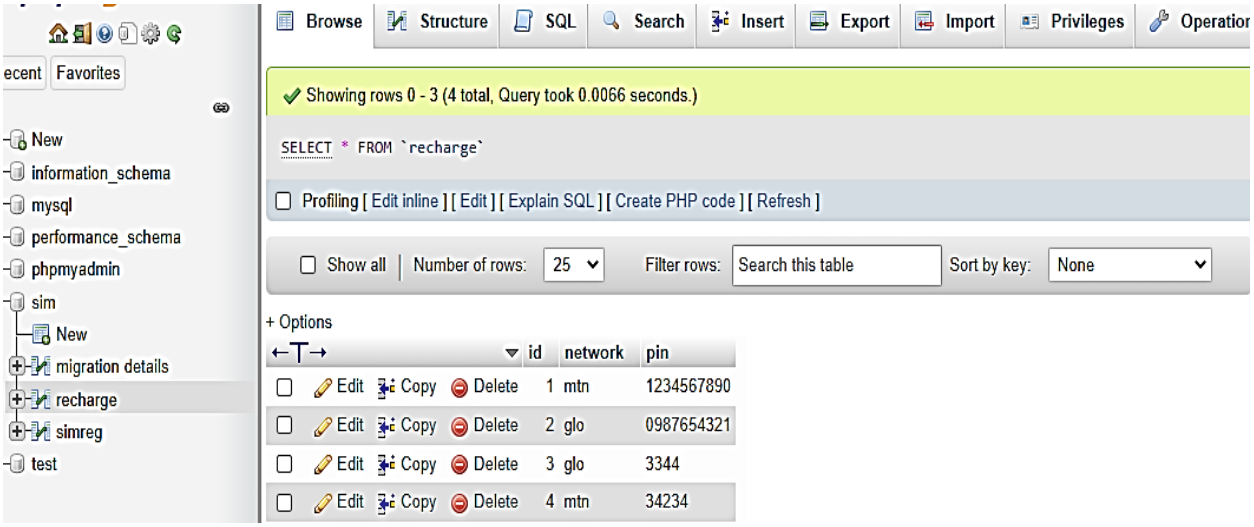


Figure 15: Recharge cards specifying the network and the card pins.

Figure 16 shows the Simcard Registration Details in the Network Integration Server Backend

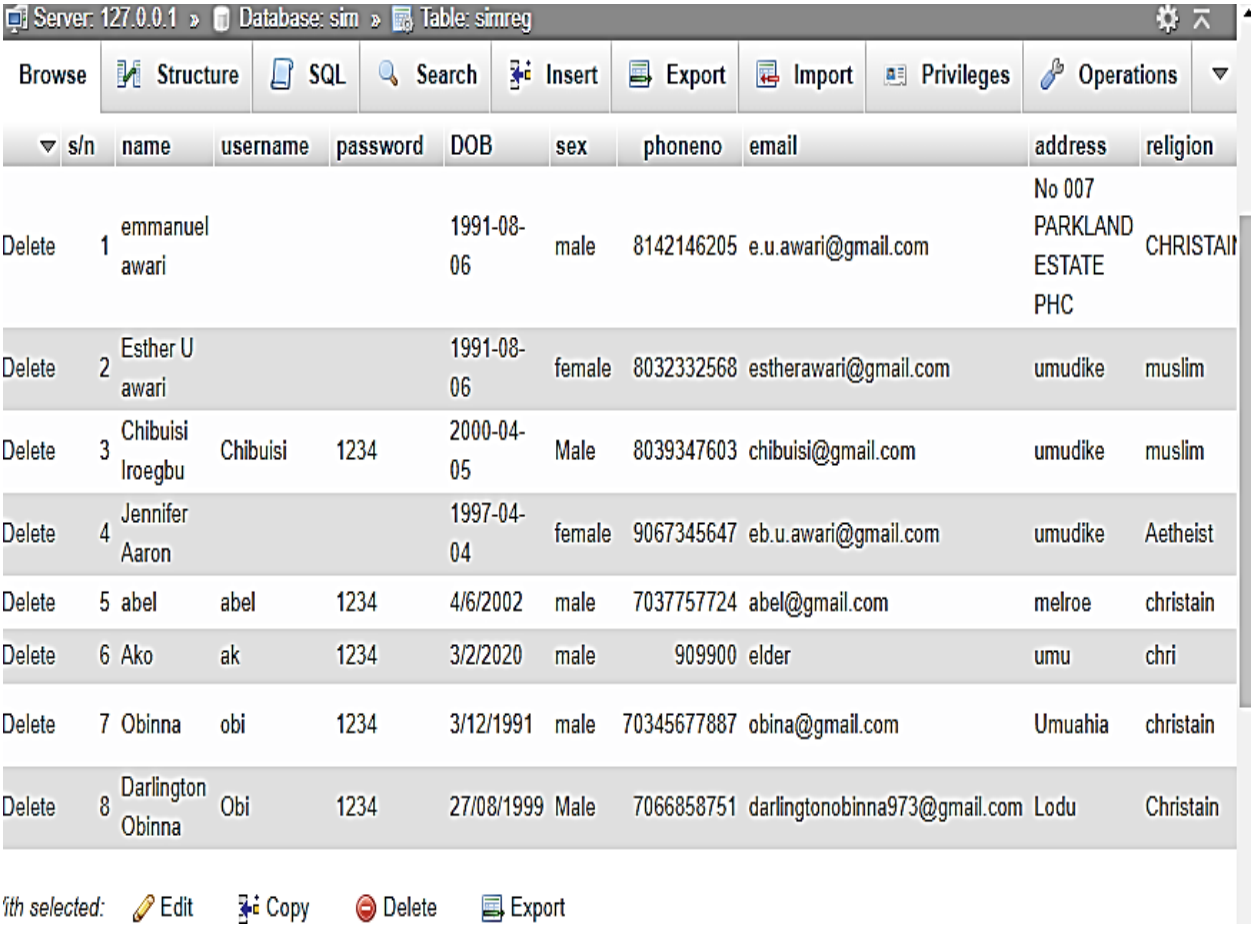


Figure 16: Simcard Registration Details in the Network Integration Server Backend

4.0. Conclusion

MNVSim suite, an improved platform which can be used as a replacement for the existing MNP vis-à-vis Subscriber Identity Module (SIM) proposed by Trusted Computing Group Mobile Phone Work Group (TCG MPWG) Reference Architecture has been developed. Consequently, this research then develops a Java VSIM portability Suite for Mobile Number Portability (MNP) while formulating a parametric SIM network algorithm. The approach in this research demonstrates the replacability of the existing MNP SIM card GSM architecture with an adequate trusted software module proposed to demonstrates the functionalities of the network integrations. In the research, a JAVA programming language was used to develop the integration front end of MNVSim Suite of the two dominant mobile network providers in Nigeria (MTN and Glo). The research successfully developed, simulated and integrated the front end with the backend of the proposed suite. The security and authentication of the suite were equally considered.

5.0 Recommendation

This work recommends that the regulators must actively encourage the use of improved MNP scheme to avoid subscriber exploitation while compelling service providers to come up with innovative scheme that will improve QoS. Also, the research recommends the concept of infrastructure sharing among the operators to reduce their cost of infrastructural deployment, maintenance, etc, allowing them to focus on QoS.

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