



## Using Software Engineering Approach in Mitigating QoS Challenges in Mobile Communication Networks in Nigeria

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### ABSTRACT

As a result of telecommunication poor Quality of Service (QoS) in Nigeria with respect to voice, data and video services, several works have been carried out using approaches such as drive test, survey design with statistical computation techniques, modeling simulation, etc. These have been employed to carry out comprehensive evaluation and optimization of Quality of Service (QoS) of Mobile Cellular Networks in Nigeria. In this context, there are five major Key Performance Indices (KPIs) which are usually considered for the evaluation, viz: Call Setup Success Rate (CSSR), Call Completion Rate (CCR), Call Drop Rate (CDR), Call Handover Success Rate (CHSR) and Standalone Dedicated Control Channel (SDCCH). In this paper, following data collated from a recently conducted drive test KPIs, we leveraged software engineering SDLC concepts, particularly using JAVA programming language to develop an optimization drive test plant for improving QoS thresholds by service providers. A test dataset for the months of April and March 2012 was used in the drive test plant design. In this regard, the raw data set, the optimized dataset and the normalized data sets were shown in the drive test plant. Relevant flowcharts were developed and discussed in the context of the drive test plant. This work argued that with the drive test plant properly integrated into the vendors Mobile Switching Centers (MSC), the QoS thresholds by NCC will be satisfied. Consequently, this work calls for a mobile community driven responses while future work will focus on integration validations necessary to boost the performance of the KPIs in order to guarantee a better Quality of Service.

**Keywords:** Quality of Service, Cellular, Networks, Software Engineering, Thresholds, Validations, Optimization.

### 1. INTRODUCTION

According to Alexander et al (2013), the objective measurement of service quality in mobile cellular networks has been very difficult to key players in the industry because of the divergence of views. Some judge quality based on reliability, security, assurance, simplicity and flexibility of the network, others focused on coverage, rewards and offering of incentives, prices of service and billing etc. A sound infrastructure in the telecommunication (telecom) sector is vital for sustainable economic growth of a country (Muhammad et al, 2010). Quality of service in Mobile communications in Nigeria and monitoring QoS of any telecommunication network requires continuous processes that measure values of the Key Performance Indicator (KPI) parameters in real-time and analyse the measured empirical data of the KPIs which determines quality of service rendered to the subscribers (Idigo, et al (2012). The Nigerian telecommunications industry is rapidly growing and many operators and their operations put forth different services, but in the diverse services provided most of the subscribers do not receive satisfaction due to the poor nature of services available on these networks.



Competition in the industry is a likely tool that would indirectly improve services rendered, but this is not yet the case in Nigeria since competition in the telecommunications industry is fairly new and may be described as being inefficient. Hence, there has been a persistent outcry in the media and series of complaints from the National Assembly on the poor performance of mobile telecommunication networks in Nigeria (Idigo, et al (2012)). There are many network parameters that evaluate the quality of delivered network service; this study will be limited to the following Key Performance Indicator (KPI) parameters: Call Setup Success Rate (CSSR), Call Completion Rate (CCR), Call Drop Rate (CDR), Call Handover Success Rate (CHSR) and Standalone Dedicated Control Channel (SDCCH). Using Software development Life Cycle (SDLC), an application that offers optimization and normalization of KPI values will be widely accepted. This paper, will first use the drive test data obtained for the months of March and April 2012 as the raw data while showing the application drive test plant for the optimization and normalization of KPI values.

## 2. RELATED WORKS

Mudassar et al (2010) in their work, evaluated real GSM Radio Access network. Different issues, findings, trials and improvements was summarized while listing their observations/recommendations to correlate the practical aspects of RF optimization, which affect the performance, and QoS of an operational cellular network. Osahenvenwen et al (2010), in their paper is focused on traffic analysis in Mobile Communication network (GSM). In their paper, traffic data (Air-interface arrival record on the MSC) were collected from the Operation and Maintenance Centre (OMC) whose investigation covered 10 routes in a period of six months. The result showed that the offered traffic and carried traffic both have a slight variation from each other. This indicates that the blocks calls experience in the routes, within that period of time is minimum. The authors opined that the results will mobile operators to carry out traffic analysis on their network and make the necessary adjustment to obtained good QoS. Madhusmita et al (2011), investigated on delivered quality of service (QoS) in the context of traffic analysis & optimization for network planning and design. The work summarized the measurements taken on an operative GSM-900 & GSM-1800 network to evaluate and optimize traffic. The authors established statistically four parametric facts while presenting the results of an extensive study of GSM network utilization. The paper consequently opined that the findings can be network planning engineers for decisions on timely, efficient management and investment on infrastructure.

Idigo et al (2012) investigated and analyze the Quality of Service (QoS) of cellular mobile networks in Nigeria using some Network Key Performance Indicators (KPI). The study was limited to Visafone Mobile Network while analyzing the following KPIs: Call Setup Success Ratio (CSSR), Call Drop Ratio (CDR) and Traffic Channel (TCH) Congestion Ratio. The measurements were sampled and collated from the Network Operating Centres (NOCs) and their values were evaluated against the standard threshold values set by telecommunications regulatory body, the Nigerian Communications Commission (NCC) in Nigeria. The results obtained were compared with NCC KPIs only. Gabor (2005), presented optimization Problems in Mobile Communication. The work analysed and provides solution approaches to some of the algorithmic questions raised by the optimization problems by using complexity theory, heuristics, approximation and online algorithms.

COPCA, (2007) proposed an improved model for GSM/GPRS/EDGE performance evaluation. The addressed the performance evaluation problem of these networks, focusing on the influence of different operational details viz different data and voice models are studied, including a traffic prioritization model of great relevance facing the increasing popularity of new multimedia services offered through these networks. In the work, the proposed models were finally applied to the performance evaluation of the local operator's network. Popoola et al (2009) gave an insight into network performance evaluation and quality of service (QoS) improvement of GSM cellular system in Nigeria. The components of QoS and mechanisms of analysing and evaluating them was discussed. The paper also identified the important key performance indicators (KPIs) for QoS evaluation which are used in evaluation the GSM network. Four assessment parameters (network accessibility, service retainability, connection quality and network coverage) for evaluating QoS on the network were employed.



Haider *et al* (2009) in their paper, carried out real GSM radio frequency (RF) network performance evaluation presented on the basis of four major KPIs i.e., Call set up success rate (CSSR), Call Drop Rate (CDR), Handover Success Rate (HSR) and Radio traffic channel (TCH) congestion rate. Different issues, findings, trials and improvements was summarized while making observations/recommendations to correlate the practical aspects of RF optimization, which affect the performance, and QoS of an operational cellular network. The work by Biebuma *et al* (2010) carried out a precise analysis of mobile user's behaviour in terms of mobility and traffic in bid to optimize capacity for both circuit and packet switched services. The research work employed the multiplicity of techniques for the capacity analysis of GSM network in Nigeria. Enhanced stochastic knapsack was evaluated for resource sharing approach in multi-services while Erlang Loss Model was adopted for SMS capacity analysis. Utpal *et al*, conducted the first detailed measurement analysis of network resource usage and subscriber behaviour using a largescale data set collected inside a nationwide 3G cellular data network.

Muhammad (2010), examined the dimensions of users' perceived service quality of cellular mobile telephone operators in Pakistan. In their approach, a structured questionnaire, covering SERVQUAL dimensions of tangible, reliability, assurance, empathy, responsiveness, and additional dimensions of network quality and convenience, was used to measure mobile phone users' perception about service quality. Jianyong *et al* (2010), proposed a novel model for evaluating optimal parameters of security and Quality of Service. The model uses an adaptive immune algorithm to get optimal parameters of security and QoS. The work concludes that the simulations results shows an effective approach to achieving optimal balance between the security and the QoS. Alexei *et al* (2009) as a part of its optimization strategy, presented an integer programming model with a computational tool for designing GSM (Global System for Mobile Communications) networks, regarding BSS (Base Station Subsystem) with optimized cost.

From the research studies carried out so far in literature, the need for KPI optimization in a Mobile Switching Center for GSM networks is observed to be very expedient. Existing works in literature have not made any attempt to use software integration for KPI optimization. Consequently, a flowchart framework for KPI optimization in GSM networks will be developed. In this research, the need for KPI Optimization in a drive test plant includes:

- 1) Efficient service delivery
- 2) Effective cost reduction in network capacity planning for BTS, MSC ,etc.

This work will concentrate on developing a software application framework which serves as an optimization engine for all providers KPIs

### 3. METHODOLOGY

#### 3.1 Description Of Drive Test Procedure for KPI Generation

This chapter describes the step-by step procedure that was carried out during the drive test. In the drive test, two major stages were employed. The first part is the data collection module, while the second part was the analysis module. For proper understanding of the processes involved in this real-time survey on mobile network performances, a brief description of the measurement tool used in acquiring the data and its merits will be vital. This statistical monitoring equipment is the most appropriate tool for QOS data measurement and evaluation. This is because mobile cellular networks design was based on statistical concept. The QOS measurement system used in this project is QVOICE which comprises two parts: QVM (Data acquisition part) and QVP (Data evaluation part). The QVM (Qvoice Mobile) is a mobile piece of equipment that is mounted in a car to enable QOS measurement in motion. This equipment is compatible with GSM/GPRS/EDGE/WCDMA/CDMA2000/HSDPA technologies. Its area of application ranges from pocket, pedestrian, vehicle, fixed, monitoring, service testing, benchmarking and optimizing etc. QVOICE uses an integrated programming language of both Visual basic and Map basic in its analysis component. Since window base programs as well as Map Info functions are required. It also uses a referenced speech evaluation algorithm in speech testing and as well can measure up to four channels simultaneously.

This avails the opportunity of testing the four GSM Mobile networks in Nigeria. Hence, the need for adoption of drive test approach for this project. Inside the QVM is a special make cell phone Nokia (6230i) used in placing calls while testing the networks performances. It consists of uplink and downlink paths corresponding to master and slave controlled by a window based system with special software, which provides interface for importation of files to database during analysis. In the course of call or file transfer, the performance of the network at any instant time and air interface data is recorded by the QVM. The QVP (QVOICE Presentation) is the evaluation part of the system. This is the main post-processing unit of the measured data from the QVM. It uses Microsoft SQL-Server. After measurement the data collated will be imported into QVP part for proper analysis, thereafter reports on them is generated.

### 3.2. Drive Test Analysis for Macromobility Scenario

Before developing the proposed drive test process plant, there is need to use the drive test macromobility strategy to obtain QOS dataset for further investigations in this work. Drive test strategy involves the use of GSM based vehicle equipped with various networks configured in master slave architecture with a terminal monitor to capture the QOS datasets (See figure 3.1). In this regard,

- It adopts a user pattern that can be programmed into the equipment; includes number of trials at a time.
- The macromobility aspect of the mobile network is fully captured in it.
- Data acquired during the drive test can be processed in the post-processing center.
- It enables generation of QOS statistics for both intra-and inter-network calls.
- Large number of calls is tested covering a wider geographical region during the drive process.
- The equipment can perfectly evaluate speech quality of connected calls.

### 3.3 Test Equipment Description

As stated earlier, the data was collected using **QVOICE** as a measuring tool, Figure (3.1) shows the parts of **QVOICE** monitoring equipment. Part (a) illustrates the data capturing part (with four Mobile phones) that was used to collect live data during the drive test. While part (b), illustrates the data evaluation part.



**Figure 3.1 (a) QVM data collection part (b) QVP data analysis part. (Source: NCC-Abuja, Nigeria)**

The test was conducted on the four major GSM operators namely: MTN, GLO, AIRTEL, and ETISALAT using Abuja as a case study for our macromobility study in this paper. Figure 3.2 shows the overall structured empirical methodology for our data gathering.

### 3.4 Measurement Environment

In this research, federal capital territory Abuja environment was used as a test-bed for the drive test macromobility study. It is located in the northern central part of Nigeria. The city has an area of about 713km squares with a population of about 776,298 inhabitants. It is an urban area made up of mid-range and few tall buildings. Its day-time temperature fluctuates between 28°C to 30°C, while night-time ranges from 22°C to 23°C. It has high altitude and undulating terrain. As shown in figure 3.2, the structured approach for QoS involves site survey, using Qvoice viz-a-vis drive test macromobility. Data transfer for post processing is carried out but if transfer success is satisfied, evaluation is then carried out; else the QVoice continues the data acquisition process.

### 3.5 Macromobility Drive Test Route

The macromobility test route in Federal Capital Territory (FCT), Abuja is in figure 3.3 considering the available number of base stations in the metropolis. The was captured using the MapInfo tool of the QVM, which was later imported into the QVP for post-processing in order to trace locations congestions and poor coverage occurred.

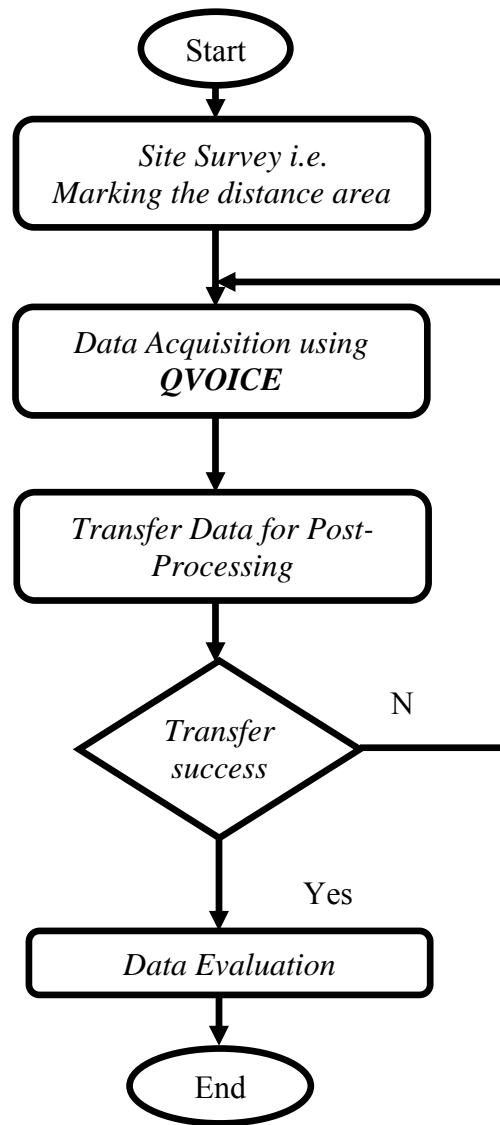
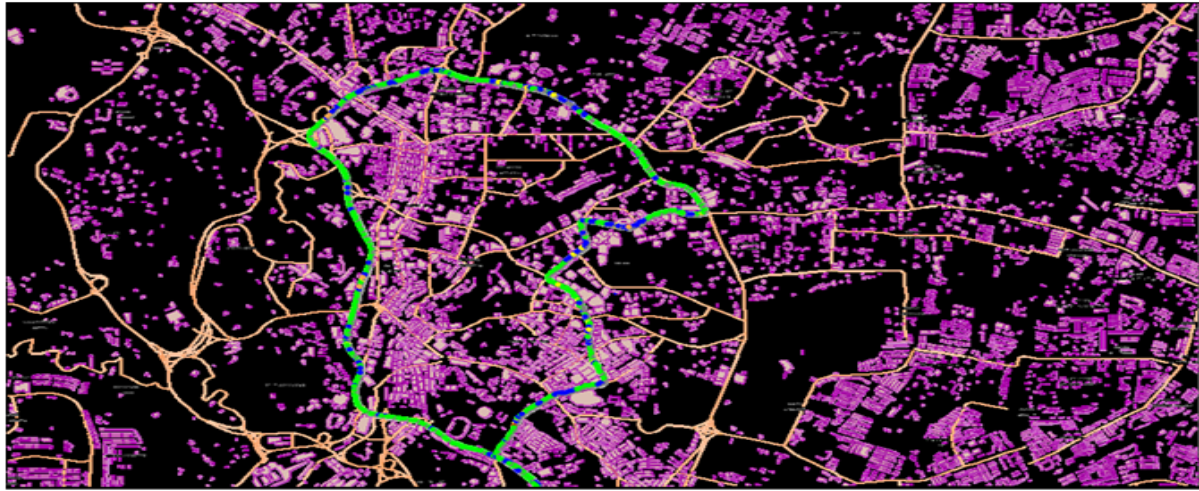


Figure 3.2: Structured Methodology for QoS Data gathering





**Figure 3.3: Macromobility Test Route (NCC-Abuja, Nigeria)**

The drive test was carried out using the client (Mobile) in accessing the live GSM network and recording the data from the air interface. External Global Positioning System (GPS) system was interfaced for acquiring location coordinates (x, y) of the measurement points; its elevation; as well as the direction of movement and the speed of the mobile equipment. As noted, the standard for BTS height is 30m above sea level, but with this GPS system, the BTS conformity test with the regulatory standards can be made as the mobile vehicle moves around covering various BTS and BSC required. In the voice channel, data on parameters like echo, gain, silence, and SNRI etc is recorded and displayed on the system as the test was on. Also, the quality of the speech (RxQual) threshold level amongst other threshold values set by the regulatory body in the telecommunications industry is shown in table 3.1 which will be used to ascertain the quality of service offered by the various network providers in Nigeria.

However, data on call error, setup, successful connections, failures etc will be shown for proper analysis. With these pre-defined thresholds stated in the table 3.1 (a, b, c), one can see that drive test approach adopted for this research captures more details parameters for analysis and evaluation of QOS. After obtaining relevant data, this project seeks to show that under macromobility scenario, the QOS of GSM operators can be captured and analyzed by a any tele-traffic analyst. In subsequent chapters, details on Key Performance Indicators (KPIs) collected and the results of its combination for the purpose of detecting problems will be illustrated. Their effects on overall performance on the network will also be considered. Some KPIs and the threshold level set on them by the operators are shown in table 3.1

**Table 3.1: KPI and their threshold levels in %**

Some KPIs and their threshold level on %	
Call setup time	≤5 second
Call failed rate	≤2%
Call setup success rate	≥98%
Call drop rate	≤2%
Call setup rate	≥96%
Call handover success rate	≥98%
Standalone Dedicated control channel	≤0.2
Speech Quality Index (MOS)	≥3.8

**Table 3.2: Speech Quality Index**

Speech Quality Index and its remarks	
Speech Quality	MOS (Mean Opinion Score)
Excellent	3.5<
Good	2.7-3.5
Fair	2.1-2.7
Poor	1.5-2.1
Bad*	1.5

**Table 3.3: Coverage Signal Strength (in dBm)**

Coverage signal strength (in dBm) and its remarks	
Coverage	GSM (RxLev)
Good	$\geq -85$ dBm
Fair	$95$ dBm $\leq$ to $< -85$ dBm
Bad	$110$ dBm $\leq$ to $< -95$ dBm
Non existent	$< -110$ dBm

### 3.6 Time for the Test

The testing was during the morning session (rush hour), afternoon session (Busy Hour), and night session over the period of seven consecutive days. The reason being to cover a greater hours in a day. During the drive test, an average speed of 60km was maintained for uniformity. The client is a Mobile phone (Nokia 6230i) which establishes the connection to the public server via a live GSM network. The QVM receives the location information from an external GPS receiver.

### 3.7 Post-Processing Stage

On the evaluation part, the data collected was transferred to QVP for analysis. It was imported into the database where data of no interest was filtered out in the window-based system. The evaluation is done by querying the relational database using SQL command.

### 3.8 Sampling and Sampling Technique

The data used in this study was collected from the live network survey (QVM) based on random sampling. The data collected were grouped into atestbed data set. The measurement samples that were taken depicting the activities on the Base Transceiver Stations and its corresponding Base Station Controller around federal capital territory Abuja. Its observation period is thirty (30) minutes. Upon completion of testing; the call statistics was displayed in the client where KPIs of interest were copied for proper analysis.

### 3.9 Procedure for Data Collection

The researcher sought the permission of the Nigerian communications commission (NCC) to use its facility (QVOICE Equipment) to carry out an independent survey using Anambra State environment. But due to some logistic factors, approval was only granted to carry out the survey in FCT Abuja under close supervision of QOS team of the Commission, since the researcher has worked with the commission in the past. The sample measurements were generated from live network serving the test environment as earlier mentioned via an air interface, which was later transferred from the QVM into QVP for analysis using file transfer tools of the system. The call statistics data like failed or dropped calls, handover complete/failure for intra-cells and inter-cells, seizure success or failures, channel requests; etc was used to determine values for the KPIs of study. The MapInfo of the QVM enables the mapping of the areas of survey or routes which was saved in the database. During the drive test, activities of BTSs, BSCs, and MSCs along the mapped routes were recorded and areas where congestions occurred noted. The data analysis and further discussions are presented below.

### 3.10 Macromobility KPI Data Analysis

Before proper analysis of the activities of these QoS KPIs in the overall performance of the network, brief introduction of call origination procedure from counter perspective will be vital.

**Step 1:** channel request or demand sent to BTS by MS in order to setup a call. BTS forwards the request to BSC. A counter activates upon receiving this channel request from MS in a cell/BTS.

**Step 2:** BSC sends the channel activation command to MS through BTS. Another counter activates here in order to count the channel allocation in the cell/BTS.

**Step 3:** After the channel allocation, call initiates after necessary authentication from core/MSC end. Once the call is connected another counter starts in order to count abnormal call drop or failures (due to BSS or radio link problems). These counters are usually computed by BSC over a measurement period (typically one hour) and stored in operation and maintenance centre for radio network (OMCR). But since QVOICE used as measurement tool accesses the live network, it records these data in its database. These data can now be imported into the QVP for KPI analysis.

- Call setup success rate (CSSR) is the rate of call attempts until traffic channel is successfully assigned.

$$\text{CSSR} = \frac{\text{No. of successfully seizures of SDCCH} \times 100\%}{\text{Total No. of requests for seizure of SDCCH channel}}$$

- Call drop rate (CDR) is the rate of calls not completed successfully.

$$\text{CDR} = \frac{\text{No. of TCH drop rate after assignment} \times 100\%}{\text{Total No. of TCH assignment}}$$

- Call handover success rate (CHSR) is the rate of successful handovers (intracell + intercell).

$$\text{CHSR} = \frac{\text{No. of successful (intracell + intercell) handovers} \times 100\%}{\text{Total No. of handover requests}}$$

Call handover success rate can be divided into two types: handover success rate and radio handover success rate.

- Call completion rate is the rate of successful completion of both incoming and outgoing calls.

$$\text{CCR} = \frac{\text{No. successful completed inbound or outbound calls} \times 100\%}{\text{Total no. of placed or received calls}}$$

Note: CCR does not take into account calls that dropped, missed or abruptly terminated.

- SDCCH is used for providing signaling service required by the user. It carries signaling data following the connection of the mobile with base station and just before a TCH assignment is issued by the base station. The SDCCH maintains connection between MS and BS. It is really an intermediate and temporary channel that accepts newly completed call from BSC and holds the traffic while waiting for the Base station to allocate a TCH channel. SDCCH is used to send authentication, user validation and alert messages as the mobile synchronizes itself with the frame structure and waits for TCH. SDCCH is the rate at which timing advance, validation and authentication of user is successfully completed.

$$\text{SDCCH} = \frac{\text{No. of successful TCH seizure or assigned} \times 100\%}{\text{Total no. of TCH request}}$$



In configuration of calls for the measurement, intra-network call was made between master and slave channels of the QVM. This was done because it is always difficult to identify particular network that is responsible for failures in inter-network calls. Although additional testing equipment can be interfaced with response or collated data from the respective networks being monitored. But unfortunately network operators are likely would not allow an independent investigative monitoring of the interfaces between its network and another for comparison purposes.

### 3.11 Macromobility Database

Upon completion of drive test, a database was created for the collated left data for analysis on the QVP workstation. It is observed that the raw data is QVM client were voluminous, hence transferred to database in a workstation for easy sorting. This enables the sorting of data in terms of BTS name, BTS codes, sectors number as well as carrier numbers.

### 3.12. Macromobility Data Analysis

The measured data is evaluated against the threshold values set by the NCC which are outlined below as.

- a. Target for ballsy hour (BH) call completion CCR rate: >96%
- b. Target for Busy Hour (BH) CDR : < 2%
- c. Target for Busy hour CHSR: >98%
- d. Target for Busy hour SDCCH: ≤0.2%

The data samples for the hours of this survey was used to determine the busy hour time of the network and as earlier mentioned, QOS judgment on these KPI values was based on this busy hour. The busy hour call attempt (BCHA) Traffic occurred at morning rush hour ay 8.00am. The peak period duration (7.00am to 10.00pm) which concedes with the average peak periods used by most networks was also considered in this analysis. Table 3.4: Summary of KPI data analyzed in hourly basis against its operator. The data which reflects the call pattern in respect of CSSR, CDR, CHSR, CCR and SDCCH showing the performance of the networks as it varied over the day. As depicted in table 3.4, from the average values of CSSR, it was observed that setup success rates of operators like MTN, GLO and Airtel is close to the threshold (i.e. 98%) with Airtel having the best performance. The CDR of Operators like Glo, Etisalat, and Airtel was found to be perfectly good.

This proves that there was a minimal congestion in these networks as at the period of this study. Considering the CHSR, it was observed that none of the operators was able to meet the NCC threshold, through the performance cannot be remarked as being poor. It was obvious that Glo performance as regards handover was the best among the networks under survey followed by Airtel. In CCR, most of the operators meet the regulators threshold except for Etisalat, which could be regarded as below average. In the month of April the average of the KPI values were represented as in fig. 3.4, where overall performance of GLO was found to be the best.

**Table 3.4: Macromobility Data Set For QOS**

<b>KPI data for March, 2012</b>					
<b>Name of Operators</b>	<b>CSSR (Target ≥ 98%)</b>	<b>CDR (Target ≤ 2%)</b>	<b>CCR (Target ≥ 96%)</b>	<b>CHSR (Target ≥ 98%)</b>	<b>SDCCH (Target ≤ 0.2%)</b>
<b>MTN</b>	97.07	1.33	96	95.14	0.58
<b>GLO</b>	97.33	1.13	96.44	97.73	0.39
<b>ETISALAT</b>	94.38	0.86	93.05	89.67	1.64
<b>AIRTEL</b>	97.39	0.86	96.56	96.64	0.58
<b>KPI data for April , 2012</b>					
<b>Name of Operators</b>	<b>CSSR (Target ≥ 98%)</b>	<b>CDR (Target ≤ 2%)</b>	<b>CCR (Target ≥ 96%)</b>	<b>CHSR (Target ≥ 98%)</b>	<b>SDCCH (Target ≤ 0.2%)</b>
<b>MTN</b>	96.42	1.41	95.78	94.67	0.61
<b>GLO</b>	97.02	1.17	96.45	97.67	0.39
<b>ETISALAT</b>	96.88	1.22	95.81	91.28	1.36
<b>AIRTEL</b>	97.48	0.92	96.59	96.33	0.47

From the results of table 3.4, it was deduced that the effect of macromobility resulted in the GSM operators not meeting the exact expectation of the QOS specified by NCC. This work now made an attempt to develop a KPI optimization plant for threshold improvement at the MSC of the GSM architecture.

#### 4. SOFTWARE ENGINEERING APPROACH-SDLC

##### 4.1. SDLC

Using System Development Life Cycle (SDLC) , the application design starts with a planning phase, which identifies the business value of the proposed drive plant system, conducts a feasibility analysis, and plans the project. The second phase is the analysis phase, which develops an analysis strategy, gathers information, and builds a set of analysis models. In the next phase, the design phase, the implementers develop the physical design, architecture design, interface design, data base and file specifications, and program design. In the final phase, implementation, the system is built, installed, and maintained. In this work, the choice of our methodology was influenced by factors like: clarity of the requirements; familiarity with the base technology; system complexity; need for system reliability; time pressures; and need to see progress on the time schedule.

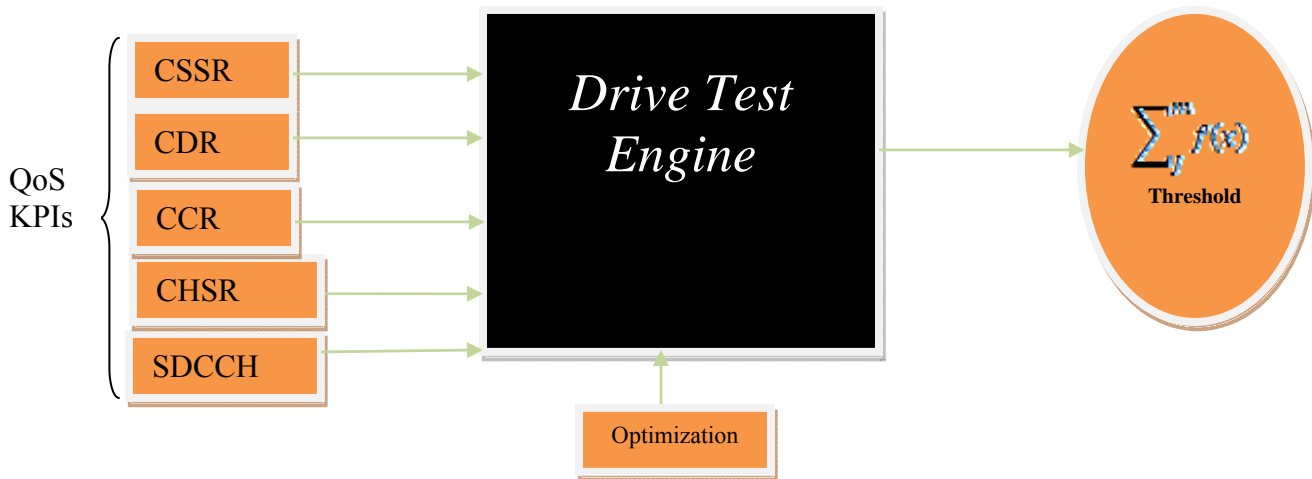
For our proposed model in figure 4.1a, the waterfall prototyping methodology was used in realizing the system since it offer better options for the implementation. In this section, having observed the limitation of QOS in various GSM networks in the context of macromobility, before designing an envisaged drive test plant, this work starts with an introduction of an analytical problem formulation with JAVA drive test Macromobility Optimization Plant which will be implemented as well. Afterwards, a complete simulation demonstration an integration model will be shown. This work leveraged on a JAVA based residual routine for the drive test plant model to optimize the KPI thresholds. Figure 4.1a shows a formulated design model for the proposed system.

#### 4.2 . Drive Test Plant Design Model Specifications

This work used the following as the JAVA drive test Macromobility Optimization Plant (See figure 4.1a) viz:

- i. Input KPIs: Traffic Channel Congestion Ratio (TCH Cong. Ratio), Call Drop Ratio (CDR), Call Setup Success Ratio (CSSR), Stand-alone Dedicated Control Channel(SDCCH)

The above inputs were feed into the system in figure 4.1a. These inputs were captured from existing GSM study where this project evaluated the Quality of Service performance of mobile telecommunications network. In the Output specification, the key component is the threshold optimizer which is software driven. To carry out the optimization scheme for our proposed macromobility scheme, a JAVA based drive test plant is designed in this project showing both the raw, optimized and normalized dataset.



**Figure 4.1a: Drive test MSC Optimization plant architecture**

The control design framework is shown in figure 4.1a, but in the design implementation, the raw data set of Table 4.1, which comprises of control parameters such as CSSR, CDR, CCR, and CHSR are injected into the plant model which uses its residual optimization to optimize and normalize the data set.

#### 4.3. Flow Diagram of the system

The system flow diagram of the for figure 4.1a shows the step by step (algorithm) representation of the system. Figure 4.1b shows the drive test optimization flowchart which is implemented in figure 4.3 and figure 4.4. From figure 4.1b, after capturing the KPIs values of the various network operators- MTN, GLO, ETISLAT, and AIRTEL, optimization and normalization routines are executed to enhance the KPIs. The system implementation using the software engineering SDLC technique was employed for the coding and deployments.

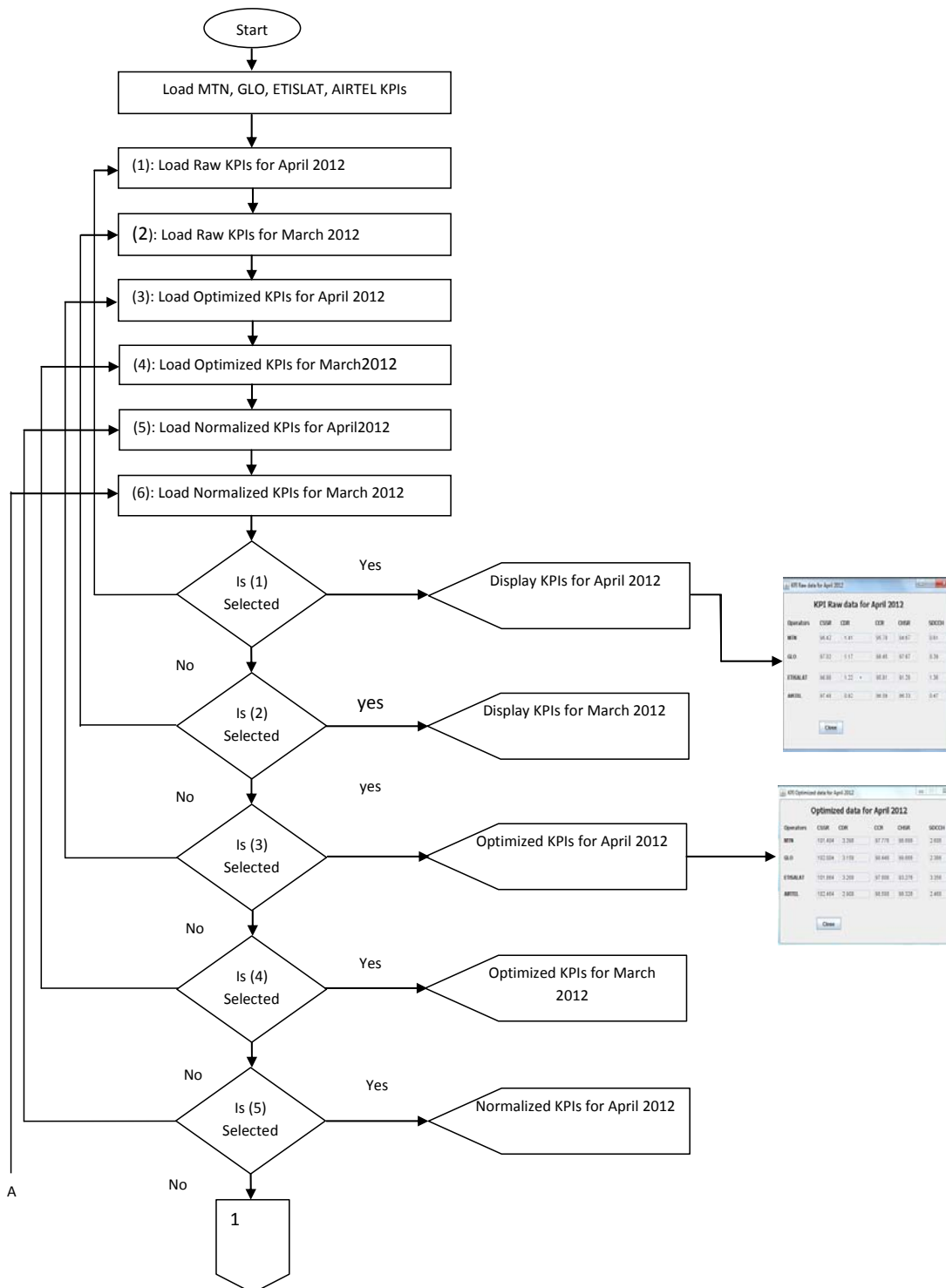
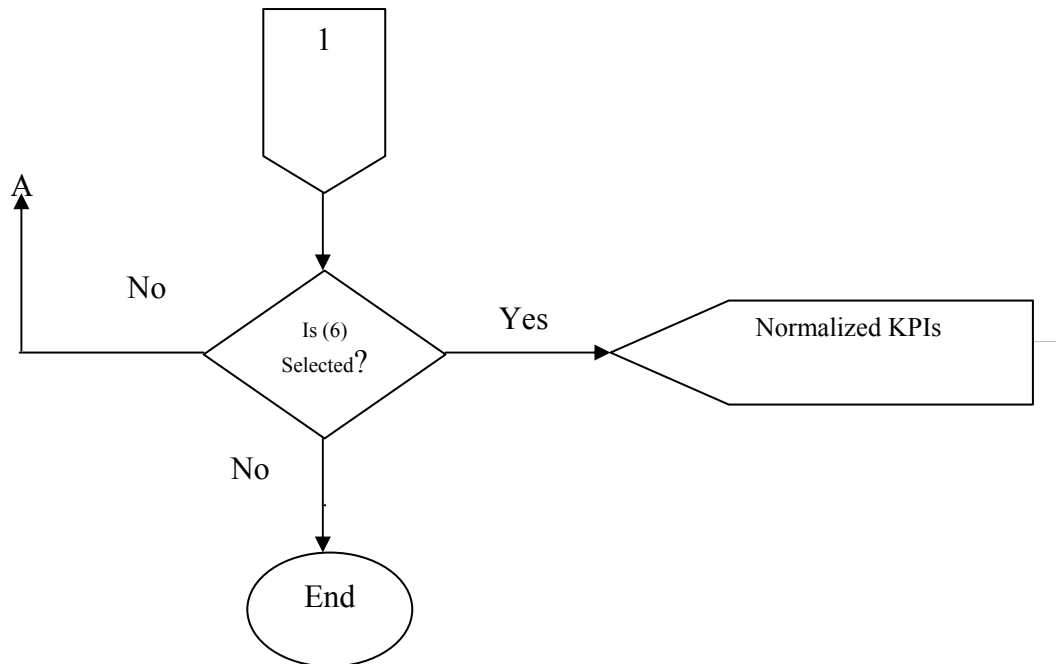


Figure 4.1a: Drive Test Optimization Flowchart



**Figure 4.1b: Drive Test Optimization Flowchart**

## 5. SYSTEM IMPLEMENTATION

The system implementation involves capturing figure 4.1b and transforming the values into its normalized and optimized forms using object oriented coding strategy following the flowchart in figure 4.1b. The model in figure 4.1a shows the JAVA drive test Macromobility Optimization flowchart of the system developed in this project.

### 5.1. System Requirements

The requirements to run the proposed system are listed below and any server computer that meets these requirements can install the system without any challenge. The Software requirements includes Microsoft windows vista or MS windows7 and JAVA Net beans 7.0.1 , while the hardware requirements includes: Monitor, 1GHZ or faster processor, Microsoft windows XP (certified for 32-bit windows XP & windows vista), 512MB of RAM, 1GB of available hard-disk space, 1.280\*800 display with 16-bit video card

### 5.2. Choice of Programming Platform/Language

In the drive test plant design, we used Net beans IDE for JAVA programming. The major administration tool is the JAVA Virtual Machine which is platform independent. This work will now discuss the development Platform for drive test plant

### 5.3. JAVA Net Beans Platform

For compilation and Running of Java Codes, Net beans IDE was used as shown in figure 4.2. The NetBeans IDE is written in Java and can run anywhere a Java virtual machine (JVM) is installed, including Windows, Mac OS, Linux, and Solaris. A Java development kit (JDK) was used for Java development functionality. The NetBeans platform allows applications to be developed from a set of modular software components called modules. Again, the NetBeansIDE being an open-source integrated development environment, supports the development of all Java application types (Java SE including JavaFX, (Java ME, web, EJB and mobile applications). The KPI drive test plant is written with JAVA programming language in NetBeans 7.0 and as such can run on any system.



Also, the NetBeans Platform is a reusable framework for simplifying the development of Java Swing desktop applications. The NetBeans IDE bundle for Java SE contains essential tools to start developing NetBeans plugins and NetBeans Platform based applications; no additional SDK is required in this case. The platform offers reusable services common to cloud computing applications, allowing developers to focus on the logic specific to their application. However, among the features of the platform are: User interface management (e.g. menus and toolbars), User settings management, Storage management (saving and loading any kind of data), Window management, Wizard framework (supports step-by-step dialogs), NetBeans Visual Library, Integrated Development Tools, An Ant-based project system, Maven support, refactoring, and version control (supporting CVS, Subversion, Mercurial and Clearcase).

## 6. RESULTS AND ANALYSIS

The JAVA netbeans IDE 7.0.1 was used for the dataset optimization shown in figure 4.2. Figure 4.3 shows the JAVA Optimization Plant for Macromobility QOS realised using SDLC framework. Figure 4.4 shows the JAVA Optimization Plant for Macromobility QOS with the KPI raw data and optimized data set for April 2012. It also have the raw data captures, optimized data captures and normalized data captures for March 2012

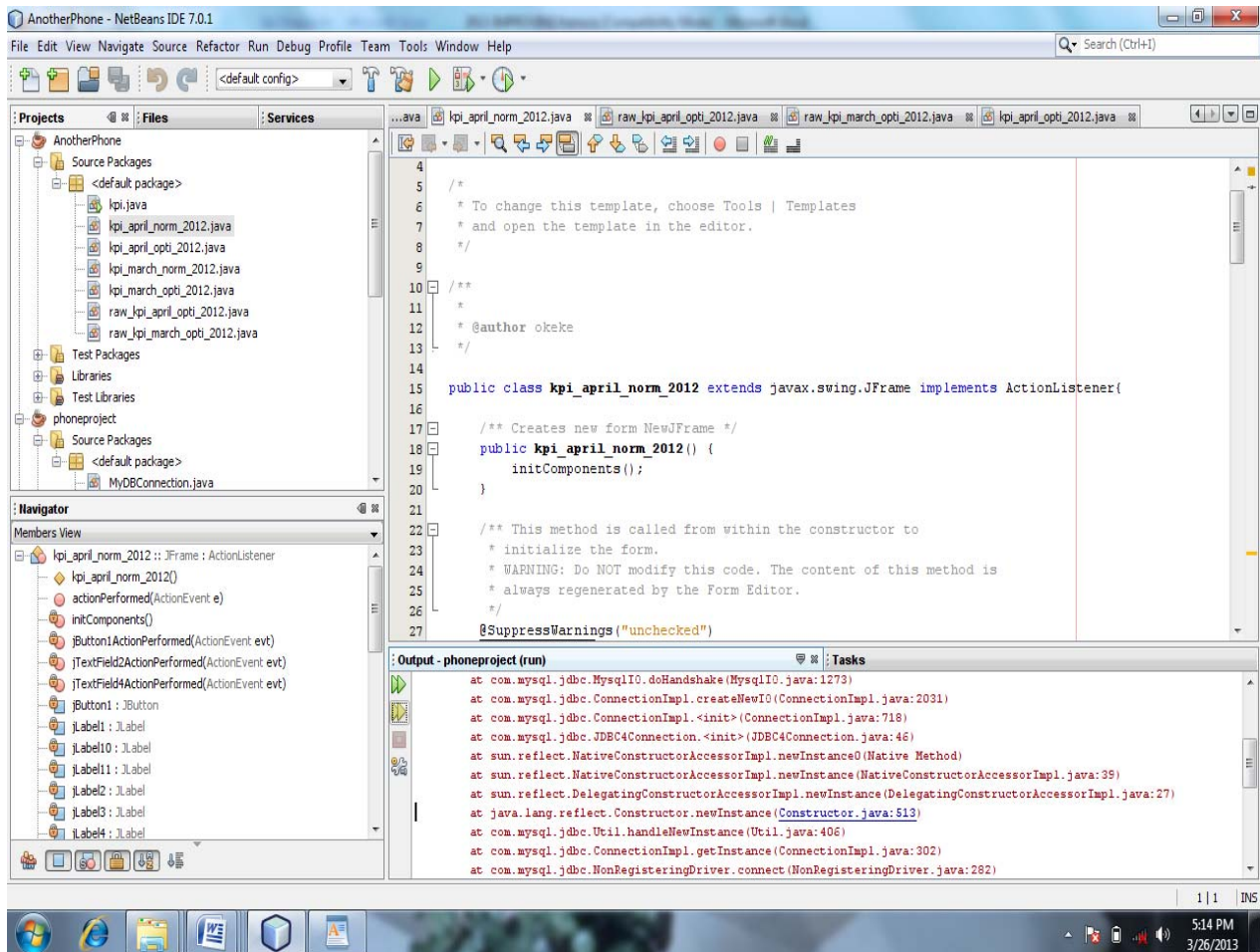


Figure 4.2: JAVA Netbeans 7.0.1 IDE for Code Implementations

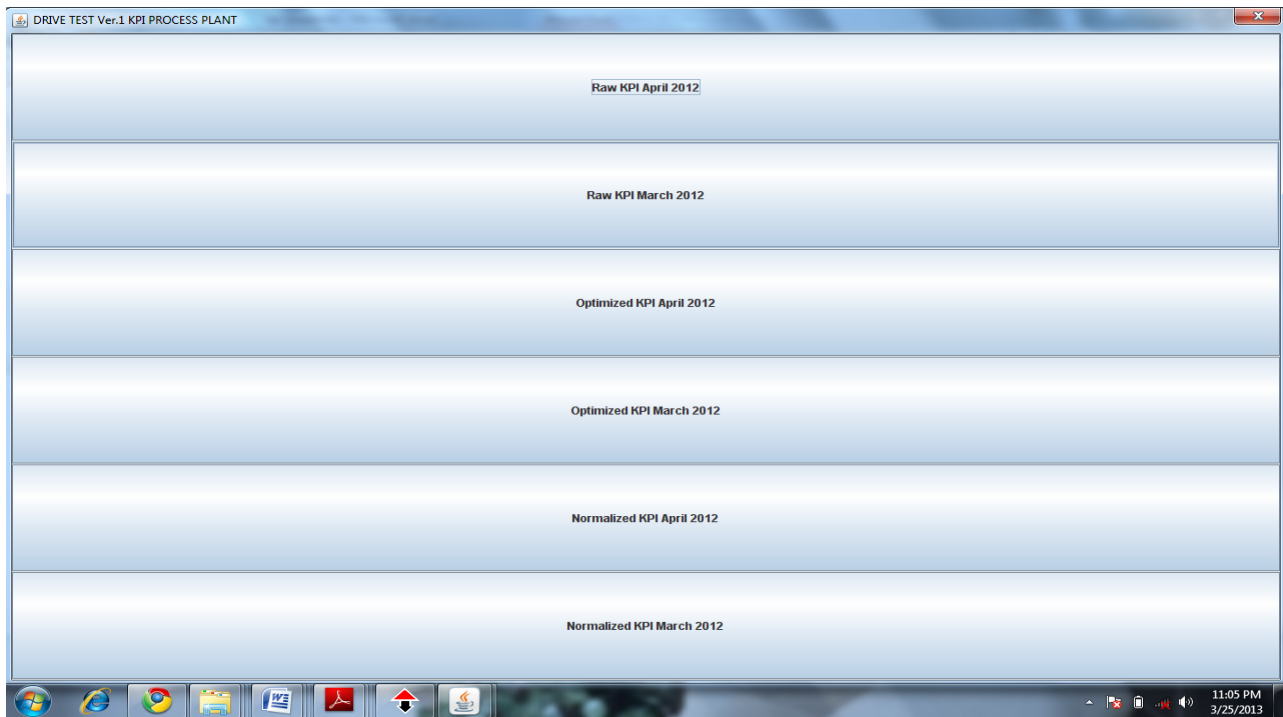


Figure 4.3: JAVA Optimization Plant for Macromobility QOS

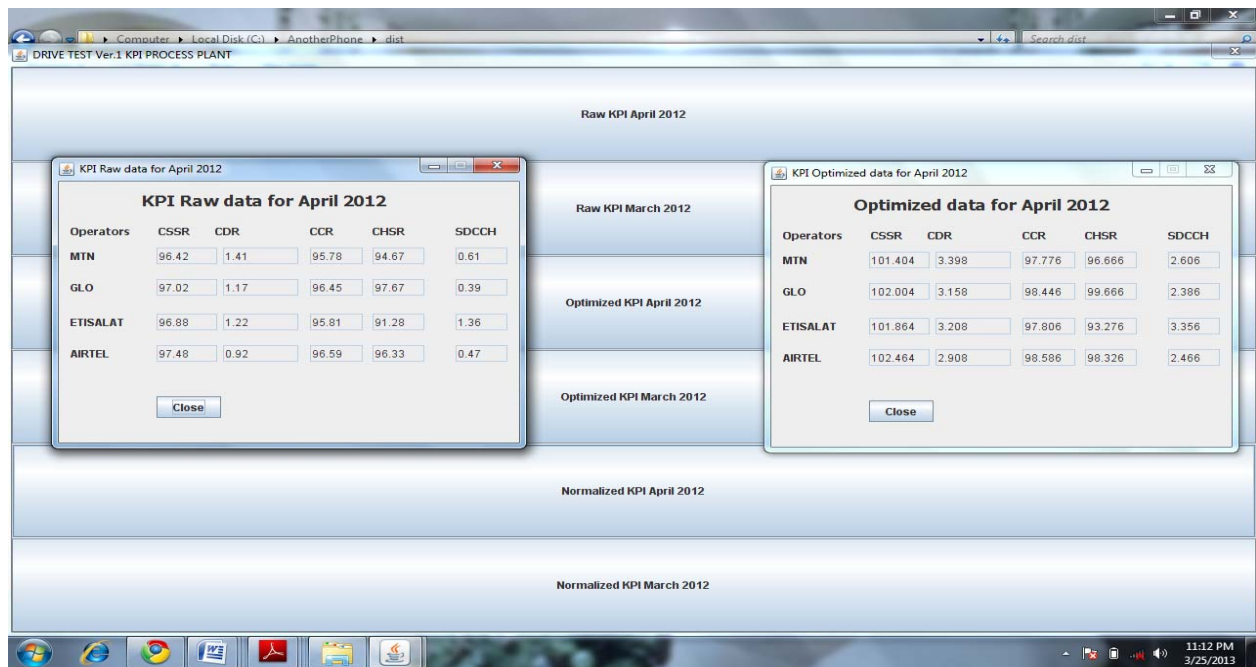
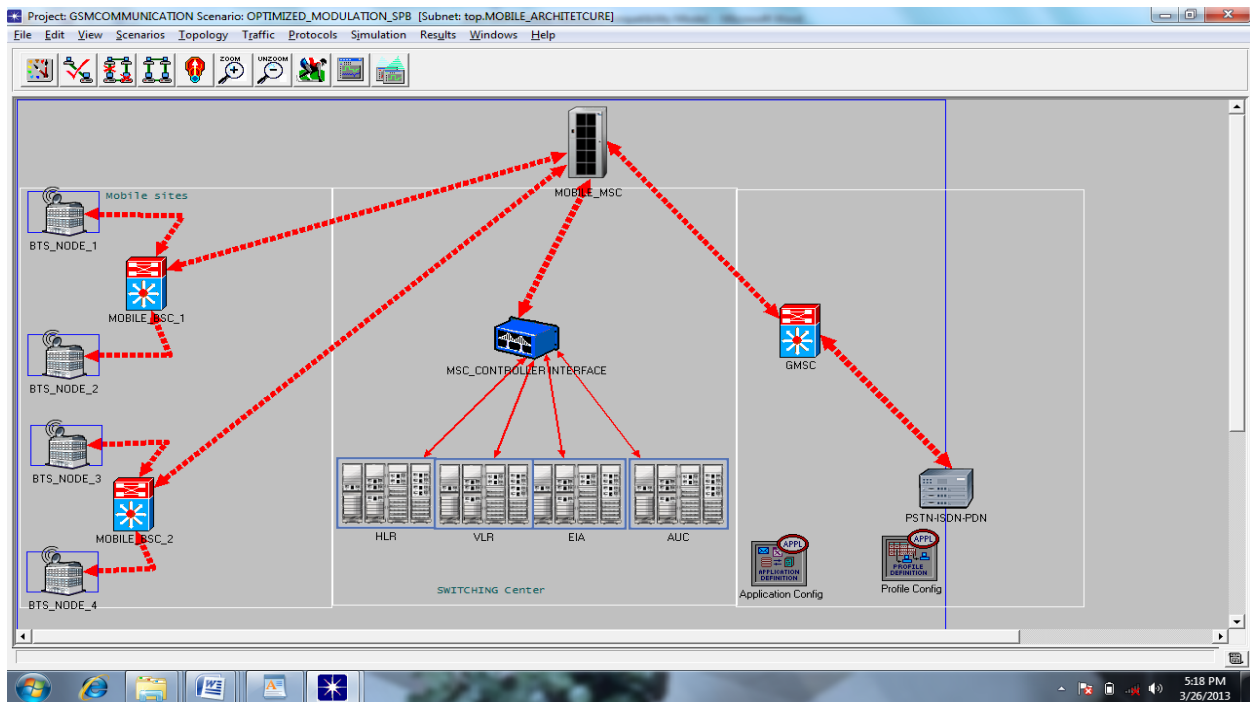


Figure 4.4: JAVA Optimization Plant for Macromobility QOS

## 7. INTEGRATION FRAMEWORK

In order to clearly demonstrate our integration approach in this research, a deployment simulation was designed with OPNET IT Guru 9.1 as captured in figure 4.5. Future will show the complete details of the integration framework in MSCs.



**Figure 4.5: An Integration Framework for Drive Test Plant Application**

## 8. CONCLUSION

This research paper has presented a software drive test plant for Quality of Service (QoS) in Nigeria. For the raw data used in the application, we used the drive test technique for the data aggregation after carrying out comprehensive evaluation and optimization of Quality of Service (QoS) of Mobile Cellular Networks in Nigeria. In this context, there are five major Key Performance Indices (KPIs) which are usually considered in the drive test, viz: Call Setup Success Rate (CSSR), Call Completion Rate (CCR), Call Drop Rate (CDR), Call Handover Success Rate (CHSR) and Standalone Dedicated Control Channel (SDCCH). Consequently, following data collated from the drive test analysis, we leveraged software engineering SDLC concepts, particularly using JAVA programming language to develop an optimization drive test plant for improving QoS thresholds by service providers. A test dataset for the months of April and March 2012 was used in the drive test plant design. In this regard, the raw data set, the optimized dataset and the normalized data sets were shown in the drive test plant. Relevant flowcharts were developed and discussed in the context of the drive test plant. This work argued that with the drive test plant properly integrated into the vendors Mobile Switching Centers (MSC), the QoS thresholds by NCC will be satisfied. Future work will focus on integration validations necessary to boost the performance of the KPIs to the expected level that could guarantee a better Quality of Service while offering explicit recommendation on the KPI drive test for QoS stability for service providers in Nigeria.



## REFERENCES

1. Alexander .N N, et al (2013). Evaluation and Optimization of Quality of Service (QoS) of Mobile Cellular Networks in Nigeria”, International Journal of Information and Communication Technology Research, Volume 3 No. 9, Sep-Oct 2013.
2. Muhammad Asif Khan,(2010). An Empirical Assessment of Service Quality of Cellular Mobile Telephone Operators in Pakistan”, Asian Social Science Vol. 6, No. 10; October 2010.
3. V.E. Idigo, et al (2012). Real-Time Assessments of QoS of mobile cellular Networks in Nigeria”, International Journal of Engineering Inventions ISSN: 2278-7461, [www.ijejournal.com](http://www.ijejournal.com) Volume 1 Issue 2, (September 2012), Pp. 1-10.
4. Mudassar Ali et al (2010). Asim Shehzad, Dr. M.Adeel Akram, “Radio Access Network Audit & Optimization in GSM (Radio Access Network Quality Improvement Techniques), International Journal of Engineering & Technology IJET-IJENS Vol: 10 No: 01, Pp.75-79.
5. Osahenvenwen O.A., Emagbetere J (2010), “Traffic Analysis in Mobile Communication in Nigeria”, Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 3 (2): Pp. 239-143
6. Madhusmita P.&Saraju .P.P,(2011), “Traffic Analysis and Optimization of GSM Network”, IJCSI International Journal of Computer Science Issues, Special Issue, ICVCI-2011, Vol. 1, Issue 1, November 2011,Pp. 28-31
7. G’abor Vilmos Szab’O (2005), “Optimization Problems in Mobile Communication”, PhD, 2005.
8. COPCA (2007). An improved model for GSM/GPRS/EDGE performance evaluation”, ACM/IFIP LANC 2007 San Jos’e, Costa Rica,2007.
9. J. J. Popoola, et al (2009). Performance Evaluation and Improvement on Quality of Service of Global System for Mobile Communications in Nigeria Journal of Information Technology Impact Vol. 9, No. 2, pp. 91-106, 2009.
10. Bilal H. et al (2009).Radio Frequency Optimization & QoS Evaluation in Operational GSM Network”, Proceedings of the World Congress on Engineering and Computer Science 2009 Vol I, WCECS 2009, October 20-22, 2009, San Francisco, USA.
11. Biebuma J.J., et al (2010). Traffic Modeling For Capacity Analysis Of GSM Networks In Nigeria”, Continental J. Information Technology 4: Pp. 78 - 89, 2010.
12. Utpal P. et al. Understanding Traffic Dynamics in Cellular Data Networks”,
13. Muhammad A.K (2010). An Empirical Assessment of Service Quality of Cellular Mobile Telephone Operators in Pakistan”, Asian Social Science Vol. 6, No. 10; October 2010.
14. Jianyong .C. et al, (2010), “A Novel Model for Evaluating Optimal Parameters of Security and Quality of Service”, Journal Of Computers, Vol. 5, No. 6, June 2010.
15. Alexei B. et al (2009). A Novel Model for "Optimized GSM Network Design”, (IJCSIS) International Journal of Computer Science and Information Security”,Vol. 4, No. 1 & 2, 2009

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