

ANALYSIS OF QOS DELIVERED TO USERS OF WCDMA BAND IN DIFFERENT LOCATIONS: CASE STUDY OF UNIVERSITY OF ILORIN, NIGERIA

by

Tiamiyu O.A. & Oje .A.

Department of Telecommunication Science, University of Ilorin, Ilorin, PMB 1515, Nigeria & Spanning Tree IT Consult, Ilorin, Nigeria. ozutiams@yahoo.com

Abstract

Since 2001, which marked the advent of modern telephony in Nigeria, there is a significant increase in the capacity of the Mobile Network Operators (MNOs). Total connected active lines were quite over a hundred million according to the reports by Nigeria Communications Commission (NCC), the regulatory body in Nigeria. However, mobile telephone users in the country are experiencing poor quality of service at different locations in the country. Thus, NCC has set benchmark values for various KPI. In this study, findings on the quality of service delivered to users of WCDMA Band by the MNOs in different locations within university of Ilorin were made.

The results showed that the overall Network Quality index is poor because of the deviation from the benchmark set by the NCC is high in most cases of the network locations of the MNOs. There were also areas with “no service mode” reported as well as “limited service mode”.

Keywords: WCDMA, Key performance Indicator (KPI), QoS, user experience, voice communication, data communication

1. Introduction

The history of mobile communication in Nigeria is traceable to the deregulation of the traditional means of communication under the civilian rule of the then president of the federal republic of Nigeria in person on President OlusegunObasanjo (GCFR). This deregulation gave birth to GSM revolution in the year 2001. Before the advent of mobile communication in Nigeria, Nigeria Telecommunication Limited (NITEL) was saddled with the responsibility of managing the telecommunications sector, which was via Landline referred to as Fixed Telephony [1]. The first Mobile Network Operator (MNO) that came on board was ECONET (now Airtel), launched on August 6, 2001; MTN followed suit almost immediately.

The Nigerian Telecommunication Industry is said to be the fastest growing telecommunication industry in the world with current teledensity of 108% and the biggest telecom industry in the world. It represent the largest provider of job opportunity in the country and contributes greatly to the country’s GDP [2?].

Before 2001, which marked the advent of modern telephony in Nigeria, teledensity in the country was at a very low level.13 years down the line, Nigeria’s telecommunication, the total connected active lines were quite over a hundred million with a teledensityabove 90 according to the reports by NCC in 2013 [3]. This implies that there was a significant increase in the capacity of the Mobile Network Operators (MNOs). This necessitated adoption of better system, like Universal Mobile Telecommunications System (UMTS) that uses Wideband Code Division Multiple Access (WCDMA) for its transmission network.

Users embraced UMTS as it is backward compatible with the already existing network architecture, which is General Packet Radio System (GPRS) or Enhanced Data rates

for Global Evolution (EDGE) network. This has minimized the investment required to set up 3G network. In addition, the regular SIM is upgradable to Universal SIM (USIM) that enables it to communicate over the UMTS network. UMTS specifies the Universal Terrestrial Radio Access Network (UTRAN), which is composed of multiple Node-Bs in place of base stations using different terrestrial air interface standards and frequency bands [4].

As seen in Figure 1, UMTS network architecture indicates that the GPRS or EDGE Core Network (CN) remains the same. This shows its Inter-Radio Access Technology (IRAT) interoperability[5, 6] [2]. 3G Architecture has three (3) main parts, the Core Network, UMTS Terrestrial Radio Access Network (UTRAN) and user equipment (UE). The CN performs the function of switching, transit, and routing of traffic between nodes (packet or circuit switched); the UTRAN (also referred to as Radio Access Technologies) has two parts, namely Radio Network Controller (RNC) and Node-Bs. RNC performs handover functions, ciphering of data in the network, Radio Resource Control, Power Management and control, Channel allocation among other functions. Node-Bs perform the functions of the Base station in 2G network, which is to provide the air interface to the User Equipment and also modulation and demodulation of traffic.

UE, which comprises the USIM as well as the Mobile Station of the user, has various identities assigned to it on the network such as IMSI, MSISDN, TMSI, IMEI and so on [7 wcdma architecture] [1].

Though UMTS has better capacity than the predecessors do, yet mobile telephone users in the country are experiencing and complaining about poor QoS at different locations in the country. There have been complaining over the QoS delivered by service providers in the country continuously over the last few years that the MNOs had to pay fines billed on them by NCC in 2013 and 2014 for poor service delivery [8, 9]. Furthermore, there were reports in the Guardian newspaper from individuals complaining about poor service from MNOs. A consumer living in Lagos complained that he hardly had successful conversations without three to four breaks in transmission. He further stressed that sometimes when he called; he hardly heard the user on the other side. According to the consumer, this got worse with time.

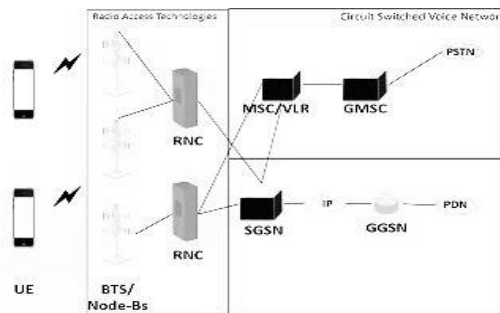


Figure 1: UMTS Network Architecture

There was also a report from a subscriber to service providers, the subscriber who was supposed to receive a notification message from a company about an interview but could not receive the message on time due to poor signal reception. The subscriber lost the job [9].

Among the complaints is the receipt of unsolicited messages by subscribers [8]. In the Guardian Newspapers in their technology section, it was reported that NCC affirmed that

mobile telephone users in the country had experienced poor QoS in Q4 of 2016 and Q1 of 2017. The poor services range from drop calls, call setup failure, poor call retention, weak signals, cross-talk, and unsolicited text messages among others [10].

As each of the MNOs is not having optimum service delivery in every location in the country, most mobile subscribers do subscribe to more than one MNO, thereby having to switch Subscriber Identity Module (SIM) from a location to another; or being forced to use more than one mobile equipment.

Thus, considering that subscribers of the MNOs in Nigeria is increasing at a very high rate, there is a need for the various MNOs to check their coverage rate and see their overall network performance meets the needs of the subscribers to their network. Moreover, the regulatory body in Nigeria, Nigeria Communications Commission (NCC) has set benchmark values for various Key performance Indicator (KPI) (Table 1) [11].

KPI	Call Setup Success Rate	Call set up time	Dropped Call Rate	Handover Success Rate	RSCP	Ec/No	Call Completion Success Rate
NCC defined benchmark	≥ 98%	≤ 6sec	≤ 1%	≥ 98%	≥ -85dBm	≥ -9dBm	≥ 97%

Table 2: Some NCC set KPI threshold Values

Hence, this has prompted researchers to make findings on the QoS delivered by the MNOs in different locations and areas of the country.

In this study, KPI for voice communication in the 3G UMTS network of the four (4) different Mobile Network Operators (MNO) in Nigeria, tagged as operator A, B, C and D respectively will be checked.

The KPIs to check include:

- Network Accessibility (Call Setup Success Rate)
- Coverage Voice Quality (-10dB ≤ Ec/No < 0 dB)
- Handover Success (HOSR)
- Coverage Reliability (% RSCP > (-85dbm)
- Speech Quality Index
- Call Setup Time
- Network Retain ability (dropped call rate)

As a means of informing people and the MNOs themselves, there is a company, OpenSignal, which monitors signal level on daily basis. This company produces reports on their website about network providers worldwide.

Thus, for a start in this study, below are the results considering the scope of this project as provided on this company’s website as at July 27, 2017. The points Painted Red are reports of poor QoS area while those painted green are areas with good QoS as depicted in the Figure 2-6 [12, 13, 14, 15].

The report for MNO A shows that there are no reported data (signal) on Jalala and Senior Staff Quarters that are located within the university of Ilorin campus, unlike within its Permanent Site where QoS is high according to the report (Figure 2 and 3).

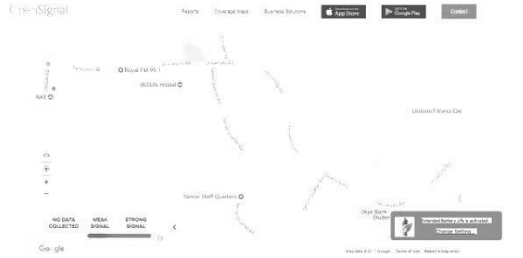


Figure 2: Open Signal MNO A Report for Jalala and Senior Staff quarters [12]



Figure 3: Open Signal MNO A Report for Permanent Site [12]

Figure 4,5 and 6 depict the report by Open Signal for signal quality of MNO B.



Figure 4: Open Signal Report for MNO B Signal Quality in Jalala [15]

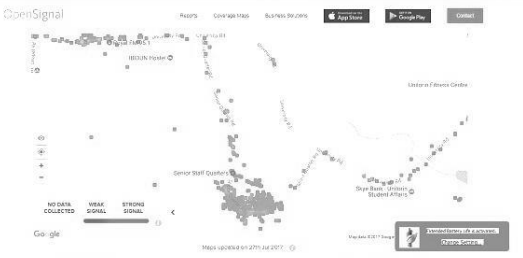


Figure 5: Open Signal Report for MNO B Signal Quality in Staff Quarters [15]



Figure 6: Open Signal Report for MNO B Coverage in Permanent Site

2. Literature Review

The P3 connect mobile test company based in the United Kingdom stated in their 2016 report that the results got from their test in the United Kingdom that the service providers all comply with the standard set for them by the regulatory body in the country [16]. The benchmark test was carried out for the following network service providers: EE, Three, O₂ and Vodafone. They gave a summary report of the general test then further broke down the results based on voice and data communication separately. At the end of their report, they compared the result for 2016 with those they have gathered in past years and it was evident that the four major Network operators that were tested had improved in the overall quality of service they provide to the subscribers of their respective networks.

In Bangkok, two Authors came together to compare the performance of Third generation technologies for Internet services provided by the major network operators in Thailand. The paper focused on developing a conceptual framework for performance testing as well as Network Optimization, and performance comparison of 3G operations on 850/900 MHz and 2100 MHz bands in Thailand. The KPIs used during the course of their analyses were Throughput, Latency and data rates [17].

The authors in [18] examined the QoS of GSM network offered by four major network providers in Nigeria taking Ikorodu Axis as their case study. They studied the quality of service in voice call only over the four service providers; MTN, AIRTEL, GLOBACOMM and ETISALAT in some parts of Ikorodu Local Government Area, Lagos State, Nigeria. They made use of TEMS 9.1 as their data collection software, Sony Ericsson C- 702 and Mapinfo Professional 11.0. Each mobile station was set to call for 90 seconds and a waiting period of 10 seconds was included in the control script. The authors analyzed their collected data using MapInfo and plotted graphs for the various KPIs and they did an analysis of bad patches.

The authors of [19] did an Evaluation and Optimization of the QoS that the mobile cellular networks in Nigeria are providing to the subscribers. They used an application called QVOICE with a pre-configured Nokia 6270i phone to collect necessary data. Five KPIs were the basis of the desired result for analysis, and they were Call Setup Success Rate (CSSR), Call Completion Rate (CCR), Call Handover Success Rate, Call Drop Rate and Standalone Dedicated Control Channel (SDCCH). The data collected was analyzed and Chi-test was performed to know the deviation from the set value by the NCC, and then transferred through SQL server for post-processing analysis. A conceptual framework was presented for Optimization using Adaptive Network-Based Fuzzy interference System (ANFIS).

A report was published in the International Journal of Research in Engineering and Technology by four authors on Optimizing radio frequency for improved QoS in Abeokuta, Nigeria [20]. The authors who carried out this research work collected data such as signal integrity, signal quality, interference, dropped calls, blocked calls, call statistics, service level statistics, QoS information and handover info among other data that were needed for thorough analysis to achieve their defined aim. They carried out drive test in defined areas to cover the Abeokuta metropolis using TEMS 9.0 and four TEMS enabled Sony Ericsson k800i. They divided the result type into two for Short and Long Calls. The short calls were used to check for Accessibility and Mobility while the Long calls were used to check retainability and sustainability of calls.

3. Methodology

This study covered the analysis of real-time data recorded with the aid of a drive test application while driving along the vehicle paths in the three selected locations within the University of Ilorin campus. The selected areas were Jalala Junior Staff Quarters (Jalala), University of Ilorin Senior Staff quarters and the University of Ilorin Main Campus (Permanent Site).

After the drivetest, post processing of the collected data was done and results discussed. Areas with bad coverage were highlighted and some possible reasons for the bad coverage was made known.

Data was collected with the aid of a drivetest and then saved as logfiles for further analysis to get desired results after the parameters have been defined.

Parameters that were considered in the course of this study include Call Setup Success Rate (CSSR), call setup time, handover attempt, handover failure, Handover Success Rate (HOSR), call attempt, Speech Quality Index (SQI), call drop, Received Signal Code Power (RSCP), Energy per Chip to Noise Ratio (E_c/N_o) and Received Signal Strength Indicator (RSSI).

The software that was used in the course of the study were licensed TEMS Investigation 15.2.2, MapInfo Professional 12.0, Snipping tool and Microsoft Excel.

The hardware or devices used were a laptop with Windows 7 Professional (Service Pack 1), a Global Positioning Service (GPS) device, four (4) Sony Ericsson W995 TEMS phone, USB hub, a car and a car Inverter for constant power supply to the laptop during the course of the drive.

It was noted that the total received signal power, i.e. RSSI, could not be considered as an indication of coverage in a WCDMA system. The RSCP value and the E_c/N_o are the values to put into consideration when working on the analysis of a WCDMA data.

The parameters recorded and evaluated that were used in measuring the QoS delivered were generally referred to as KPI.

3.1. KPIs Used and their Definitions

Call Setup Success Rate (CSSR): Often referred to as Accessibility KPI. It is a measure of the amount of calls that are successfully setup after attempt has been made on the call. If a call has been setup and later drops, the call has been successfully setup and connection has been made. When calls are not successfully setup, it is called Call block. Call could be blocked because of abnormal RRC (Radio Resource Control) connection release, no alerting/connection, no Radio bearer setup, and timer expiration among others. CSSR is It is expressed as a percentage of the ratio of Call Setup to the number of Call attempts. Mathematically,

$$CSSR = \frac{Call\ Setup}{Call\ Attempt} \times 100$$

Call Drop Rate (CDR): Also referred to as Network retainability. The call drop rate is the rate at which calls drop after setup and assignment of channel has taken place. The rate at which calls drop depends on various factors such as failure to reestablish connection or other unspecified reasons. It is expressed as a percentage of the ratio of call drop to call setup. Mathematically,

$$CDR = \frac{Call\ drop}{Call\ Setup} \times 100$$

Soft Handover Success Rate (HOSR): This is the successful rate at which Radio Link is added, removed or replaced. It is the ratio of success of these to the failures expressed in percentage.

Call Setup Time: This is the time taken to setup the call after the attempt has been successfully made. Taking into consideration the benchmark set by the NCC for this KPI, which is that it must be less than 6 seconds. Hence, to include it in the calculation, the amount

of call setup time less than 6 sec was expressed as a percentage of the total number of call setup time.

Coverage Reliability: The coverage reliability can be expressed as the reliability of the network for connection at any time. Connection is reliable at the Received Signal Code Power (RSCP) value. The benchmark set for this value by the NCC is -85dBm. Thus, the percentage coverage reliability was calculated as the sum of RSCP values greater than the set benchmark expressed as a percentage of the total.

The ranges used were as follows:

- $\text{Min} \leq x < -95$
- $-95 \leq x < -85$
- $-85 \leq x < -75$
- $-75 \leq x < -65$
- $-65 \leq x < -55$
- $-55 \leq x < \text{Max}$

Coverage Quality: this is the value of Energy per chip to Noise Ratio (E_c/N_o) greater than a desired value that guarantees optimum connectivity and quality. The coverage quality can be expressed in value as the percentage of number of values above the set threshold to the total number of values. For this project, a threshold of -10dBm was used.

The ranges used were as follows:

- $-34 \leq x < -10$ (Bad)
- $-10 \leq x < -7$ (acceptable)
- $-7 \leq x < 0$ (good)

Speech Quality Index (SQI): It is a special attribute incorporated into the KPI value and being checked by TEMS for complete and efficient evaluation of the quality of voice signals heard or passed across a communication link during a particular call. It ranges from 0 to 30 with 0 been the poorest and 30 been the best.

- $-20 \leq x < 1$ (Bad)
- $1 \leq x < 19$ (acceptable)
- $19 \leq x < 30$ (good)

The test was carried out in two phases, which were;

- i. Data Collection phase
- ii. Data Analysis phase

In data collection phase, drivetest was performed and the software, TEMS Investigation, was used for the collection of data. TEMS Investigation is an active E2E test system, being used for verification, troubleshooting and optimization of services delivered in Radio Access Networks (RAN). It enables MNOs and infrastructure suppliers to test the quality of service they are delivering to subscribers. It covers in-vehicle, in-building, as well as the service quality received by pedestrians [18]. TEMS combines two key attributes – Speed and simplicity, to help in responding quickly to customer's complaints, while offering an unequalled ease of operation to users. TEMS Investigation 15.3 was installed on the laptop used for the study, as well as MapInfo Professional 12.0 and Microsoft Office Excel, 2016 edition for data analysis.

The test could as well be carried out using a motorcycle or bicycle. Instead of drivetest, walktest could also be carried out.

The connections were made to a laptop with necessary software installed and TEMS License Key (Dongle) attached. A GPS device and Mobile stations were connected via USB. The GPS device connected to the laptop was placed on top of the car during the course of the drivetest to enable it to have a clearer view of the sky for more accurate results.

The collected data during drivetest data could be analyzed in real time during the test or after the test.

3.2. Drivetest Routes

Drivetest routes that indicated where testing would occur was defined based on several factors, mainly related to the purpose of the test. The drive routes showed the essential part of the area that must be covered, being the guide as to know which part had been covered and which part had not. Other places in the area might be tested as well based on the discretion.

Google Earth application was used in creating a drive route. The final image for drive route was taken to guide during drive test. Drivetest route chosen for this project were the Senior Staff Quarters of University of Ilorin (Figure 7), the University of Ilorin Main Campus Permanent Site (Figure 8) and the Jalala Junior Staff Quarters University of Ilorin (Figure 9).



Figure 7: Staff Quarters drive route [21]

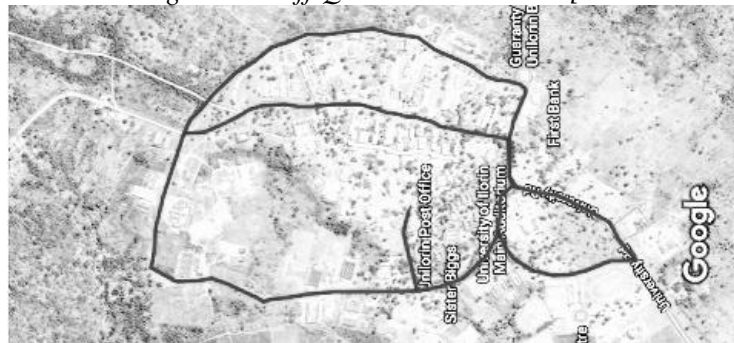


Figure 8: Permanent Site Drive route [21]

3.3. The Drivetest

The drivetest was performed using two phones (one was making calls (CALL) from a specific number from time to time, while the other was maintained in IDLE mode). Thus, data were collected in IDLE and CALL modes for the network. The CALL duration were for short (30-60 seconds) and long (up to 180 seconds or more). Short calls checked the rate at which calls were successfully established and completed, while long calls checked the retainability of the network. Figure 10 shows a snippet of the voice call.



Figure 9: Junior staff quarters drive route [21]

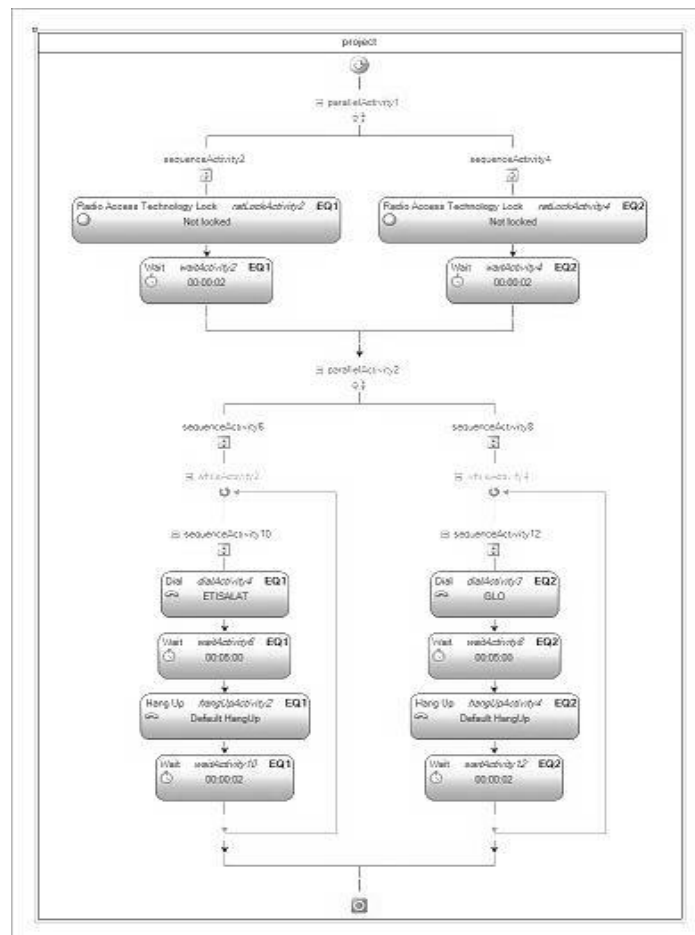


Figure 10: Voice Call Snippet

3.4. Data Collection Process

Before starting the drivetest, the worksheet to be used in monitoring the devices connected during the drive was created after launching TEMS Investigation 15.3, then the voice scripts to be used during the course of the drives.

The Road Map to use in knowing the path taken during the project and the cell file, which is the information about the BTS in the environment, were loaded and data were collected.

While driving, voice prompt on any activity was carefully attended to as it might had occurred as a result of disconnection of any of the devices, in which case the test would have to be rerun. Ongoing calls were allowed to end or stop the running script before stopping recording the logfile because the interruption might cause the call to be interpreted erroneously as dropped call.

4. Results and Analysis

After the drivetest, the values of the RSCP, Ec/No, and SQI per location and per type of call for each MNO were plotted in MapInfo. For all Networks, there was 100% success rate in the handover at all locations. Summary based on various KPI values, for all MNOs, were seen in the Table 2 through Table 7.

JALALA Long Call Summary				
	MTN	Etisalat	Airtel	Glo
% Call Setup Time MOC <6s	25.00	0.00	100.00	0.00
Figure 15: Long call script - RAT layer		Etisalat	Airtel	GLO
	%Cov	52.35	60.24	41.49
	MTN	Etisalat	Airtel	Glo
%Coverage Quality (-10 <= Ec/No < 0 dB)	21.49	37.70	31.06	51.18
	MTN	Etisalat	Airtel	Glo
Accessibility (CSSR)	85.71	50.00	75.00	80.00
	MTN	Etisalat	Airtel	Glo
Retainability (100 - Dropped Call Rate)	33.33	100.00	100.00	50.00
	MTN	Etisalat	Airtel	Glo
Handover Success (HOSR)	100.00	100.00	100.00	100.00
	MTN	Etisalat	Airtel	Glo
SQI	86.45	0.00	24.80	67.70

Table 2: Summary of Long Call for MNOs in JALALA

JALALA Short Call Summary				
	MTN	Etisalat	Airtel	Glo
% Call Setup Time MOC <6s	75.00	50.00	100.00	8.33
	MTN	Etisalat	Airtel	GLO
%Coverage Reliability RSCP > (-85dbm)	57.21	65.04	75.28	25.42
	MTN	Etisalat	Airtel	Glo
%Coverage Quality (-10 <= Ec/No < 0 dB)	60.74	65.43	25.49	37.18
	MTN	Etisalat	Airtel	Glo
Accessibility (CSSR)	85.71	50.00	88.89	85.71
	MTN	Etisalat	Airtel	Glo
Retainability (100 - Dropped Call Rate)	83.33	100.00	87.50	83.33
	MTN	Etisalat	Airtel	Glo
Handover Success (HOSR)	100.00	100.00	100.00	100.00
	MTN	Etisalat	Airtel	Glo
SQI	37.45	0.00	65.77	66.99

Table 3: Summary of Short Call for MNOs in JALALA

PERMANENT SITE LONG CALL SUMMARY				
	MTN	Etisalat	Airtel	Glo
% Call Setup Time MOC <6s	92.31	81.82	100.00	50.00
	MTN	Etisalat	Airtel	GLO
%Coverage Reliability RSCP > (-85dbm)	89.79	69.22	93.85	90.62
	MTN	Etisalat	Airtel	Glo
%Coverage Quality (-10 <= Ec/No < 0 dB)	21.49	37.70	31.06	51.18
	MTN	Etisalat	Airtel	Glo
Accessibility (CSSR)	100.00	100.00	100.00	73.33
	MTN	Etisalat	Airtel	Glo
Retainability (100 - Dropped Call Rate)	92.31	100.00	100.00	72.73
	MTN	Etisalat	Airtel	Glo
Handover Success (HOSR)	100.00	100.00	100.00	100.00
	MTN	Etisalat	Airtel	Glo
SQI	84.05	0.00	55.22	67.47

Table 4: Summary of Short Call for MNOs in JALALA

STAFF QUARTERS SHORT CALL SUMMARY				
	MTN	Etisalat	Airtel	Glo
% Call Setup Time MOC <6s	85.71	0.00	N/A	20.00
	MTN	Etisalat	Airtel	GLO
%Coverage Reliability RSCP > (-85dbm)	58.96	53.69	99.51	42.66
	MTN	Etisalat	Airtel	Glo
%Coverage Quality (-10 <= Ec/No < 0 dB)	57.65	54.20	95.19	84.51
	MTN	Etisalat	Airtel	Glo
Accessibility (CSSR)	100.00	66.67	0.00	100.00
	MTN	Etisalat	Airtel	Glo
Retainability (100 - Dropped Call Rate)	100.00	100.00	0.00	100.00
	MTN	Etisalat	Airtel	Glo
Handover Success (HOSR)	100.00	100.00	N/A	100.00
	MTN	Etisalat	Airtel	Glo
SQI	74.97	0.00	0.00	77.92

Table 5: Summary of Short Call for MNOs in JALALA

STAFF QUARTERS LONG CALL				
	MTN	Etisalat	Airtel	Glo
% Call Setup Time MOC <6s	80.00	100.00	100.00	40.00
	MTN	Etisalat	Airtel	GLO
%Coverage Reliability RSCP > (-85dbm)	57.55	62.34	76.86	88.77
	MTN	Etisalat	Airtel	Glo
%Coverage Quality (-10 <= Ec/No < 0 dB)	61.48	63.57	55.71	84.68
	MTN	Etisalat	Airtel	Glo
Accessibility (CSSR)	100.00	100.00	100.00	100.00
	MTN	Etisalat	Airtel	Glo
Retainability (100 - Dropped Call Rate)	92.31	100.00	100.00	72.73
	MTN	Etisalat	Airtel	Glo
Handover Success (HOSR)	100.00	100.00	100.00	100.00
	MTN	Etisalat	Airtel	Glo
SQI	82.63	0.00	50.40	87.45

Table 6: Summary of Short Call for MNOs in JALALA

PERMANENT SITE SHORT CALL				
	MTN	Etisalat	Airtel	Glo
% Call Setup Time MOC <6s	100.00	71.43	100.00	29.17

	MTN	Etisalat	Airtel	GLO
%Coverage Reliability RSCP > (-85dbm)	99.92	70.58	91.08	86.29
	MTN	Etisalat	Airtel	Glo
%Coverage Quality (-10 <= Ec/No < 0 dB)	58.15	39.47	51.34	51.34
	MTN	Etisalat	Airtel	Glo
Accessibility (CSSR)	12.96	89.47	6.25	76.67
	MTN	Etisalat	Airtel	Glo
Retainability (100 - Dropped Call Rate)	100.00	100.00	100.00	78.26
	MTN	Etisalat	Airtel	Glo
Handover Success (HOSR)	100.00	100.00	100.00	100.00
	MTN	Etisalat	Airtel	Glo
SQI	17.05	0.00	0.00	61.27

Table 7: Summary of Short Call for MNOs in JALALA

4.1. Junior Staff Quarters

As obvious from the Table 2 and 3as well Figure 11 and 12, at Junior Staff Quarters, all the networks had poorer accessibility (accessibility is a measure of the CSSR for Short calls) compared to the benchmark set by NCC, which is 98%. MNO Ahad 88%, which was the highest value recorded. In this location, MNO B had the least Accessibility.

On the measure of how well a network retains connections without leading to a drop in the call, i.e. retainability, NCC set benchmark for this is that the drop call rate has to be less than or equal to 1%. MNO B led here followed by MNO A then MNO C. MNO D retainability for this area is the poorest.

Combining results for the Long and Short calls, MNO C led in the quality of voice sent over link. MNO D came second; followed byMNO A. MNO B had the poorest SQI in this location as they had 0% values in the acceptable range of SQI.

For both types of call, MNO D had the highest call setup time and MNO A had the least. Overall, MNO Acame first with all its calls setup time taking less than 6 seconds. MNO D came second here;followed by MNO B. MNO C came last in this category.

Coverage category of the KPI is of two types, which are coverage reliability and quality. In reliability, MNO A led when the result of both call types were combined together, followed closely by MNO B. MNO D and MNO C were in 3rdand 4th positions respectively. As for the coverage quality, which is the Ec/No, MNO Bled, followed by MNO C.MNO A had the least coverage quality.

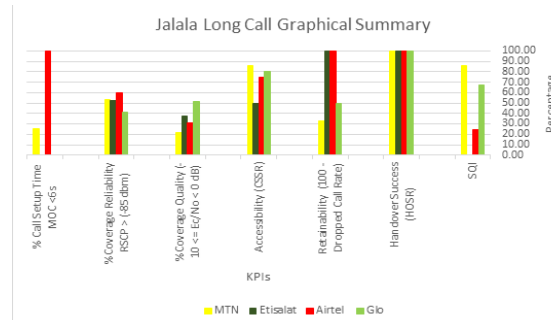


Figure 11: JALALA Long Call Graphical Summary

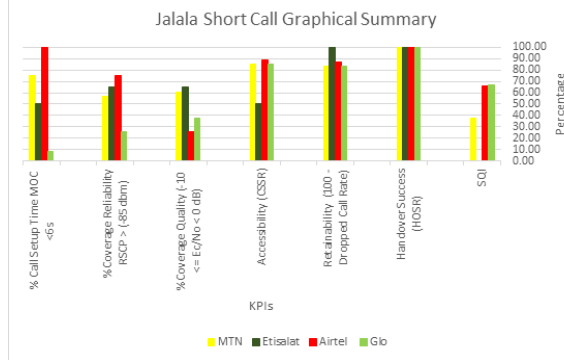


Figure 12: JALALA Short Call Graphical Summary

Summary of the calls, considering KPI values, were done for both senior Staff Quarters (Table 4 and 5 as well as Figure 13 and 14) and the Permanent Site (Table 6 and 7 as well as Figure 15 and 16) as well. Followings are the brief summary:

4.2. Senior Staff Quarters

Accessibility: MNO D and MNO C networks had 100% accessibility for their subscribers. MNO A was least accessible.

Retainability: MNO D had the best retainability, followed by MNO C and MNO B. However, accessing MNO A was difficult, its retainability was 100% once the call was setup.

SQI: In this environment, MNO C had the best speech quality from the calls. MNO D was close to MNO C in speech quality. MNO B’s speech quality was poorest as there was no value greater than the acceptable KPI value for the network.

Call Setup time: Talking about the time taken to setup call on network in this location, MNO D was the best; followed by MNO A. MNO C was the worst among as a very low percentage of its calls took less than 6 seconds for setup.

Coverage: MNO C had the best coverage followed by MNO D and MNO B. The most reliable here was MNO A network, while MNO C had the best quality of coverage followed by MNO D.

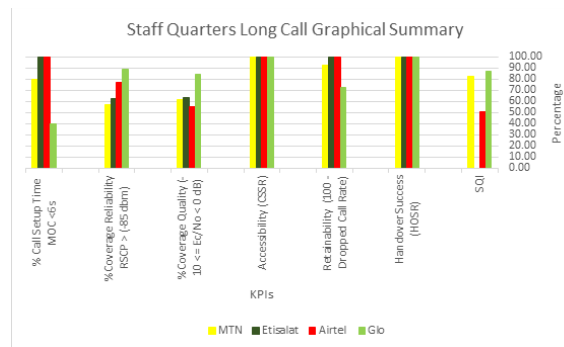


Figure 13: Staff Quarters Long Call Graphical Summary

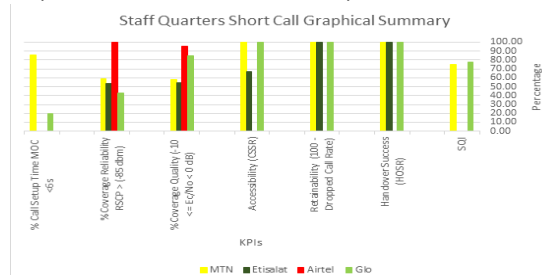


Figure 14: Staff Quarters Short Call Graphical Summary

4.3. Permanent Site

Accessibility: MNO B network was best accessible for the location, followed closely by MNO C. MNO D and MNO A had poor accessibility (MNO A had the poorest).

Retainability: MNO B and MNO A Networks were leading in this KPI in the Permanent Site environment. Though MNO D followed them closely, yet MNO C network also had an equally good retainability but are far from the NCC set benchmark. It had up to 11% dropped call rate instead of 1% specified.

SQI: MNO C led with the highest number of its SQI value in the acceptable range. MNO D followed MNO C network, though MNO D was having a widely varying value recorded. MNO B came last in the hierarchy of value.

Call Setup time: MNO A had the best call setup time, always less than 6 seconds. MNO D followed closely while MNO C had the lowest call setup duration.

Coverage: MNO D network had the best network coverage reliability followed by MNO A. In this category of KPI, MNO B had the least. The coverage quality was generally low across all networks. MNO C led followed by MNO A. MNO D was in the 3rd place.

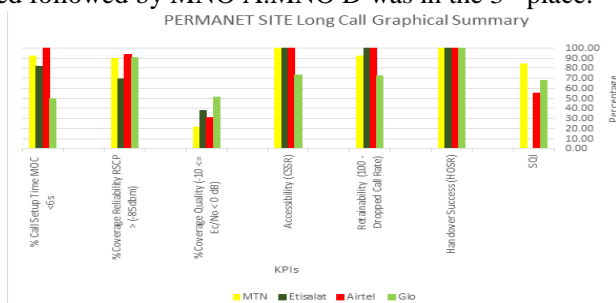


Figure 15: PERMANET SITE Long Call Graphical Summary

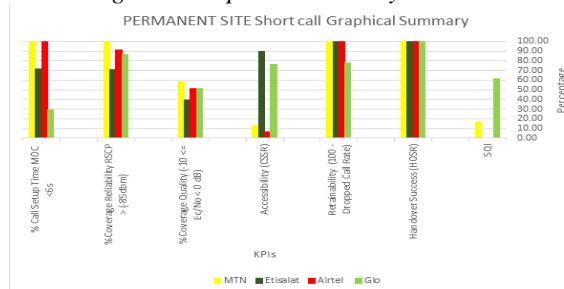


Figure 16: PERMANET SITE Short Call Graphical Summary

5. Conclusion

Evaluating the QoS delivered by the MNOs to the subscribers is as important as checking an area for the history of natural disaster before constructing a structure there. After evaluation and results provided, the MNOs that are rendering services in the area in question would be eager to improve on QoS in those areas should it be necessary.

Naturally, MNOs should do random check in various areas to check the QoS they are providing to the populace as well as trying, in the least, conforming to the benchmark set by the NCC.

This study carried out created awareness about the QoS being rendered by various MNOs in the environs being considered. The results aid in deciding which of the MNOs to use in those locations.

Furthermore, the results buttressed the complaints by the subscribers.

The results showed that the overall Network Quality index is poor because of the deviation from the benchmark set by the NCC is high in most cases of the network locations of the MNOs. There were also areas with “no service mode” reported as well as “limited service mode”. Therefore, there is need for government and the regulatory body to improve on monitoring and enforce compliance of MNOs to meet up with already set benchmark values.

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