Scientia Africana, Vol. 18 (No. 2), August, 2019. Pp 127-144
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PERFORMANCE EVALUATION AND MONITORING OF A MOBILE TELECOMMUNICATION NETWORK

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Received: 10-05-19
Accepted: 17-06-19

ABSTRACT

This study aims to determine both qualities of service provided by the network service provider as well as developing a monitoring technique of overseeing mobile telecommunication network in Nigeria. Key performance indicators of call setup success rate, call drop rate and call block rate, receive quality level and the receive signal level are used to determine the quality of service of the various service provider of Mtn, Globacom, Airtel, and 9mobile(then Etisalat). This research uses Unison mobile software, telemonitoring segment to improve performance and was carried out in Ifo metropolis, Ogun State, Nigeria. The telemonitoring segment is achieved using an IP camera which is networked using a wide area network (WAN). The IP camera is connected to a mobile phone module which contains a mobile signal measurement application that measures the received signal strength level of the neighbouring base station. The information of the signal strength can be obtained remotely and quality of service determined. The result of the quality of service shows that receive signal level of ≥ 65dBm was highest for Airtel with 83.5% while the lowest of 14% was recorded for Globacom network. The studies also incorporate methods of remotely obtaining signal strength measurement in any part of the Country using networking.

Keywords: Key performance indicator, quality of service, network operators, cellular mobile, subscriber.

INTRODUCTION

Wireless networks and mobile communication systems have evolved into one of the most exciting areas in telecommunications industries. The mobile communication system has evolved rapidly over the years from 2G to 5G network. Voice service was strictly offer by 2G evolving into 3G where both voice and data service were offered. 4G network created room for multimedia application. Over the years, service provided by the service providers deteriorate sharply raising customer concern over services provided. Quality of service is the expectation of every subscriber or customer. In this paper, quality of service is determined by key performance indicators of call setup success rate, call drop rate and call block rate,

receive quality level and the receive signal level. These are used to assess the performance of the mobile telecommunication network. In addition, tele-monitoring tool is developed to ensure that mobile network can be monitored remotely. Regretably, other research articles do not include tele-monitoring as a method of forcing mobile service providers to improve their services. Several research articles were reviewed and their works outline below.

In her paper, Nnochiri I. U. [1]determined quality of services using performance indicator of call setup success rate and call drop rate and suggested ways of improving the quality of service by doing proper and co-ordinated network planning.

Similarly, Ozovehe A. and Usman A.U.[2] used call set up success rate, call drop rate and hand over success rate to determine the quality of service. The author concluded that reconfiguring the broadcast control channel and antenna realignment will be needed to improve the quality of service.

Gordon O. et al [3] used performance index of hand off success rate (HOSR), hand off failure rate (HOFR), call set up success rate (CSSR), call set up failure rate(CSFR) using drive test technique to determine the performance of a mobile telecommunication network. Hand off success rate of 98% was recorded. Though, none of the service provider met up to the required standard.

Joseph Isabona [4] determined the performance of a network by examining performance indicators of coverage area of signal, number of callers carried and the RF signal received among others. Quality of services were enhanced after optimization was carried out.

Key Performance Indicators (KPI) are standard network parameters that are universally accepted by the network providers to evaluate and assess end user's perception of the service quality. These values are kept within some specified threshold in order to meet the required quality of service (QOS) criteria accepted by the regulatory bodies and the mobile users. The most essential Key Performance Indicators used for measuring the performance of radio network are studied and are given below [5]:

Call Setup Success Rate (CSSR) - Call Setup Success Rate is the measure of a successful connected call that occurs when a call attempt invokes a call set up procedure. It is used by network operators to assess the performance of their network. The higher this value, the easier it is to set up a call. It is expressed as:

$$\text{CSSR} = \frac{\text{Number of Successful call setup}}{\text{Number of call attempt}} * 100\%$$

Call Dropped Rate (CDR) - is the rate of calls that are not completely successful due to quality degradation. In mobile communication, CDR gives a quick overview of network quality and revenue lost. It is a Key Performance Indicator to determine service retainability. It has a direct great influence on the customers' satisfaction and loyalty [2].

$$\text{CDR} = \frac{\text{Number of Dropped calls}}{\text{Number of call setup}} * 100\%$$

Many research papers have been written on performance of mobile telecommunication network but none have utilized the idea of remote monitoring of mobile network as a way of making mobile service provider to

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continually upgrade and improve service quality because their network are continuously being monitored. This paper is written to fill this gap.

MATERIALS AND METHODS

This involves the use of UNISON MOBILE SOFTWARE to do drive test along some route in Ifo Metropolis, Ogun State and networking this information so that they can be received anywhere.

1 Unison Mobile Software.

2 Designing Monitoring Tool over a Wireless Wide Area Network (WAN).

Unison Mobile Software

The drive test was performed using Unison Mobile Software, mobile station (MS). The information provided is displayed in status windows of the unison mobile. This information includes cell identity, Base Station Identity Code (BSIC), Absolute Radio Frequency Channel Number (ARFCN), mobile Country Code (CC), mobile Network Code (NC) and the Location Area Code (LAC) and Received signal strength level (RxLev) of the serving cell while the 'my places GPS' allows access to location information of the site/cells: latitude (LAT), longitude (LOG) and other topographical data.

Call Test

The mobile station (MS) was placed inside the car during the test and no external antenna was used. Two different measurement methods were used to collect the log file for this performance analysis, namely, short calls for (subscriber in) same cell, (subscriber in) different cell and long calls. A sample of the Call test is shown in Figure 1.

i. Short calls were used to collect accessibility statistics. A short voice call attempt was performed every 10 seconds, including 10 seconds of idle time between two consecutive calls. A script in the Unison Mobile logging tool automatically initiates the short call which is set to 10 seconds manually. An event "Call Attempt" was generated every time the script triggered a new call attempt (meaning a number was dialled). The other event "Blocked Call" was generated every time the call setup procedure failed. The script automatically saves the results of the call attempt

ii. Long calls were used to obtain retainability statistics. Long voice calls were established automatically and were ended by blocks, drops or normal user release. Unison Mobile tool generated an event "Drop Call" every time the connection dropped. In this test, the long call was manually set to end after 120 seconds.

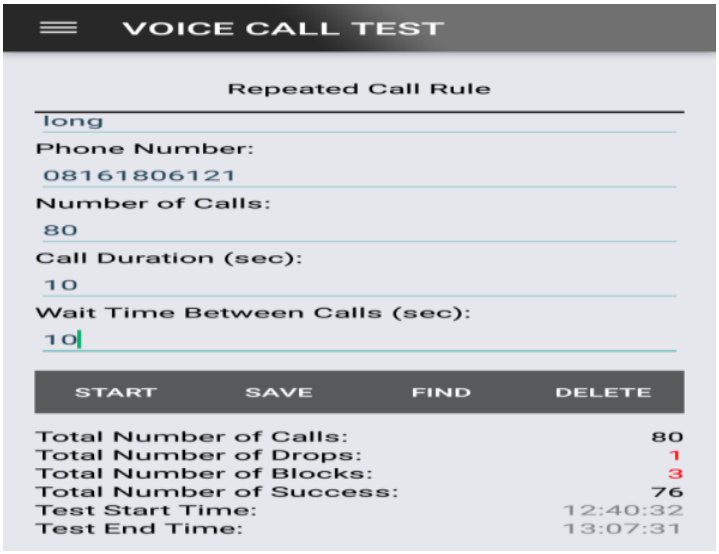

Fig 1: Call Test for the Analysis

After Test Analysis

Log file can easily be analysed by post processing of data: plotting Received Signal Level (RxLev), Received Quality(RxQual), for overall picture of the driven area and obtaining the call setup success rate (CSSR), call drop rate (CDR), and call block rate (CBR).

The drive test analysis was carried out from iyana coker through Abeokuta expressway road and many adjourning streets in Ifo Metropolis. The areas are shown based on the log file collected with Unison Mobile software.

Designing Monitoring Tool over a Wireless Wide Area Network

A class-C IP address is use here. It is one with IP address ranging from 192.0.0.0 to 223.255.255.255

Number of host on a class–C Network = 2^N -2

Where N = number of network bits available for the host; which in this case is 8 for a class C The number of host that can be connected using class C IP address is about 254 hosts.

In this paper, the IP camera is networked wirelessly and strategically installed on street light poles across the Nation. A mobile phone module containing mobile signal application is used to obtained received signal strength of the surrounding base station. This information can be obtained remotely. The camera serve the purpose of surveillance. Through the IP camera placed close to the mobile station, information on received signal strength can be assessed remotely.

Since small network is needed, class C Private IP address is used.

The remaining two IP by default are reserved for the network and broadcast address with the sub-net mask of 255.255.255.0 The following static IP-addresses have been allocated:

Default Gateway: 192.168.5.10

Server Operating System: 192.168.1.3.

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192.168.5.0 is used as the network address while 192.168.5.255 is used as the broadcast address. The remaining IP address from 192.168.5.1 to 192.168.5.254 can be allocated to the client (smart mobile module)

The rest of the IP-addresses are allocated to the Dynamic Host Control Protocol (DHCP) services to allocate to the client network. Figure 2 shows a networking configuration for a wide area network.

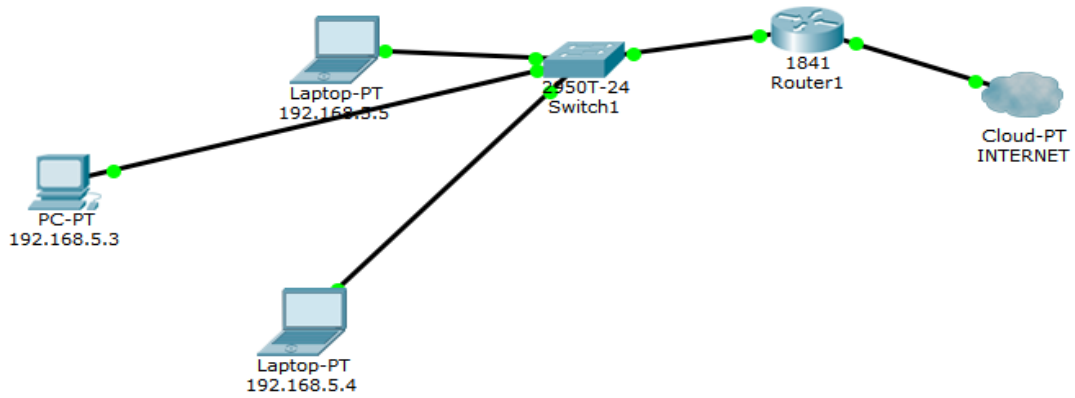

Figure 2: A network connected to the internet using Packet tracer software.

RESULTS

The coverage penetration level of signals of MTN, 9MOBILE, GLO and AIRTEL network in different parts of Ifo Metropolis are given in this paper. Some of the Key Performance Indicator (KPI) plotted are received signal quality (RxQual) and received signal level (RxLev). The Rx Lev values, between 0 to -30dBm indicates excellent coverage; - 30 to -69dBm is very good; -70 to -89dBm is fair / average; -89 to -110dBm is poor and. below -110dBm it is assumed there is no coverage.

A value of RxQual of ≥ -9dB indicates excellent quality; and less than ≤ -9dB indicates poor quality. Summary of all events that happened during the drive test on each network is shown in tables.

The values of network signals taken at random intervals along the drive test routes are tabulated below in a typical cell reference format.

Performance Evaluation for Glo Network Operator

Table 1: call test event for caller to callee in different cell.

SUBSCRIBER IN DIFFERENT CELL

OPEATOR	EVENTS	NUMBER
GLO	CALL ATTEMPTS	80
	CALL SUCCESS	72
	CALL DROPS	0
	CALL BLOCKS	8

Table 2: call test event for caller to callee in same cell.

OPERATOR	EVENTS	NUMBER
GLO	CALL ATTEMPTS	85
	CALL SUCCESS	85
	CALL DROPS	0
	CALL BLOCKS	0

Table 3: total call test event

OPERATOR	EVENTS	NUMBER
GLO	CALL ATTEMPTS	165
	CALL SUCCESS	157
	CALL DROPS	0
	CALL BLOCKS	8

The values of Glo network signals taken at random intervals along the drive test routes are tabulated below in a typical cell reference format.

Table 4: sample of GLO network signals of serving cell

CELLID	BCCH	LAT	LONG	MCC	MNC	LAC	RXLEV(dBm)	RXQUAL(dB)
27798	488	6.8148	3.1959	50	621	10883	-61	-16
27798	488	6.8148	3.1959	50	621	10883	-67	-16
27798	488	6.8147	3.1961	50	621	10883	-75	-16
27798	488	6.8146	3.1962	50	621	10883	-71	-16
27798	488	6.8145	3.1962	50	621	10883	-75	-16
27798	488	6.8148	3.1959	50	621	10883	-67	-16
27791	488	6.8138	3.1964	50	621	10883	-71	-16
27792	361	6.8128	3.1969	50	621	10883	-65	-16
27792	361	6.813	3.196	50	621	10883	-69	-16

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27792	361	6.812	3.197	50	621	10883	-77	-16
27799	361	6.812	3.196	50	621	10883	-81	-16
27799	361	6.812	3.196	50	621	10883	-73	-16
27792	361	6.812	3.197	50	621	10883	-75	-16
27790	142	6.811	3.195	50	621	10883	-71	-16
27790	361	6.811	3.196	50	621	10883	-81	-16
4108	289	6.810	3.196	50	621	10883	-81	-16
4108	289	6.810	3.197	50	621	10883	-83	-16
27792	361	6.810	3.197	50	621	10883	-73	-16
27792	361	6.810	3.197	50	621	10883	-77	-16
4108	289	6.810	3.198	50	621	10883	-75	-16
4108	289	6.809	3.198	50	621	10883	-73	-16
27708	44	6.809	3.198	50	621	10883	-65	-16
4101	289	6.808	3.198	50	621	10883	-69	-16
4101	289	6.809	3.198	50	621	10883	-71	-16
4108	289	6.808	3.199	50	621	10883	-81	-16
4101	289	6.808	3.199	50	621	10883	-73	-16
33359	46	6.809	3.198	50	621	10883	-73	-16
27708	44	6.8092	3.1987	50	621	10883	-69	-16
27792	361	6.8097	3.1983	50	621	10883	-65	-16
27792	361	6.8098	3.1983	50	621	10883	-73	-16
27792	361	6.8102	3.1981	50	621	10883	-79	-16
27792	361	6.8112	3.1978	50	621	10883	-69	-16
27792	361	6.8121	3.1964	50	621	10883	-75	-16
27708	44	6.8111	3.1952	50	621	10883	-69	-16
27790	142	6.8149	3.1938	50	621	10883	-63	-16
27790	142	6.8149	3.1939	50	621	10883	-71	16

Calculating the network key parameter index

CSSR = $\frac{call\ sucess}{call\ attempts} = \frac{157}{165} \times 100 = 95\%$

CDR = $\frac{call\ drops}{call\ \ sucess} = \frac{0}{165} \times 100 = 0\%$

CBR = $\frac{call\ blocks}{call\ attempts} = \frac{8}{165} \times 100 = 5\%$

Rx Level **(**≥ -65dBm**)** = $\frac{nos\ of\ samples \geq -65dBm}{total\ nos\ of samples} = \frac{5}{36} \times 100 = 14\%$

Rx Qual **(**≥ -9dB**)** = $\frac{nos\ of\ samples \geq -9dB}{total\ nos\ of\ samples} = \frac{0}{36} \times 100 = 0\%$

Fig 3: Received signal level for glo along drive test route.

Performance Evaluation for 9mobile Network Operator

The values of network signals of the serving cell taken at random intervals along the drive test routes are tabulated below in a typical cell reference format.

CALL TEST

Table 5: call test event for caller to caller in different cell.

OPERATOR	EVENTS	NUMBER
9MOBILE	CALL ATTEMPTS	80
	CALL SUCCESS	76
	CALL DROPS	1
	CALL BLOCKS	3

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Table 6: call test event for caller to callee in same cell

OPERATOR	EVENTS	NUMBER
9MOBILE	CALL ATTEMPTS	85
	CALL SUCCESS	80
	CALL DROPS	0
	CALL BLOCKS	0

Table 7: total call test event

OPERATOR	EVENTS	NUMBER
9MOBILE	CALL ATTEMPTS	165
	CALL SUCCESS	156
	CALL DROPS	1
	CALL BLOCKS	3

The values of 9Mobile network signals of the serving cell taken at random intervals along the drive test routes are tabulated below in a typical cell reference format.

Table 8: sample of 9MOBILE (then ETISALAT) network signals of serving cell

CELLID	BCCH	LAT	LONG	MCC	MNC	LAC	RXLEV(dBm)	RXQUAL(dB)
39893	18	6.8147	3.1958	60	621	32051	-67	-37
39893	18	6.8147	3.1962	60	621	32051	-51	-37
39893	18	6.8146	3.1962	60	621	32051	-91	31
39893	18	6.8146	3.1962	60	621	32051	-91	23
39893	18	6.8143	3.1963	60	621	32051	-85	27
39893	18	6.8139	3.1965	60	621	32051	-51	-37
39893	18	6.8138	3.1965	60	621	32051	-65	-29
39893	18	6.8136	3.1966	60	621	32051	-63	-30
39893	18	6.8135	3.1966	60	621	32051	-91	27
39893	18	6.8130	3.1969	60	621	32051	-75	-19
39893	18	6.8130	3.1969	60	621	32051	-61	-35
40002	3	6.8124	3.1970	60	621	32051	-41	-36
40002	3	6.8124	3.1969	60	621	32051	-45	-39
40002	3	6.8122	3.1968	60	621	32051	-53	-38
39893	18	6.8119	3.1960	60	621	32051	-78	-32
39893	18	6.8117	3.1959	60	621	32051	-83	-34
39893	18	6.8115	3.1960	60	621	32051	-89	-24
39893	18	6.8113	3.1960	60	621	32051	-91	13
39893	18	6.8105	3.1961	60	621	32051	-91	18
39893	18	6.8105	3.1961	60	621	32051	-77	-31
39893	18	6.8104	3.1961	60	621	32051	-71	-29
39893	18	6.8104	3.1962	60	621	32051	-77	-30
39893	18	6.8103	3.1963	60	621	32051	-91	15
39893	18	6.8104	3.1965	60	621	32051	-97	12

40002	3	6.8104	3.1966	60	621	32051	-81	-18
40002	3	6.8104	3.1966	60	621	32051	-91	16
40002	3	6.8104	3.1967	60	621	32051	-83	-23
40002	3	6.8104	3.1969	60	621	32051	-79	-35
40002	3	6.8105	3.1969	60	621	32051	-77	-38
40002	3	6.8104	3.1970	60	621	32051	-87	-35
40002	3	6.8104	3.1970	60	621	32051	-71	-38
40002	3	6.8104	3.1970	60	621	32051	-85	21
40002	3	6.8104	3.1971	60	621	32051	-73	-37
40002	3	6.8105	3.1974	60	621	32051	-59	-38
40002	3	6.8105	3.1975	60	621	32051	-79	-32
40002	3	6.8106	3.1966	60	621	32051	-61	-39
40002	3	6.8106	3.1979	60	621	32051	-85	27
40002	3	6.8103	3.1979	60	621	32051	-43	-39
40002	3	6.8088	3.1984	60	621	32051	-85	39
40002	3	6.8084	3.1989	60	621	32051	-45	-40
40002	3	6.8087	3.1991	60	621	32051	-71	-34
40002	3	6.8090	3.1986	60	621	32051	-85	41
40002	3	6.8098	3.1983	60	621	32051	-45	-36
40002	3	6.8101	3.1982	60	621	32051	-43	-35
40002	3	6.8109	3.1979	60	621	32051	-45	-38
40002	3	6.8121	3.1974	60	621	32051	-55	-36
40002	3	6.8117	3.1957	60	621	32051	-75	-30
39893	18	6.8106	3.1943	60	621	32051	-91	17
39893	18	6.8110	3.1941	60	621	32051	-59	-36
39893	18	6.8116	3.1941	60	621	32051	-65	-33
39893	18	6.8124	3.1941	60	621	32051	-63	-36
39893	18	6.8127	3.1941	60	621	32051	-71	-35
39893	18	6,8137	3.1940	60	621	32051	-91	18
39893	18	6.8137	3.1940	60	621	32051	-91	18
39897	18	6.8143	3.1940	60	621	32051	-75	-33
39893	18	6.8149	3.1944	60	621	32051	-91	24
39897	18	6.8149	3.1947	60	621	32051	-63	-31
38987	18	6.8148	3.1955	60	621	32051	-91	19
38987	18	6.8145	3.1962	60	621	32051	-91	22

Calculating the network key parameter index

CSSR = $\frac{call\ success}{call\ attempts} = \frac{156}{165} \times 100 = 89\%$

CDR = $\frac{call\ drops}{call\ sucess} = \frac{1}{165} \times 100 = 0.64\%$

CBR = $\frac{call\ drops}{call\ attempts} = \frac{3}{165} \times 100 = 1.8\%$

Rx Level **(**≥ -65dBm**)** = $\frac{nos\ of\ samples \geq -65dBm}{total\ nos\ of\ samples} = \frac{20}{59} \times 100 = 34\%$

Rx Qual **(**≥ -9dB**)** = $\frac{nos\ of\ samples \geq -9dB}{total\ nos\ of\ samples} = \frac{19}{59} \times 100 = 32\%$

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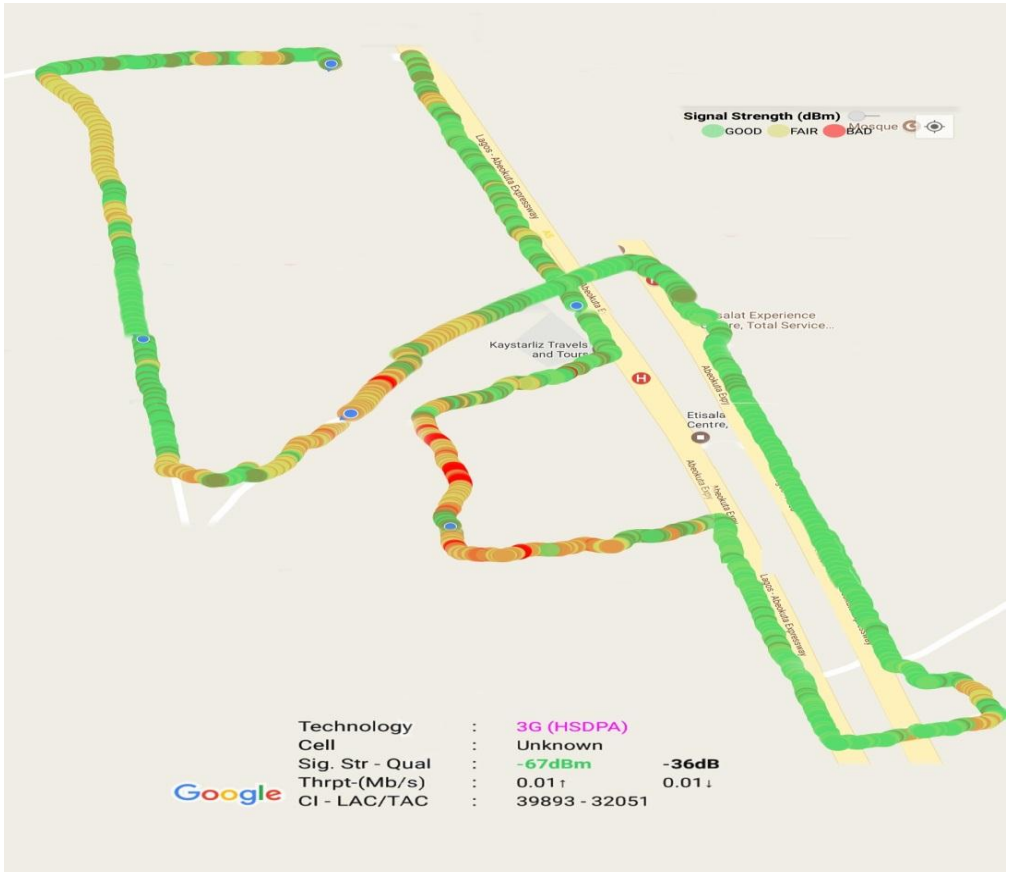

Fig 4: Received signal level for Etisalat (9mobile) along drive test route.

Performance Evaluation for MTN Network Operator

The values of network signals of the serving cell taken at random intervals along the drive test routes are tabulated below in a typical cell reference format.

Table 9: call test event for caller to callee in different cell.

OPERATOR	EVENTS	NUMBER
MTN	CALL ATTEMPTS	100
	CALL SUCCESS	93
	CALL DROPS	3
	CALL BLOCKS	4

Table 10: call test event for caller to callee in same cell.

OPERATOR	EVENTS	NUMBER
MTN	CALL ATTEMPTS	80
	CALL SUCCESS	77
	CALL DROPS	1
	CALL BLOCKS	2

Table 11: total call test event

OPERATOR	EVENTS	NUMBER
MTN	CALL ATTEMPTS	180
	CALL SUCCESS	170
	CALL DROPS	4
	CALL BLOCKS	6

The values of network signals of the serving cell taken at random intervals along the drive test routes are tabulated below in a typical cell reference format.

Table 12: sample of MTN network signals of serving cell

CELLID	BCCH	LAT	LONG	MCC	MNC	LAC	RXLEV(dBm)	RXQUAL(dB)
4101	289	6.8087	3.1985	30	621	10833	-57	-21
4101	289	6.8088	3.1984	30	621	10833	-67	-19
4101	289	6.8086	3.1985	30	621	10833	-55	-26
4101	289	6.8085	3.1986	30	621	10833	-75	-16
4101	289	6.8084	3.1986	30	621	10833	-73	-16
4101	289	6.8084	3.1988	30	621	10833	-61	-20
4101	289	6.8084	3.1989	30	621	10833	-43	-41
27792		6.8084	3.1989	30	621	10833	-85	-16
27792		6.8084	3.1990	30	621	10833	-91	-16
27792		6.8086	3.1990	30	621	10833	-67	-16
27792		6.8086	3.1992	30	621	10833	-91	-16
27792		6.8087	3.1993	30	621	10833	-49	-26
4101	289	6.8086	3.1993	30	621	10833	-85	32
27792		6.8086	3.1993	30	621	10833	-97	40
4101	289	6.8087	3.1990	30	621	10833	-49	-14
4101	289	6.8089	3.1988	30	621	10833	-47	-32
4101	289	6.8090	3.1988	30	621	10833	-85	27
4101	289	6.8090	3.1986	30	621	10833	-67	-16
4101	289	6.8089	3.1987	30	621	10833	-61	-31
4101	289	6.8092	3.1986	30	621	10833	-35	-10
4101	289	6.8093	3.1995	30	621	10833	-51	59
4101	289	6.8085	3.1994	30	621	10833	-60	-7
4101	289	6.8097	3.1983	30	621	10833	-71	56
27792		6.8100	3.1982	30	621	10833	-77	-23
27792		6.8101	3.1982	30	621	10833	-31	-13
4101	289	6.8103	3.1981	30	621	10833	-73	82
27793	142	6.8105	3.1978	30	621	10833	-41	36
27793	142	6.8109	3.1970	30	621	10833	-43	-28
27793	142	6.8114	3.1962	30	621	10833	-37	-26
27793	142	6.8117	3.1957	30	621	10833	-41	-31
27793	142	6.8109	3.1950	30	621	10833	-43	-22
27793	142	6.8108	3.1948	30	621	10833	-73	-35
27701		6.8107	3.1945	30	621	10833	-85	16

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27793	142	6.8107	3.1945	30	621	10833	-45	-28
27793	142	6.8107	3.1944	30	621	10883	-85	29
27793	142	6.8119	3.1940	30	621	10883	-63	35
27793	142	6.8122	3.1940	30	621	10883	-45	-32
27793	142	6.8126	3.1940	30	621	10883	-45	-32
27793	142	6.8136	3.1940	30	621	10883	-37	-35
27793	142	6.8148	3.1938	30	621	10883	-49	13
27793	142	6.8149	3.1941	30	621	10883	-39	-24
27793	142	6.8148	3.1954	30	621	10883	-67	35
27793	142	6.8142	3.1964	30	621	10883	-65	-4

Calculating the network key parameter index

$$\text{CSSR} = \frac{call\ success}{call\ attempts} = \frac{170}{180} \times 100 = 94\%$$

$$\text{CDR} = \frac{call\ drops}{call\ sucess} = \frac{4}{180} \times 100 = 2.22\%$$

$$\text{CBR} = \frac{call\ drops}{call\ attempts} = \frac{6}{180} \times 100 = 3\%$$

$$\text{Rx Level } (\geq \text{-65dBm}) = \frac{nos\ of\ samples \geq -65dBm}{total\ nos\ of\ samples} = \frac{25}{43} \times 100 = 58\%$$

$$\text{Rx Qual } (\geq \text{-9dB}) = \frac{nos\ of\ samples \geq -9dB}{total\ nos\ of\ samples} = \frac{12}{43} \times 100 = 28\%$$

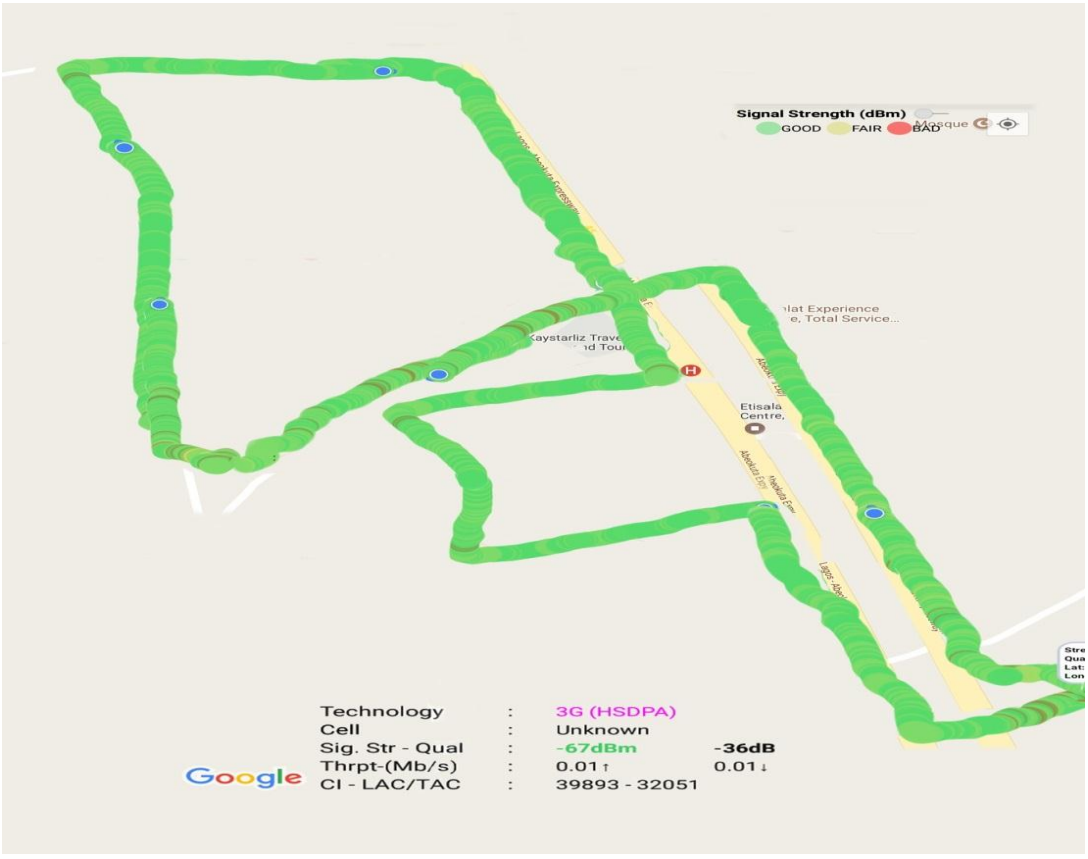

Fig 5: Received signal level for MTN along drive test route.

Performance Evaluation for Airtel Network Operator

The cells along the route for the network subscriber is described below in a tabulated format.

Table 13: call test event for caller to callee in different cell.

OPERATOR	EVENTS	NUMBER
AIRTEL	CALL ATTEMPTS	80
	CALL SUCCESS	80
	CALL DROPS	0
	CALL BLOCKS	0

Table 14: call test event for caller to callee in same cell.

OPERATOR	EVENTS	NUMBER
AIETEL	CALL ATTEMPTS	80
	CALL SUCCESS	80
	CALL DROPS	0
	CALL BLOCKS	0

Table 15: total call test event.

OPERATOR	EVENTS	NUMBER
AIRTEL	CALL ATTEMPTS	160
	CALL SUCCESS	160
	CALL DROPS	0
	CALL BLOCKS	0

The values of Airtel network signals of the serving cell taken at random intervals along the drive test routes are tabulated below in a typical cell reference format.

Table 16: sample of AIRTEL network signals of serving cell

CELLID	BCCH	LAT	LONG	MCC	MNC	LAC	RXLEV(dBm)	RXQUAL(dB)
10721	327	6.8148	3.1961	20	621	306	-62	-37
10721	327	6.8148	3.1961	20	621	306	-61	49
10721	327	6.8147	3.1962	20	621	306	-59	-36
10721	327	6.8147	3.1962	20	621	306	-54	-37
10721	327	6.8146	3.1962	20	621	306	-52	-37
10721	327	6.8145	3.1963	20	621	306	-50	-37
10721	327	6.8144	3.1963	20	621	306	-49	-38
10721	327	6.8143	3.1963	20	621	306	-61	59
10721	327	6.8142	3.1964	20	621	306	-61	-33
10721	327	6.8141	3.1964	20	621	306	-62	-33
10721	327	6.8141	3.1964	20	621	306	-59	-36

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10721	327	6.8139	3.1965	20	621	306	-55	-33
10721	327	6.8138	3.1965	20	621	306	-62	-39
10721	327	6.8138	3.1965	20	621	306	-62	-39
10721	327	6.8137	3.1966	20	621	306	-67	49
10721	327	6.8136	3.1966	20	621	306	-60	-32
10721	327	6.8136	3.1966	20	621	306	-63	-27
10722	292	6.8132	3.1968	20	621	306	-58	-36
10722	292	6.8125	3.1971	20	621	306	-65	-32
10722	292	6.8123	3.1967	20	621	306	-68	-37
10722	292	6.8120	3.1962	20	621	306	-45	-25
10722	292	6.8118	3.1959	20	621	306	-53	-23
10722	292	6.8114	3.1960	20	621	306	-85	33
10722	292	6.8110	3.1961	20	621	306	-68	-27
10722	292	6.8104	3.1962	20	621	306	-33	-33
29749	290	6.8104	3.1965	20	621	306	-45	-35
29749	290	6.8105	3.1969	20	621	306	-97	26
29749	290	6.8105	3.1969	20	621	306	-85	40
10728	292	6.8107	3.1976	20	621	306	-33	-37
10728	292	6.8107	3.1978	20	621	306	-85	42
29749	290	6.8193	3.1979	20	621	306	-60	-38
29749	290	6.8100	3.1980	20	621	306	-65	-34
29749	290	6.8097	3.1981	20	621	306	-63	47
29749	290	6.8094	3.1982	20	621	306	-63	-49
29749	290	6.8090	3.1984	20	621	306	-63	47
29749	290	6.8086	3.1985	20	621	306	-54	-38
29749	290	6.8088	3.1991	20	621	306	-51	-34
29749	290	6.8090	3.1990	20	621	306	-85	29
10728	292	6.8095	3.1984	20	621	306	-58	-37
10728	292	6.8101	3.1982	20	621	306	-57	-36
10728	292	6.8107	3.1980	20	621	306	-61	51
10728	292	6.8114	3.1977	20	621	306	-57	-37
10728	292	6.8117	3.1976	20	621	306	-53	-39
10728	292	6.8121	3.1974	20	621	306	-53	-37
10728	292	6.8123	3.1969	20	621	306	-63	-38
10728	292	6.8122	3.1966	20	621	306	-31	-37
10728	292	6.8120	3.1962	20	621	306	-43	-28
10728	292	6.8118	3.1959	20	621	306	-53	-22
10729	293	6.8116	3.1957	20	621	306	-61	-39
10729	293	6.8113	3.1953	20	621	306	-85	38
10729	293	6.8107	3.1947	20	621	306	-37	-37
10729	293	6.8108	3.1941	20	621	306	-53	-30
10729	293	6.8119	3.1941	20	621	306	-35	-38
10729	293	6.8124	3.1941	20	621	306	-33	-39
10729	293	6.8129	3.1941	20	621	306	-66	-39
10729	293	6.8136	3.1940	20	621	306	-65	-37
10729	293	6.8140	3.1940	20	621	306	-35	-37
10729	293	6.8143	3.1940	20	621	306	-85	34
10729	293	6.8146	3.1938	20	621	306	-57	-29
11879	382	6.8149	3.1939	20	621	306	-43	-32
11897	382	6.8149	3.1940	20	621	306	-43	-22

10727	327	6.8149	3.1945	20	621	306	-53	-35
10727	327	6.8149	3.1951	20	621	306	-61	42
10727	327	6.8148	3.1956	20	621	306	-63	43
10727	327	6.8147	3.1961	20	621	306	-60	-38
10721	327	6.8148	3.1961	20	621	306	-61	49
10721	327	6.8145	3.1963	20	621	306	-50	-37

Calculating the network key parameter index

CSSR = $\frac{call\ success}{call\ attempts} = \frac{160}{160} \times 100 = 100\%$

CDR = $\frac{call\ drops}{call\ sucess} = \frac{0}{160} \times 100 = 0\%$

CBR = $\frac{call\ drops}{call\ attempts} = \frac{0}{160} \times 100 = 0\%$

Rx Level (≥ -65dBm) = $\frac{nos\ of\ samples \geq -65dBm}{total\ nos\ of\ samples} = \frac{56}{67} \times 100 = 83.5\%$

Rx Qual (≥ -9dB) = $\frac{nos\ of\ samples \geq -9dB}{total\ nos\ of\ samples} = \frac{16}{67} \times 100 = 23.9\%$

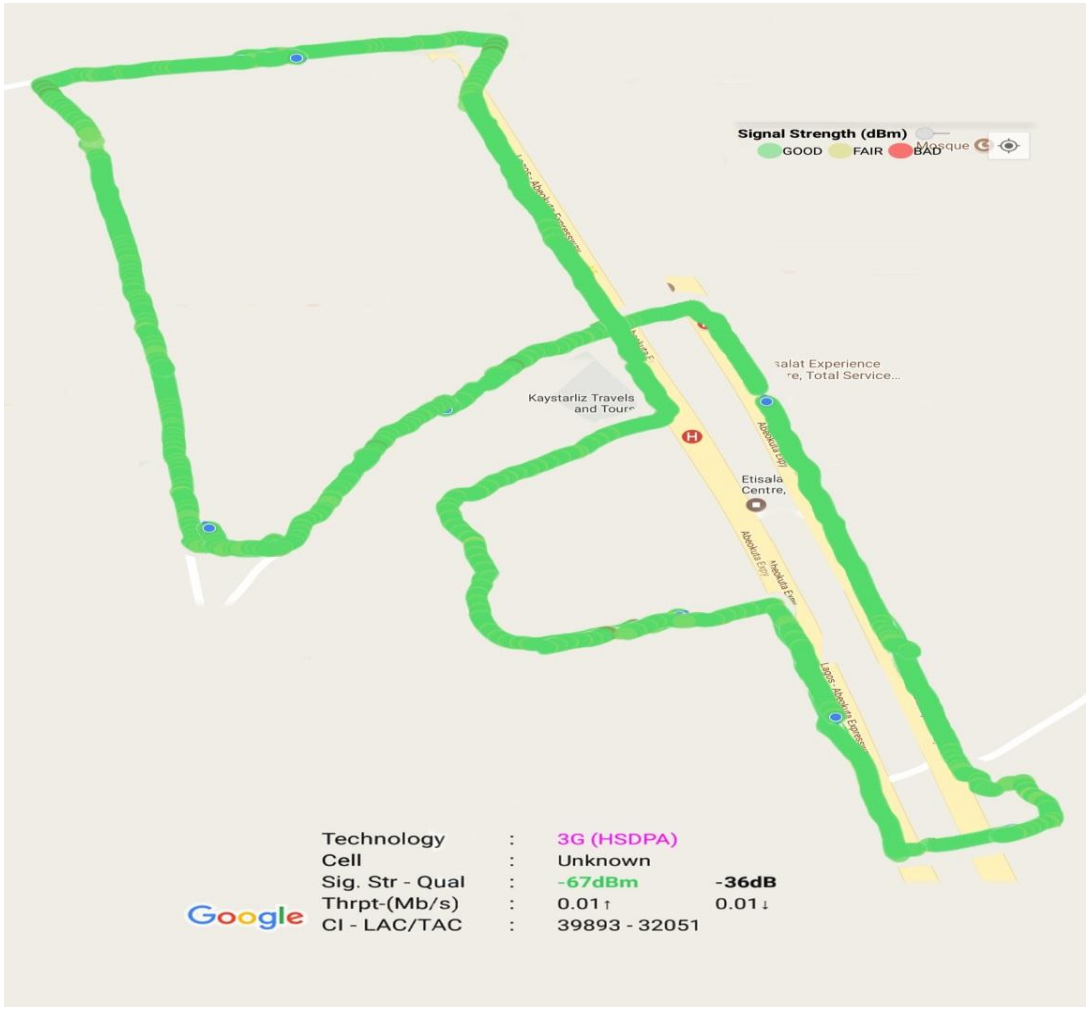

Fig 6: Received signal level for AIRTEL along drive test route

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Comparism of Network Operators Based on NCC KPI Targets

Table 17: Ranking of various network quality using NCC KPIs target

KPI	NCC TARGET	GLO	MTN	ETISALAT	AIRTEL	GENERAL RANKING
Rx Level	≥ -65dBm	14%	58%	34%	83.5%	Airtel
Rx Qual	≥ -9 dB	0%	28%	32%	23.9%	Etisalat
CSSR	≥98%	95%	94%	89%	100%	Airtel
CDR	≤ 1%	0%	2.35%	6.1%	0%	Airtel
CBR		5%	3%	18%	0%	Airtel

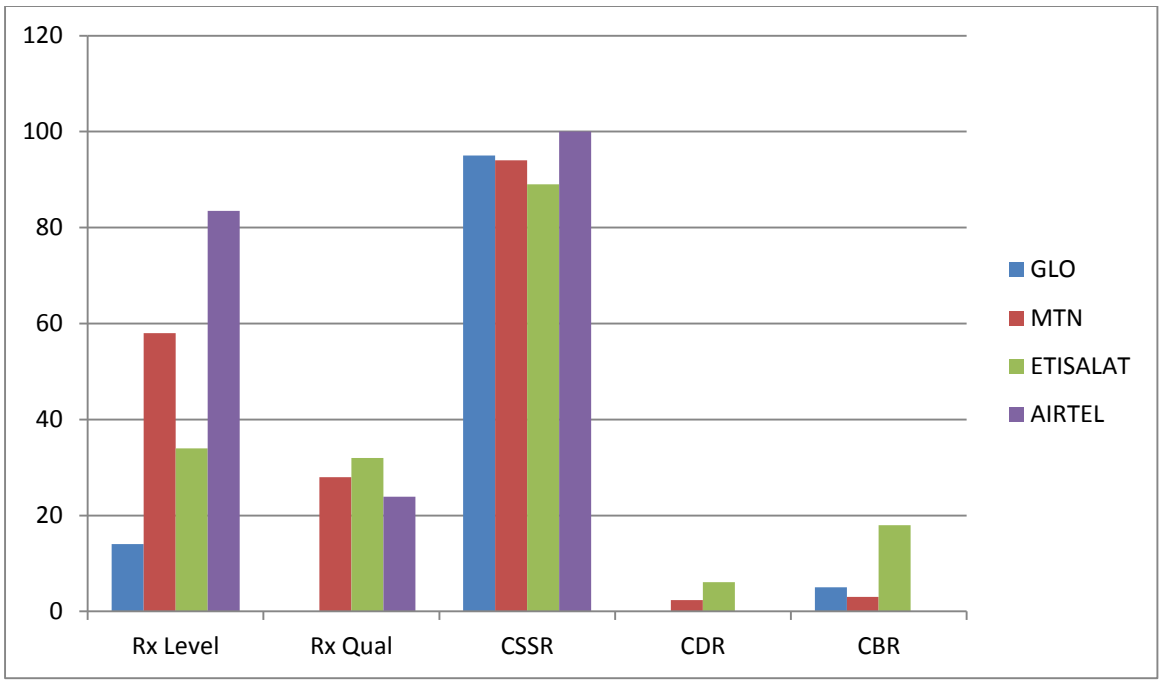

Fig 7: graphical representation of KPIs of each network operator

DISCUSSIONS

It is observed that three-quarter of the service provider did not meet up the receive signal level of at least 65dBm. This suggests that signal coverage by the service provider is poor in Ifo community and therefore more base stations should be located in these area. Also, in order to reduce economic impact of building new base station, a lease arrangement should be contracted among the service provider where microwave radio and BTS can be co-located. In order words, Airtel mast can be used by MTN, 9Mobile, Glo. With this, cost of setting a Radio link will reduce while enhancing signal coverage. This paper utilizes the idea of remote monitoring of mobile network as a way of making mobile service provider to continually upgrade and improve service quality because their network are continuously being monitored. Other research papers did not include telemonitoring tool. This study is therefore conducted to address this gap.

CONCLUSION

The result shows that receive signal level of ≥ 65dBm was highest for Airtel with 83.5% and lowest for Glo with 14%. The receive signal quality was generally poor for all the four service provider of Glo, MTN, 9mobile then Etisalat and airtel. The call set up success rate was generally good for the four service provider with no call drop for Glo and airtel. The inclusion of the tele-monitoring segment enhances the performance of services by service provider as signal strength can be monitored in any part of the country by the telecommunication regulator (NCC) prompting the service provider into action of maintaining good signal in every part of the country

To maintain constant excellent signal, it is therefore recommended that more base station should be set up in area with few numbers of base station. The optimisation team of the mobile service provider should constantly monitor site ensuring all the equipments in base stations are working optimally.

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