





such as reliability, delay, jitter, bandwidth, and so on. The requirement of above parameters will differ from one application to another application. The applications among others are video, audio, file transfer and web access. One of the aims of QoS is to manage the service response provided to low-speed devices such as mobile wireless devices. The QoS can be ensured only when the achieved / actual performance is greater than or equal to the desired performance. With the growth of mobile services, it has become very important for an operator to measure the QoS

services (call answered by operator and complaints handling) and inaccurate billing to approximately measure the QoS. The result of the interview and meetings with the focused groups were presented in a table and analysed. This revealed that there exist high tariffs and poor QoS as reported by [23]. Prepaid subscribers observed that they are overcharged for their talk time. It was confirmed by the views of one of the interviewee who stated: "after our talk over mobile phone, at times it happens that we are debited/charged more than our actual talk time".



users in the country. These groups include the households, business people and the professionals. Further the QoS was also differentiated into two broad groups of equipment and system oriented quality that include: activities directly related to the network and the people and process oriented quality comprising of activities provided over the network or face to face. He singled out the QoS indicators like network performance (made up of call success rate/ call set up success rate, call dropping rate, voice quality), customer

$$\text{CSSR (\%)} = \frac{\text{Number of successful call establishments} \times 100}{\text{Number of call attempts}} \quad \text{equation 3}$$

Beginning of the call attempt: successful pressing send button (it is important to check, if coverage has been given when send button is pressed).

Successful call establishment: open connection between A-party and B-party, where both parties can hear each other.  
Call Completion Rate Circuit Switched Telephony (CCR-CS-T):

Probability that a successful call attempt is maintained for a predetermined time until it is released intentionally by A- or B-party.

CCR-CS-T (%)

= Number of intentionally terminated calls x 100 **equation 4**  
Number of successful call attempts telephony

Successful call attempt: connect measurement (e.g. 'alerting' or 'busy' detected by A- party)

Terminated call: release of connection directly by A- or B-party

### 3.1 Materials and Procedure

For the purpose of this paper the following materials will be needed:

KPI	Globacom	Zain	Starcomms	Visafone
Accessibility	97.6	94.6	94.1	98.2
Set up Time	6.9	7.0	6.9	6.9
Success Ratio	92.8	89.9	91.1	93.4
Completion Rate	97.5	96.2	94.3	94.5

Mobile cellular phones that are in full good working conditions, Subscribers Identification Modules (SIMs) for all the networks under consideration (ZAIN and Globacom) and an electronic stop watch as well as a researchers' designed form to collect the data for the parameters under study such as: Name of network, call setup time telephony, Call Setup Success Ratio calls completion status among others for both intra and inter network calls.

The mobile cellular sets were each equipped with a different SIM card from each network under study. Assurance was made of full power, enough credit, and full functioning of the cellular phone. Calls were made randomly from ten selected locations around Zaria to any other part of the Country. On daily basis, the data was collected four times Starting at 6.00am stretching over to 6 p.m. at an interval of every two hours. This therefore, lasted for a period of twelve hours where each call made took duration between fifteen seconds and sixty seconds. This daily period of twelve hours, is to ensure that peak call periods are covered. The exercise lasted for a period of fourteen days (two weeks). At the end of every time slot therefore, 160 (16 call x 10 areas) calls were made while for the whole day, 640 (4 times x 160) calls were carried out. This gives a total of 8,960 (14 days x 10 different areas x 4 times x 16) calls for the fourteen days of data collection period.

The calls were made for both intra and inter networks and then GSM and CDMA (Code Division Multiple Access) networks to ensure that all of the network interactions are attended to. At each instance, the data collected either from the mobile cellular set or the electronic stop watch or both was recorded in the appropriate form designed.

Data for analysis was extracted from the data in the designed form for each network type. Line graphs were used to show the trend of intra and inter connection while bar charts were also used for the comparison of the network type based on each KPI for given instance or period as the case may be.

Calculations of inter connection for each of the KPIs for each network and network type was made. A graph of the values was plotted using Micro soft Excel for windows 2007, first for each intra network type and secondly for inter network type, one for each network and network type to show the individual trend on the QoS for the particular KPIs under consideration. The mean values of each KPI per network together with the line graph were able to reveal the network with a better QoS for intra and inter network telephony.

### 3.2 Data Presentation and Analysis

The data collected during the research period was hereby presented and the analysis done for all the KPIs under consideration for all the network types.

A total of 8,960 calls were made from the networks under study, the averages and totals for the call set up time and other KPIs respectively were calculated for the ten different locations for the study period. This reduces the data to a total of 640 calls. Furthermore, the averages for each intra and inter connections for each network and time instance are found. This was done same by finding the totals of the other KPIs. These averages were now used to determine the behavior of the networks for each site of data collection according to the equations 1, 2, 3 and 4 relative to the KPIs under consideration.

Table 1: KPI performance for Samaru Area

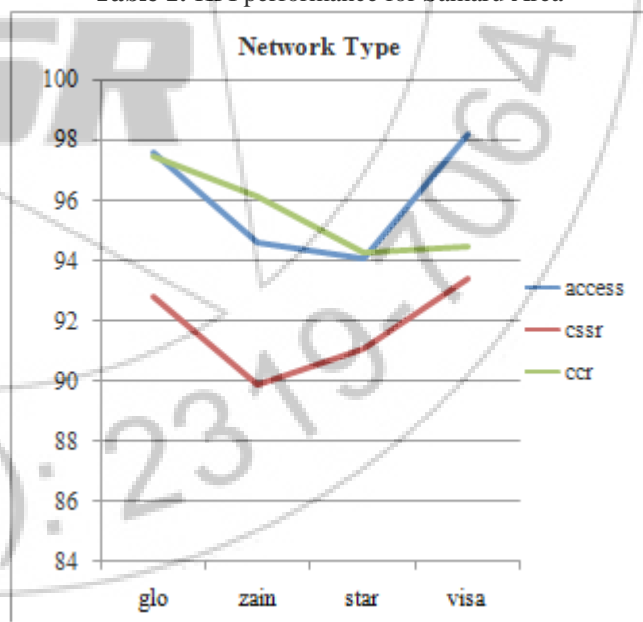


Figure 1: Graph of KPI performance for Samaru Area

The percentages of Service Accessibility, call set up success ratio and call completion success rate and the average Setup time values for each inter and intra-connection of each of the networks was done, then the average percentages for all the KPIs were calculated and the results were recorded in the table below.

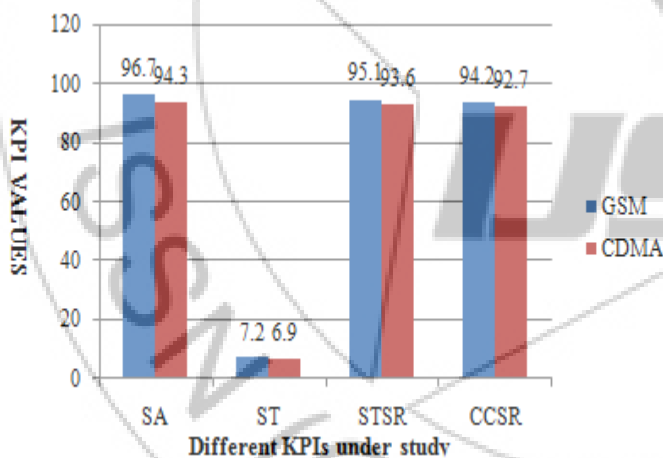
**Table 2:** General outcome of all KPIs for both inter and intra GSM and CDMA connections.

KPI	GSM				CDMA			
	GLO		ZAIN		STAR		VISA	
	Intra	Inter	Intra	Inter	Intra	Inter	Intra	Inter
Service Accessibility (%)	96.2	96.8	97.5	96.1	97.3	95.9	96.4	95.5
Set up Time (secs)	7.1	7.2	7.1	7.1	6.9	7.2	6.5	6.8
Call Set up Success Ratio (%)	96.4	95.2	95.2	93.4	94.0	94.2	92.7	93.5
Call Completion success Ratio (%)	95.4	94.4	94.5	92.5	93.4	93.2	91.9	92.2

The values for the comparison were obtained by finding the averages of values for each intra and inter connection of each KPI for each similar network as shown in table 2 and recording them in table 4 below. These values were used to compare the performance relative to QoS of both GSM and CDMA networks situation in Zaria

**Table 3:** Table showing the average values of GSM and CDMA intra and interconnections as extracted from table 3

KPIs	GSM			CDMA		
	GLO	ZAIN	$\bar{x}$	STAR	VISA	$\bar{x}$
Service Accessibility (%)	96.5	96.8	96.7	96.6	92.0	94.3
Set up Time (secs)	7.2	7.1	7.2	7.1	6.7	6.9
Call Set up Success Ratio (%)	95.8	94.3	95.1	94.1	93.1	93.6
Call Completion success Ratio (%)	94.9	93.5	94.2	93.3	92.1	92.7



**Figure 2:** Graph Showing General Performance of GSM and CDMA Networks

**SA:** Service Accessibility, **ST:** Set-up Time, **STSR:** Set-up Success Ratio, **CCSR:** Call Completions Success Ratio

It could be seen from the graph that higher values in each case of KPIs were experienced in the GSM networks than those of CDMA. It could be also be noted from the graph that the CDMA networks had a shorter set up time than the GSM; but many of their calls did not go to completion as those of GSM.

#### 4. Summary

This paper on Performance Analysis of the QoS of GSM and CDMA Cellular Networks in Zaria was carried out from the user's perspective and using manual/statistical method. The data was collected from ten different locations around Zaria well spread enough so as to ensure that double data was not collected from one and the same base station or transceiver. This data was collected by making use of full functioning and equipped mobile stations containing the various Subscribers' Identification Modules (SIMs) for different networks under study. The data was collected for a period of fourteen days, four times a day at an interval time of four hours starting from 6am to 6pm. All the values obtained for both intra and inter calls were recorded on a researcher's designed form. A total of 8,960 calls were made at the final stage. The parameter considered for the research included strictly telephony and the associated KPIs under study included; Service Accessibility, Call set up Time, Call setup Success Ratio and Call completion success ratio. Averages of the various data were calculated and recorded in appropriate tables, also lines graphs were plotted using MS Excel Office 2007 software package to determine the performance of each network relative to each KPI for different data collection areas. To compare network types, the mean of the averages of each KPI was calculated and recorded on tables and their bar charts plotted.

Regarding the different GSM operators as revealed in table 3, Globacom performance is better than that of Zain since most of its KPIs values are higher than those of Zain except for the setup time where Zain performs better than Globacom. In the same manner Starcomms contain most of the values greater than those of Visafone which contains a (6.7 seconds) set up time as the only indication of good performance over Starcomms.

From table 3, it was observed that this research obtained values for the different KPIs under studies as thus: a low service accessibility of 96.7% for GSM and 94.3%, Setup Time of 7.2 and 6.9 seconds respectively for GSM and CDMA. Also, Call Set up Success Ratio stood at 95.1 and 93.6% for GSM and CDMA networks respectively, while the Call Completion Success Ratio was 94.2% for GSM and 92.7% for CDMA.

#### 5. Conclusion

The research results showed that GSM; especially Globacom is the most favourable network in Zaria while Starcomms stood same for the CDMA network type.

Considering individual KPIs, CDMA has a poor success ratio and completion rate. This implies that most calls that are successfully established did not go through and even end up prematurely either due to noise or other interferences.

Notwithstanding, the general trend and performance of the KPI in Zaria are fair enough; thus the QoS. This goes a long way to show that the general performance of both GSM and CDMA network type are permissible. Thus, it was also seen from the research work that the values of individual KPIs are not just too different from those stipulated by the NCC and other GSM regulatory bodies.

## 6. Recommendations

Despite the fact that the KPI values fall within the recommended range, some are woefully below the agreed values. This leads to a loud cry from the subscribers because low and deplorable QoS is experienced. At this end, the following recommendations are made:

- 1) The government, NCC and other regulatory bodies should enforce a regular monitoring of the network operators and submission of reports on their performances at very short intervals so that QoS can be established to meet up with demands of the subscribers.
- 2) Operators should upgrade and optimize the capacities of all existing base stations so that the network will be able to handle the demand from the subscribers. The outcome of this will be an improvement in the call set up time.
- 3) Researchers should go into more researches so as to develop other means and algorithms to monitor, evaluate and address QoS and performance issues of cellular networks in all parts of the country.
- 4) Similar researches should be carried out in other parts of the country as well using same or other QoS parameters so as to give a more detail picture of the network trend in the country as a whole.

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