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Performance evaluation of key performance indicators for UMTS Networks in Calabar, Nigeria.

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Abstract

For appropriate regulation and quality assurance, continuous monitoring of cellular network services is necessary. A drive test measurement was carried out in Calabar, to investigate four UMTS networks, taking cognizance of Call Setup Success Rate (CSSR), Drop Call Rate (DCR), Handover Success Rate (HOSR), Call Setup Time (CST), Received Signal Code Power (RSCP) and Signal-to-Interference Ratio (Ec/Io). The collected data was analyzed and the obtained results was compared with the performance threshold levels of the Nigerian Communication Commission (NCC). The four networks had excellent CST, with MTN leading, followed by Airtel, then 9mobile and Globacom. For CSSR, Airtel had excellent performance, as there was no blocked call. This was followed by MTN and Globacom. 9mobile failed in CSSR as it was below the NCC recommended benchmark. There was no drop call in Airtel, MTN and 9mobile, but Globacom's performance was below the recommended threshold for dropped calls. For HOSR, the four networks showed excellent performance as they were able to handover calls between cells, as recommended by NCC. Considering the RSCP, the four networks displayed excellent services as subscribers experienced good voice and data services. However, the four networks had poor coverage quality (Ec/Io), the worst, being displayed by MTN. This shows that the equipment capability of the networks is low. The network operators are advised to monitor their services often, so as to optimize their networks for a better Quality of Service (QoS).

Keywords: Call setup time; Call setup success rate; Drop call rate; Handover success rate; Call setup time; Received Signal Code Power; Signal-to-Interference ratio

1. Introduction

Guglielmo Marconi, in 1896, using a morse code operating at a frequency of 1 MHz, demonstrated radio's ability to provide continuous contact with ships and this laid a foundation to the various evolutions of mobile technology [1]. Mobile communication, also known as cellular network [2] was introduced into Nigeria in August 2001 and the phase of information and communication technology in the country changed [3]. Cellular communication system has grown with increasing coverage and new services [4]. Institutions, industries, government agencies, ministries and organizations are all recipients of this estimable revolution [5] that has shrunk the world into a small village [6].

However, the emergence of mobile network in Nigeria is characterized by failed trials to make calls, poor audio quality [7] and dropped calls [8]. This poor QoS triggered the subscribers to forward a petition to the House of Representatives [9] and after thorough deliberation, NCC, the body responsible for the regulation of cellular networks in Nigeria, on 6th July, 2007 issued out the threshold levels on KPIs [10]. Thereafter, researchers in Nigeria commenced the investigation of mobile networks QoS and these was not limited to researches conducted by [11][12][13][14][15][16][17]. The importance of the analysis of these data is usually needful for appropriate regulations and quality assurance [18].

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This article is aimed at analyzing the QoS of UMTS networks operating in Calabar, Nigeria. The analysis is based on a drive test conducted in Calabar in November, 2021. Based on the analysis, we shall be able to detect the problems facing the various cellular networks and also adjudged which one is better in each KPI. This will keep the network operators updated, so that they visit their network sites for optimization.

2. Methodology

A Garmin Global Positioning System (GPS), four W995 TEMS mobile phones, four SIM cards, one for each network, TEMS 15.1 investigation software, a laptop, a USB hub, a car inverter and a car are the materials used for this study in Calabar, Nigeria.

The SIM cards are slotted into the TEMS phones while the TEMS investigation software is installed in the laptop. The TEMS phones is powered by connecting them to the USB hub which is plugged to the laptop. The GPS, which is also powered by the laptop, gives the location for the drive test. An extensive drive test measurement is conducted and the KPIs (CSSR, DCR, CST, HOSR, and RSCP and Ec/Io) are collected over UMTS base stations in Calabar, using TEMS investigation software running on a Windows 10 operating system laptop.

Collected log files are analyzed using a TEMS discovery software and the results are presented in the form of tables and plots. The results are further analyzed based on the NCC performance threshold levels so as to deduce which network performs best in each KPI. The KPIs are CSSR with a benchmark ≥ 98%, DCR ≤ 1%, CST ≤ 6 secs, HOSR ≥ 98%, RSCP ≥ -85dBm and Ec/Io ≥ -9dBm [19][20].

The cellular networks investigated are Airtel, MTN, Globacom and 9Mobile networks.

3. Results and discussion

The performance evaluation of four UMTS networks (Airtel, MTN, Globacom and 9mobile) has been analyzed based on their KPI data obtained from a benchmarking drive test. A summary of the drive test result for DCR, HOSR, CSSR and CST is given in Table 1. Also, Figure 1, Figure 2, Figure 3 and Figure 4 gives a picture of the RSCP by means of coverage plots for 9mobile network, Globacom network, MTN network and Airtel network while Figure 5, Figure 6, Figure 7 and Figure 8 gives a picture of the Ec/Io by means of quality plots for 9mobile network, Globacom network, MTN network and Airtel network.

Table 1 Summary of CSSR, DCR, HOSR and CST for the four UMTS Networks under study

S/N	KPI	Unit	Airtel Network	MTN Network	Globacom Network	9mobile Network
1.	DCR	%	0	0	5	0
2.	BCR	%	0	1.49	1.64	3.23
3.	HOSR	%	100	100	99.87	100
4.	CSSR	%	100	98.51	98.36	96.77
5.	CST	s	2.854	2.211	3.990	3.324
6.	Call Attempts	counts	220	335	305	310
7.	Handover Attempts	counts	1937	1788	1586	1598
8.	Handover Failures	counts	0	0	2	0
9.	Blocked Calls	counts	0	5	5	10
10.	Calls Established	counts	220	330	300	300

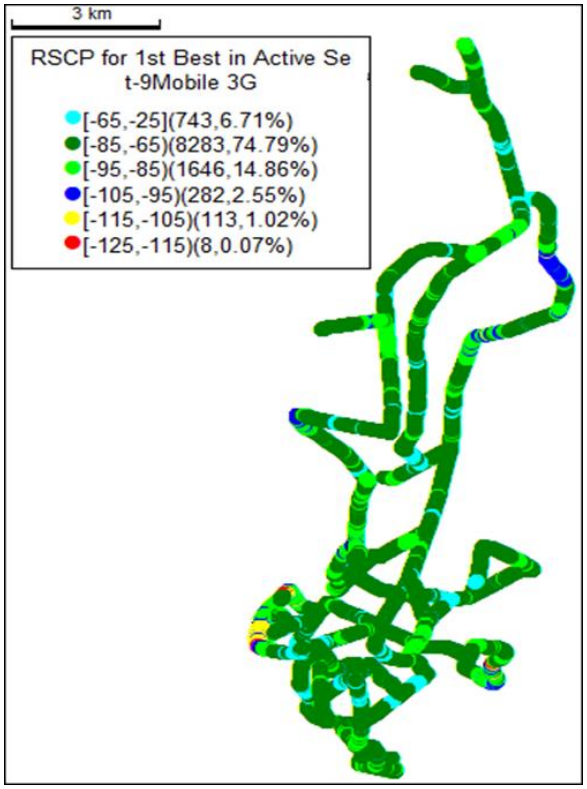

Figure 1 UMTS Coverage Plots for 9mobile Mobile Network

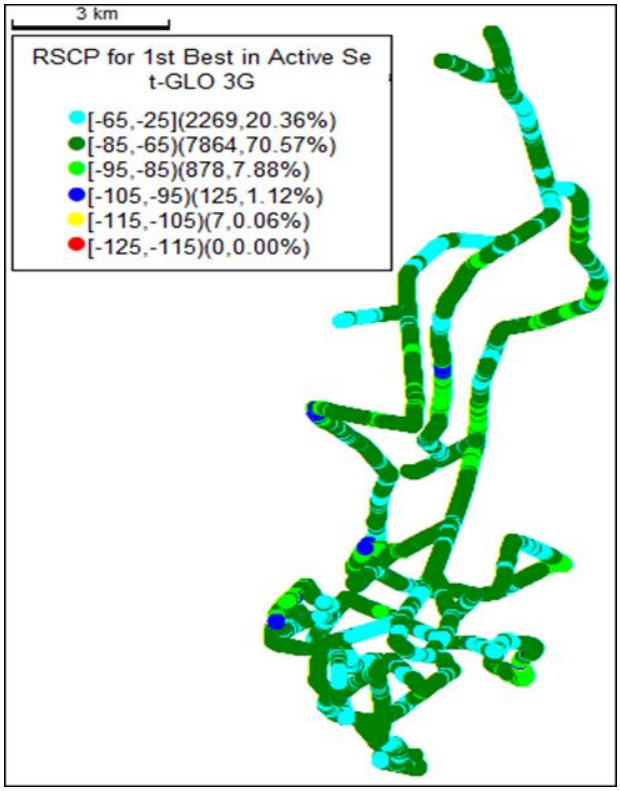

Figure 2 UMTS Coverage Plots for Globacom Mobile Network

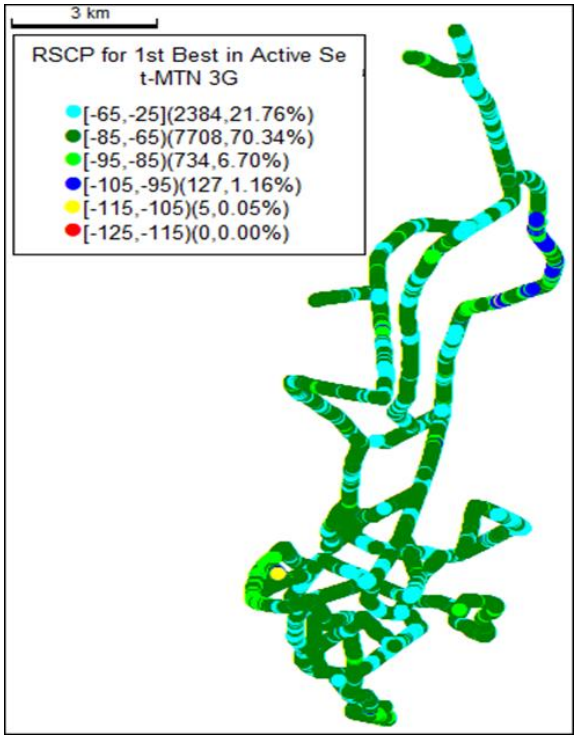

Figure 3 UMTS Coverage Plots for MTN Mobile Network

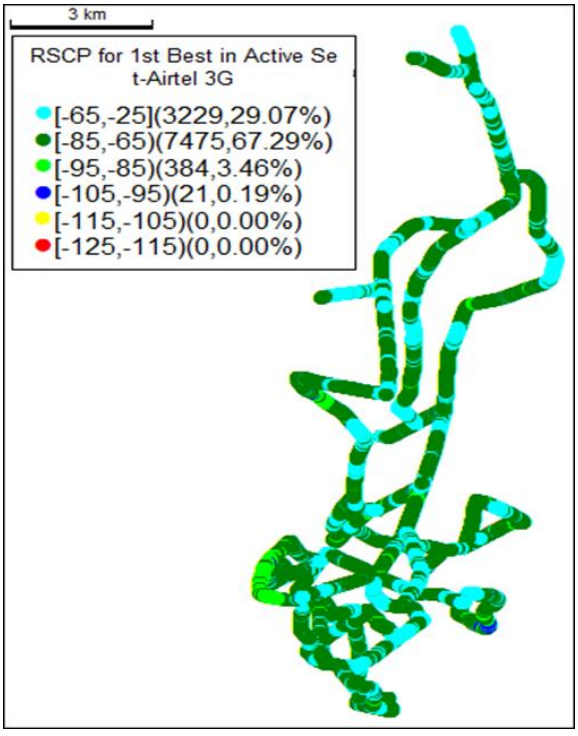

Figure 4 UMTS Coverage Plots for Airtel Mobile Network

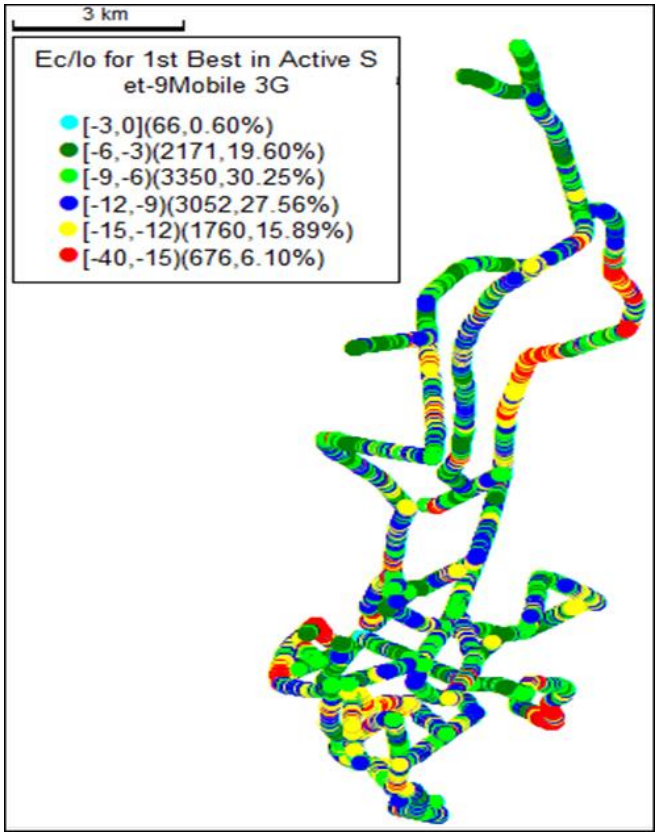

Figure 5 UMTS Quality Plots for 9mobile Mobile Network

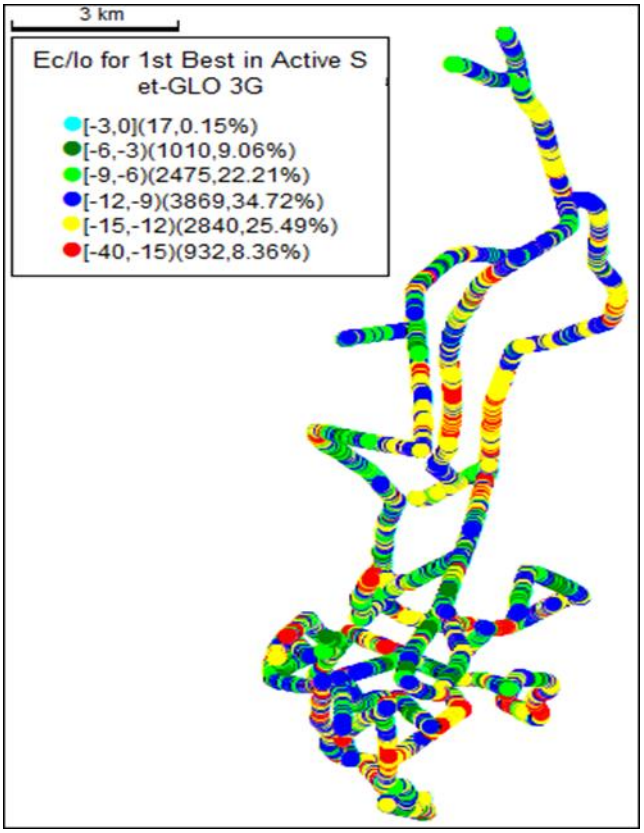

Figure 6 UMTS Quality Plots for Globacom Mobile Network

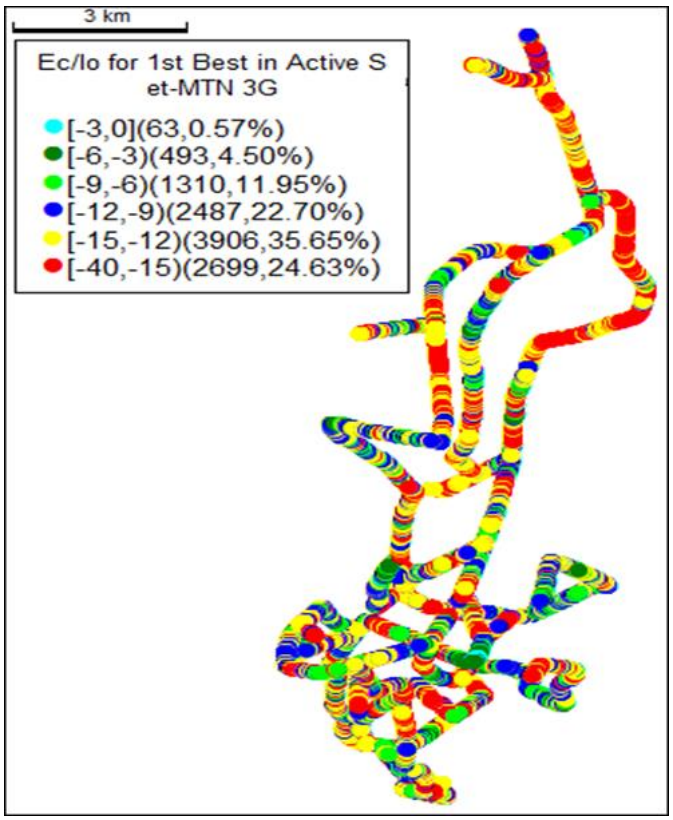

Figure 7 UMTS Quality Plots for MTN Mobile Network

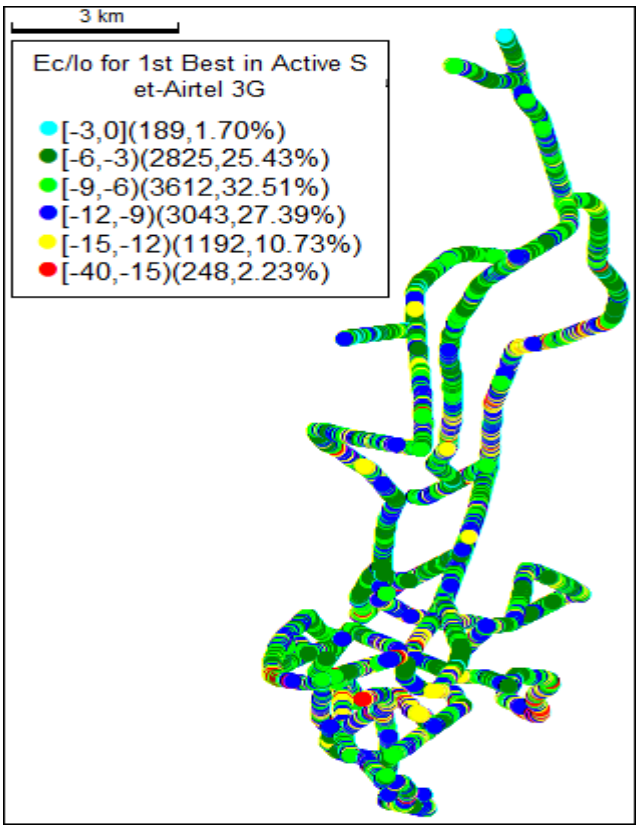

Figure 8 UMTS Quality Plots for Airtel Mobile Network

As shown in table 1, a total of 220 call attempts were made for Airtel network, 335 for MTN network, 305 for Globacom network and 310 for 9mobile network and this resulted to 220, 330, 300 and 300 established calls for Airtel, MTN, Globacom and 9mobile network respectively. All call attempts in Airtel were successfully established and this made Airtel the best in terms of CSSR, followed by MTN and then Globacom network. For 9mobile network, it fell below the minimum benchmark of at least 98% stipulated by NCC.

In terms of CST, MTN was the fastest, followed by Airtel and 9mobile and then Globacom network. The four network operators were within the threshold limit of at most 6 seconds set by NCC. This was not the same for DCR as Globacom network had the worst performance of 5% against the NCC benchmark of at most 1%. Airtel, MTN and 9mobile had no drop calls during this study period. Furthermore, all the networks under study, except Globacom network, successfully performed handover. However, the handover experienced by Globacom users was still within the NCC minimum benchmark.

In comparing the four networks in terms of their RSCP and with respect to NCC performance threshold of at least –85dBm, Airtel had the best coverage, followed by MTN, Globacom and then 9mobile network. For signal-to-interference ratio, Airtel and 9mobile had a fair performance, Globacom network showed bad network quality while the worst was observed in MTN network.

For the sake of knowledge, we intend to interpret the coverage and quality plots in Figure 1 to Figure 8. In the coverage plots and quality plots, regions denoted with light green had excellent coverage and signal quality with remarkably satisfied subscribers. Regions with deep green had very good coverage and signal quality with very satisfied subscribers. In the blue region, subscribers were satisfied because they had good coverage and signal quality. The yellow region is characterized by dissatisfied subscribers, fair coverage and signal quality with moderate interference. Finally, the red region has poor coverage and signal quality, higher interference and very dissatisfied subscribers.

4. Conclusion

A drive test was used to investigate service retainability, service accessibility and service reliability of UMTS networks in Calabar. Results obtained shows that the networks were performing in line with the minimum benchmarks of NCC, in terms of CSSR, DCR, HOSR, CST and RSCP. However, results obtained in terms of Eo/Io shows that the networks lack equipment capability and therefore, needs more base stations and frequent optimization on their networks.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest by the authors.

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