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Performance Analysis of Telecommunications Regulations in Nigeria: A Quality Of Service Approach

[1]Kafilu Barau Danbatta, [2]Tasiu Zangina

Nigerian Communications Commission
Plot 426 Aguiyi Ironsi Street
Maitama Abuja, Nigeria

[2] Department of Physics
Federal University Dutse
Jigawa State, Nigeria

Abstract

The revolution of wireless communications regulations in Nigeria signifies enhancement in ICT innovation, investment opportunities, fair competition and inclusive growth through, strategic collaboration and partnerships to protect and empower consumers. The demand for data in the 4G (Fourth Generation networks) and 5G (Fifth Generation networks) is becoming excessively high and the solution is being investigated to effectively utilize the available spectrum at the physical layer across different protocols to speed-up bandwidth access from 2.5 to 10 times to support new high-performance applications (e.g. e-health, high definition video streaming, network gaming, e-commerce, e-government etc.) To realize the above targets the operators need to provide some form of Quality of Service (QoS) and Quality of Experience (QoE) assurance. The 8-Point Agenda of the EVC/CEO of Nigerian Communications Commission (NCC) factored upon a tripod of Availability, Accessibility and Affordability of Service, the Nigerian Communications Act 2003, the National Telecommunications Policy, the Strategic Management Plan of the Commission, the National Digital Economy Policy and Strategy and other extant regulatory provisions are utilized to regulate telecommunications services and promote universal access in Nigeria. This paper reviewed the QoS Key Performance Indicators (KPIs) like The CSSR, DCR, SDCONG, and TCHCONG CSSR, MTTR, and Power Availability for 2G, 3G and 4G according to the International Telecommunications Union Standards (ITU-T) and NCC criteria. Literature review on QoS and congestion control analysis were conducted and the research gaps were identified for the development of effective regulations and operational excellence. Recommendations were made on the way forward to explore the optimization of electricity supply to base station using hybrid system, renewable and green energy to reduce operational cost and emissions.

Key Words: *CSSR, DCR, SDCONG, and TCHCONG,* Busy hour, Key performance indicators, NSP (Network Service Providers)

INTRODUCTION

Teletraffic theory defines the relationship between quality of services and equipment cost. Therefore there is a need of proper planning and control for optimal network configuration in order to meet the ever increasing demand of consumers. The QoS is defined in the ITU-T

**Author for Correspondence*

Recommendation E-800 as: "*The collective effect of service performance, which determines the degree of satisfaction of a user of the service*". Service Level Agreement (SLA) between consumers and NSPs would only be justified economically, if bandwidth resources are optimally shared among the existing subscribers according to Erlang B model in loss mode operation and Erlang C model in a queuing mode operation. This is to enhance the interoperability of networks applications through technical Interfacing, Stasiak et al. (2011). Normal day depicts usual activities in a day while High load condition corresponds to festivals.

As the world's demand for data is increasing at an amazing rate, there is a need for seamless and ubiquitous content rich interoperability between NSP (Network Service Providers). With current 4G and 5G customer devices consuming tremendous amount of data, the current network architecture needs major transformation to meet up with the subscribers' demand. The 5G network as a fifth generation mobile technology is expected to outperform earlier versions of wireless communication technology Huawei (2021). Fifth Generation (5G) wireless communication network development addresses the shortcomings of the current Fourth Generation (4G) LTE and WiMAX. The 5G networks for future applications in all domains support wide range of new technologies like IoT, smart cities and Cyber and Information Security as well as broadband penetration. It would support the administration of new governance, enhancement of current business models, efficiency in the health care delivery, economic growth and insecurity reduction in the totality of human endeavor Bakare et al (2021). According to the International Telecommunication Union's IMT-2020 standard 5G is expected to offer a theoretical peak download speed of 20 gigabits per second and 10 gigabits per second upload speed, 99.999% reliability and less than 1 msec latency. (Wikipedia). QoS parameters like speed, priority queuing and reliability need to be differentiated for optimal volume-based tiering tariff implementation so as to increase customers' WTP (Willing to Pay) for 5G services. NCC Task Force and Industry Working Group on QoS were assigned to improve Quality of Service and Experience and to ensure that all telecommunications hard wares and soft wares have been type approved according to the world best practices.

The Telecom Industry in Nigeria has to be regulated in order to facilitate healthy competition and growth. A customer has to be protected against excessive tariff by NSPs and poor Network QoS. The services offered should always be available, easily accessible and affordable in order to meet customers' demand and satisfaction. In ensuring the above, NCC identified some QoS Key Performance Indicators (KPIs). The KPIs are Call Setup Success Rate (CSSR), Dropped Call Rate (DCR), Standalone Dedicated Control Channel Congestion Rate (SDCONG), Traffic Channel Congestion Rate (TCHCONG), Mean Time to Repair (MTTR), and Power Availability for 2G, 3G and 4G. These are periodically evaluated according to the International Telecommunications Union Standards (ITU-T) and NCC criteria for effective regulations and operational excellence. The congestion in the networks would be drastically reduced to the barest minimum, if the targets of these KPIs were met and this would translate into customer's subjective satisfaction. The essence of this paper is to conduct a performance analysis to find out if these targets are being met by the NSPs and to identify areas of underperformance so as to recommend ways of improvement to the NSPs and the strategies to be adopted by the regulator. This research covers all the most important KPIs that translate totally the performance of the NSPs and the data utilized is Nationwide unlike the paper by Galadanci and Abdullahi (2019) that analyzed the performances of three GSM networks in Kano, which is regional in nature. In this paper two additional KPIs power availability and MTTR were added in the analysis. These were omitted in the previous researches like the research conducted by Nnamdi, Aneke and James (2017).

LITERATURE REVIEW

Danbatta (2014) developed a price based congestion control models using the Erlang B and C models to determine the optimum network capacity based on detailed user behavior and demanded QoS parameters in an overall telecommunication system. A simulation result using MATLAB showed that the congestion in the network was reduced by 21% compared with other existing models. Bakare et al (2021) reviewed 5G Network implementation strategies in Nigeria**.** The 5G networks for future applications in all domains support wide range of new technologies like IoT, smart cities and Cyber and Information Security as well as broadband penetration. It would support the administration of new governance, enhancement of current business models, efficiency in the health care delivery, economic growth and insecurity reduction in the totality of human endeavor. Aneke and James (2017) have developed control procedures for the administration of traffic and control channels congestion. It explores the use of Erlang-B in determining the minimum percentage of the GoS.

The work of Mughele and Wole (2012) established that a major cause of MTN network congestion is poor allocation of network resources to satisfy customers' demand. Similarly, Ohaneme et al. (2012) used the QoS parameters like Completion Ratio (CCR) and Answer Seizure Ratio (ASR) on four mobile network's BTS and BSC in Nigeria. Some traffic models were simulated in evaluating the performance of GSM networks. The KPIs indicated lower levels of QoS. The work did not fully address the solutions to the congestion problem. Galadanci and Abdullahi (2019) utilizes the CDR (Call Detail Record) of three GSM networks in Kano, to analyze their performances using statistical analysis and simulation procedures. The performances of the KPIs during the period of study including the festivals indicates the need of Network optimization. Emuoyibofarhe and Ozchi (2015) recommended the re-planning of the cells in various BTSs' antennas, be it Omni directional or sectorized. The control channels, traffic and dedicated channels would be optimized according to proper planning of frequency re-use factor, traffic intensity and handover scenarios. Ozovehe1 et al (2011) addressed congestion during busy hour and analyzed real-time traffic to determine the level of congestion in the system. Sani Man-Yahaya (2007) conducted a performance management studies in communication networks with specific interest on the Mobile Switching Centre of Celtel limited Lagos area. A traffic data was obtained on weekly basis for nine mobile switching centres located in three different locations in Lagos area, and recommended the establishment of more MSCs in Victoria Island. Isabel Frostne (2011) studies the Network in Kulyab region. After collecting and analyzing the data, the new MSC was configured, so it meets the current traffic demands along with appropriate number of base stations it can support and the extent to which it improves the overall network performance in terms of increased reliability, capacity, and throughput. Osahenvemwen and Emagbetere (2011) analyzed using excel, some BSC performances during busy hour using offered traffic, carried traffic, block traffic, call completion rate (CCR), busy hour call attempt (BHCA) and GOS as traffic performance indicators. Similarly, Ozovehe1 et al (2011) established a congestion control mechanism during busy hour using real-time traffic to forecast the pattern of customers' demand so that resources could be dimensioned optimally. Nnamdi,

QUALITY OF SERVICE INDICATORS FOR NETWORK SERVICE PROVIDERS

According to the regulations, the Quality of Service (QoS) indicators must be reported to NCC Quarterly. The report covers the nation-wide network services and individually covering the six geo-political zones. These locations were selected regionally viz: Urban Areas of Lagos, Aba, Abuja, Kano, Benin City, Maiduguri, and Port-Harcourt cities. As the number of customers increases along with the excessive demand of various wireless IT applications, there is a need to evaluate the QoS of NSPs periodically. The Call Setup Success Rate (CSSR)

is a ratio of the number of unblocked call attempts to the total number of call attempts. A dropped call is a call that is prematurely terminated before being released normally by either the caller or called party. The Dropped Call Rate (DCR) is a ratio of dropped calls to the total number of call attempts. The Standalone Dedicated Control Channel Congestion Rate is defined as the probability of failure of accessing a Standalone Dedicated Control Channel (SDCCH) during call set up. The SDCCH is to provide a reliable connection for signaling and SMS. Traffic Channel Congestion Rate (TCCH) is the probability of failure of accessing a traffic channel during call setup for transferring voice and data between mobiles and the BTS.

RESULTS AND DISCUSSION

The data obtained covers Nationwide Industry Statistics from July 2020 to June 2021. Figure 1 shows the CSSR Nationwide performance for Airtel, 9mobile, Globacom and MTN. Performance Threshold of the CSSR should be equal to or greater than 98%.All the Networks performed excellently within the minimum NCC threshold. The MTN is leading with 99.72%. Figure 2 shows the DCR Nationwide performance for Airtel, 9mobile, Globacom and MTN. Performance Threshold of DCR should be equal to or less than 1%. All the Networks performed excellently within the minimum NCC threshold. The MTN is leading with 0.38 in the month of May 2021 followed by 9mobile and Globacom each one with 0.39 in the months of Feb and April 2021 respectively. Figure 3 shows the SDCCH Nationwide performance for Airtel, 9mobile, Globacom and MTN. Performance Threshold of SDCCH Congestion Rate should be equal to or less than 0.2%. All the Networks performed excellently within the minimum NCC threshold with the exception of 9mobile which performed poorly in the months of May and June 2021 at 0.27 and 0.39 respectively. The Airtel is leading with 0.06 and 0.05 in the months of Jan and Feb 2021 respectively. Figure 4 shows the TCH Nationwide performance for Airtel, 9mobile, Globacom and MTN. Performance Threshold of the TCH Congestion Rate should be equal to or less than 2% All the Networks performed excellently within the minimum NCC threshold. The Airtel is leading with 0.06 and 0.05 in the months of May and Jun 2021 respectively.

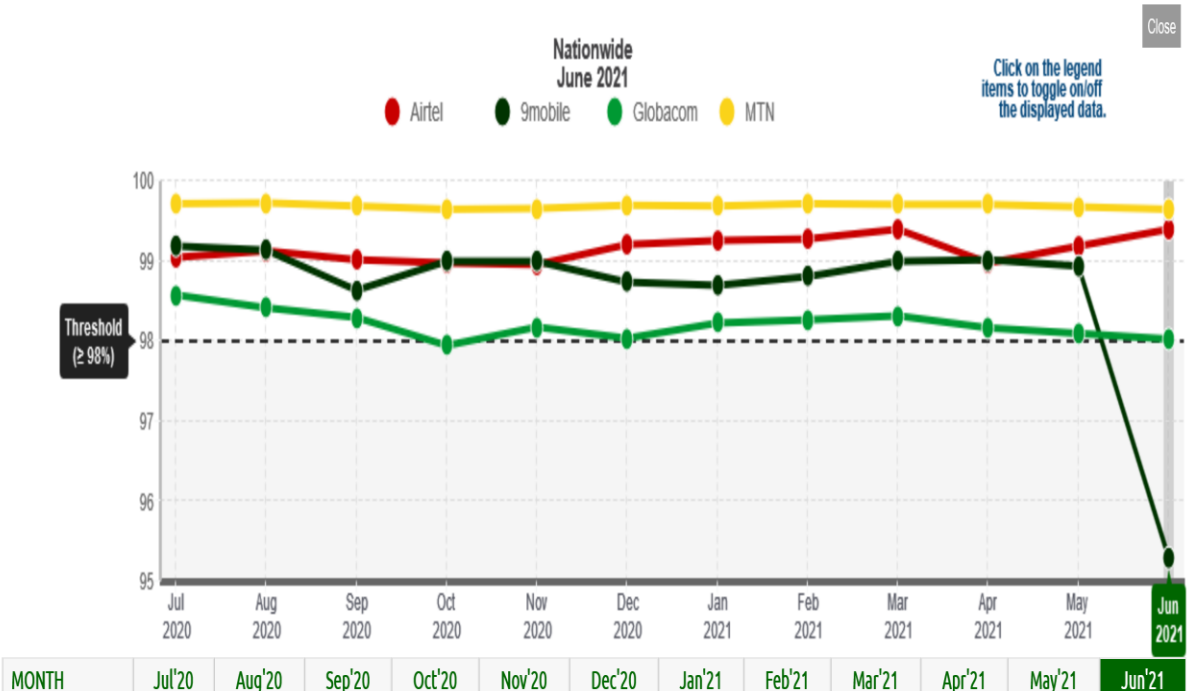

Figure1: The graph of the CSSR Nationwide performance for Airtel, 9mobile, Globacom and MTN from Jul 2020 –Jan 2021 extracted from www.ncc.gov

Table1: The Nationwide CSSR for Airtel, 9mobile, Globacom and MTN (Jul 2020 –Jan 2021) extracted from www.ncc.gov

MONTH	Jul'20	Aug'20	Sep'20	Oct'20	Nov'20	Dec'20	Jan'21	Feb'21	Mar'21	Apr'21	May'21	Jun'21
Airtel	99.05	99.13	99.02	98.98	98.96	99.21	99.26	99.28	99.4	98.98	99.19	99.4
9mobile	99.19	99.14	98.64	99	99	98.74	98.7	98.81	99	99.02	98.94	95.3
Globacom	98.58	98.42	98.3	97.95	98.18	98.04	98.23	98.27	98.32	98.17	98.1	98.03
MTN	99.72	99.73	99.69	99.65	99.66	99.7	99.69	99.72	99.71	99.71	99.68	99.65

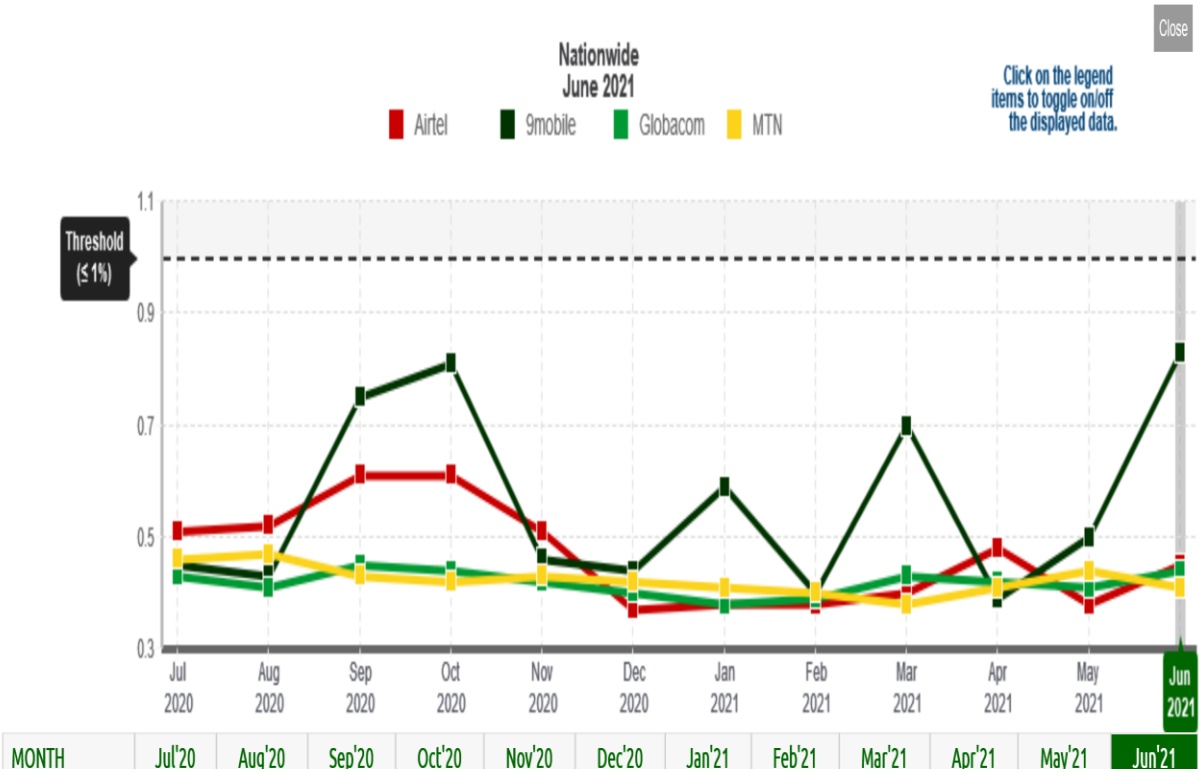

Figure2: The graph of Nationwide DCR performance for Airtel, 9mobile, Globacom and MTN (Jul 2020 –Jan 2021) extracted from www.ncc.gov

Table2: The Nationwide DCR for Airtel, 9mobile, Globacom and MTN (Jul 2020 –Jan 2021) extracted from www.ncc.gov

MONTH	Jul'20	Aug'20	Sep'20	Oct'20	Nov'20	Dec'20	Jan'21	Feb'21	Mar'21	Apr'21	May'21	Jun'21
Airtel	0.51	0.52	0.61	0.61	0.51	0.37	0.38	0.38	0.4	0.48	0.38	0.45
9mobile	0.45	0.43	0.75	0.81	0.46	0.44	0.59	0.4	0.7	0.39	0.5	0.83
Globacom	0.43	0.41	0.45	0.44	0.42	0.4	0.38	0.39	0.43	0.42	0.41	0.44
MTN	0.46	0.47	0.43	0.42	0.43	0.42	0.41	0.4	0.38	0.41	0.44	0.41

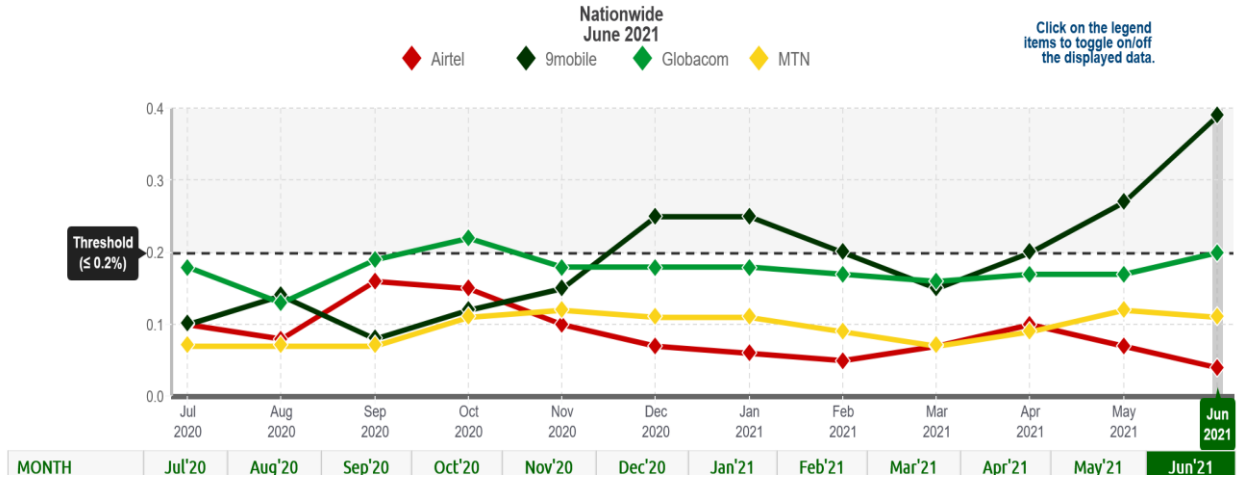

Figure3: The graph of Nationwide SDCCH performance for Airtel, 9mobile, Globacom and MTN from Jul 2020 – Jan 2021 extracted from www.ncc.gov

Table3: The Nationwide SDCCH, for Airtel, 9mobile, Globacom and MTN from Jul 2020 –Jan 2021extracted from www.ncc.gov

MONTH	Jul'20	Aug'20	Sep'20	Oct'20	Nov'20	Dec'20	Jan'21	Feb'21	Mar'21	Apr'21	May'21	Jun'21
Airtel	0.1	0.08	0.16	0.15	0.1	0.07	0.06	0.05	0.07	0.1	0.07	0.04
9mobile	0.1	0.14	0.08	0.12	0.15	0.25	0.25	0.2	0.15	0.2	0.27	0.39
Globacom	0.18	0.13	0.19	0.22	0.18	0.18	0.18	0.17	0.16	0.17	0.17	0.2
MTN	0.07	0.07	0.07	0.11	0.12	0.11	0.11	0.09	0.07	0.09	0.12	0.11

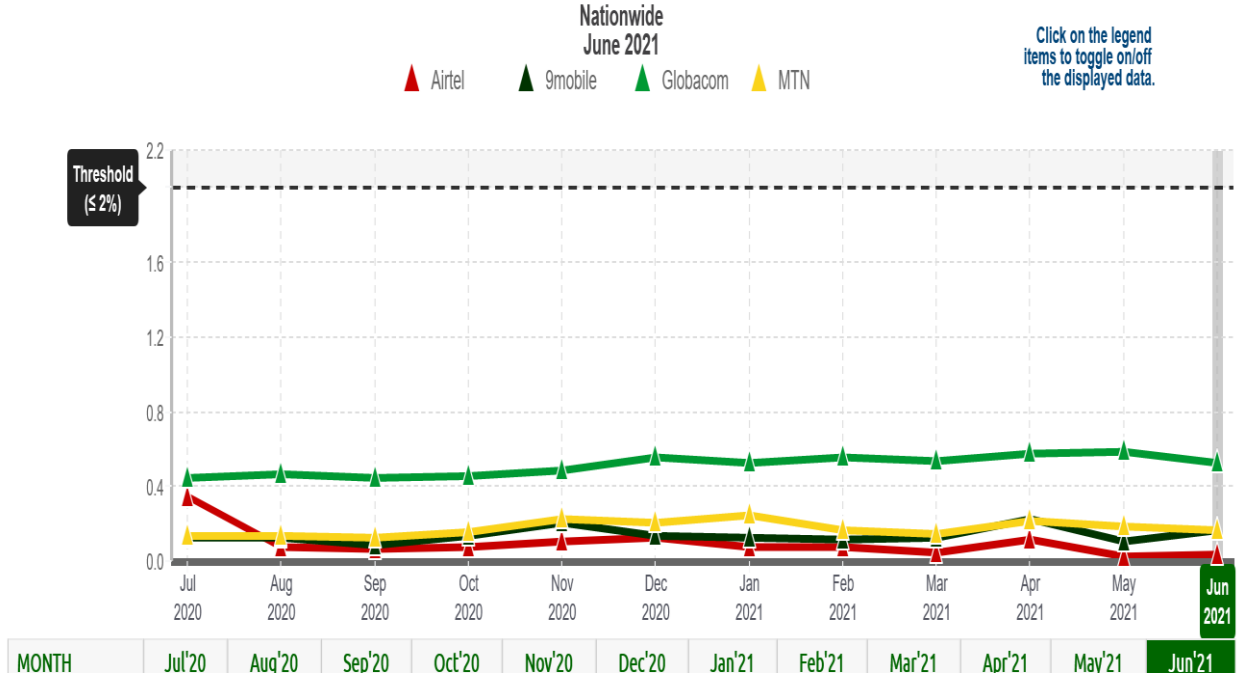

Figure4: The graph of Nationwide TCH performance for Airtel, 9mobile, Globacom and MTN (Jul 2020 –Jan 2021) extracted from www.ncc.gov

Table4: The Nationwide TCH for Airtel, 9mobile, Globacom and MTN (Jul 2020 –Jan 2021) extracted from www.ncc.gov

MONTH	Jul'20	Aug'20	Sep'20	Oct'20	Nov'20	Dec'20	Jan'21	Feb'21	Mar'21	Apr'21	May'21	Jun'21
Airtel	0.35	0.08	0.07	0.08	0.11	0.13	0.08	0.08	0.05	0.12	0.03	0.04
9mobile	0.13	0.13	0.09	0.14	0.21	0.14	0.13	0.12	0.13	0.23	0.11	0.17
Globacom	0.45	0.47	0.45	0.46	0.49	0.56	0.53	0.56	0.54	0.58	0.59	0.53
MTN	0.14	0.14	0.13	0.16	0.23	0.21	0.25	0.17	0.15	0.22	0.19	0.17

The following graphs depicts the monthly power availability indicators of the major Collocation Service Providers (CSPs) i.e. ATC Nigeria Wireless Nigeria (ATC) and IHS Nigeria (IHS).

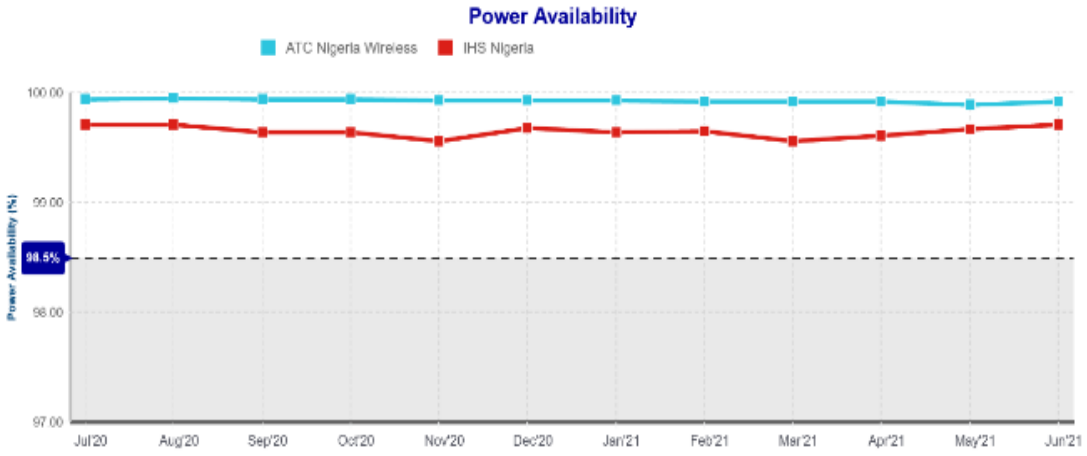

Figure 5: Power Availability of ATC and HIS

The BTS power supply in Nigeria depends largely on excessive cost of diesel and this translates to high subscribers' tariff as well as environmental air and water pollution. The running cost of BTSs in the rural areas that are mostly not connected to the national electricity affects the availability, accessibility and affordability of the services. From Figure 5, the ATC Nigeria Wireless has 100% power availability while the HIS Nigeria has between 97% and 98%. Figure 6 shows that the MTTR for ATC and HIS were above 2 hours in the months of March and May 2021 respectively. This is below the target of 2 hours minimum MTTR set by NCC.

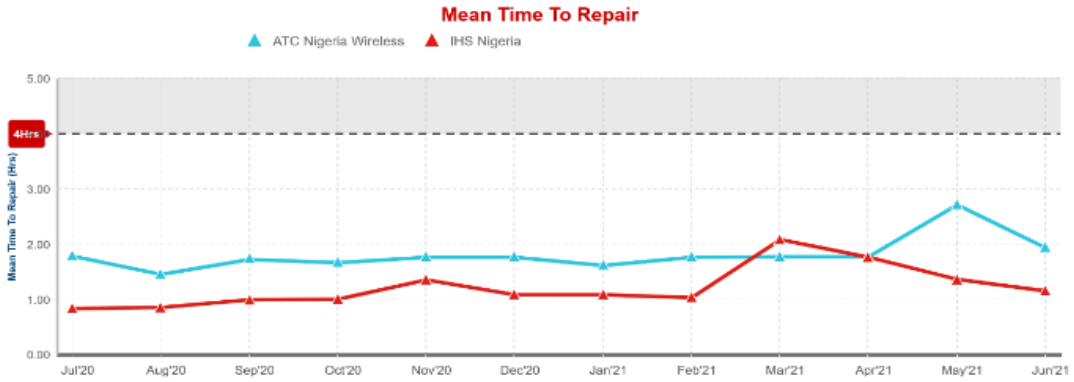

Figure 6: MTTR for ATC and HIS

CONCLUSION

The Nigerian Communications Commission, the regulator of the telecommunications industry in Nigeria, annually sponsors telecommunications-based research innovations to be conducted in the selected Nigerian universities by utilizing locally sourced materials so as to contribute to the growth of the telecommunications industry. Network vandalization cases are being attended by the judiciary and the Office of the National Security Adviser (ONSA). NCC had drafted the Nigerian Communications Industry e-Waste Regulations in 2018 with the objective to manage e-waste to reduce greenhouse emissions as well as enhance sustainable development efforts. Type-approval processes are being carried out by the Commission to ensure that all equipment used in the telecommunications industry are of acceptable standards, to combat the proliferation of fake, counterfeit, substandard and cloned communication devices. The CSSR, DCR, SDCONG, and TCHCONG have improved from 98.3%, 0.68%, 0.76%, and 0.60% in 2015 to 98.99%, 0.52%, 0.17% and 0.33% in 2019 respectively. NCC defined KPI target metrics to assist NSPs to dimension network resources effectively to optimize the network, avoid congestion and improve network performance. About 80% failure of the network occur as a result of power failures at the BTS sites. NSPs mostly depend on diesel generators to power their BTSs as the grid power is becoming less reliable. Solar electricity generation in Nigeria has a high potential for renewable energy. Resources such as energy crops, forest and agricultural residues (bioenergy) would be utilized to generate electricity as well as wind energy and biomass energy. The use of waste to generate energy has been in the pipeline and the major problem is the high cost of waste collection and management. Majority of BTS down-time is highly attributed to The Mean Time to Repair (MTTR). The ATC Nigeria has an average of 2 hours MTTR while the HIS Nigeria has an average of 1 hours MTTR.

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