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Examination of call setup success rate and dropped call rate for 4g networks in Yenagoa-southern Nigeria

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Abstract

This study compares the call setup success rate and dropped call rate of four mobile telecommunication networks operating in Yenagoa, Southern Nigeria, to industry benchmarks and competitor networks in an effort to identify areas for improvement, set performance targets, and establish a relationship between them. The results show that the four networks (MTN, 9mobile, Airtel, and Globacom) performed within the regulator's benchmark in the majority of cases, while noting many instances where their performance fell below the benchmark. The maximum value obtained within the period in view for call setup success rate was 99.77% and it was gotten from MTN while the minimum value obtained was 94.07% and it was from Globacome.; conversely for dropped call rate, the maximum values obtained within the period in view was18.52% and it was in March 2016 for Globacom while the least value recorded is 0.00% and it was in September 2018 for 9mobile. For Airtel, 9mobile, Globacom, and MTN, the correlation coefficients between CSSR and DCR were -0.34, -0.47, -0.60 and -0.69 respectively. The four networks' negative correlation coefficient values show that, in every scenario, a rise in CSSR results in a corresponding drop in DCR and vice versa.

Keywords: Call Setup Success Rate; Dropped Call Rate; Key Performance Indicator; Call Setup Failure Rate; Handover Failure Rate; Data; Mobile Network.

1. Introduction

In the telecommunications sector, the Call Set-Up Success Rate (CSSR) and Dropped Call Rate (DCR) are very important key performance indicators (KPI) that gauges how well voice or data calls are connected to networks. They are essential metric for evaluating a telecom network's dependability and caliber. In mobile communication networks, such as GSM (Global System for Mobile Communications), CDMA (Code Division Multiple Access), and other cellular technologies, CSSR and DCR are especially pertinent [1,4].

Call Set-Up Success Rate is the percentage of successfully established calls compared to the total number of attempted call setups [3]. It is expressed as a ratio and is calculated using the following formula:

$$\text{CSSR} = \left(\frac{\text{Successful Call Setups}}{\text{Total Attempted Call Setups}}\right) \times 100 \qquad 1$$

Call Set-Up Success Rate is composed of two components

Successful Call Setups: In order to connect two parties for a voice call, video call, or data transfer, a number of complex procedures must be followed for call setups in mobile telecommunications networks to be successful [2,5]. Positive user experiences and effective communication are guaranteed by these procedures. There are multiple steps in the call setup process, such as registration, location updating, call establishment, and handovers [3]. Key elements and steps involved

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in Successful Call Setups in Mobile Telecommunication Networks are Network Registration, Location Updating, Call Establishment, Resource Allocation, Call Routing, Connection Establishment, Handovers, Call Termination, Security Measures, Error Handling/Redundancy and Continuous Optimization [6,7,8]. The intricate interplay of registration, authentication, resource allocation, routing, and security measures is necessary for successful call setups in mobile telecommunications networks. In order to offer consumers dependable, superior communication services, network operators continuously improve and streamline these procedures. The efficiency and efficacy of call setups in mobile telecommunications will continue to be enhanced by the integration of cutting-edge technologies like 5G and the continuous optimization of network architectures [9].

Total Attempted Call Setups: In mobile networks, the total number of attempts made by mobile subscribers to initiate voice, video, or data calls is known as the "Total Attempted Call Setups" [7]. In order to optimize their infrastructure, control network congestion, and guarantee a satisfactory user experience, network operators must comprehend and analyze these attempted call setups. Factors, Processes and Considerations related to Total Attempted Call Setups in mobile telecommunication networks are Initiation Process, Call Request Handling, Resource Allocation, Network Capacity Planning, Congestion Management, Call Setup Success Rate, Quality of Service (QoS) Monitoring, Load Balancing, Error Handling and Retries, Network Optimization, User Experience Enhancement and Security Measures [7,10,11,12]. One important indicator of a network's effectiveness and health in mobile telecommunications is the total number of attempted call setups [13]. Network managers use this information to put strategies into place for managing congestion, planning capacity, and general optimization. Operators can make sure that the telecommunications infrastructure is strong and dependable and can accommodate the changing demands of mobile subscribers by closely observing and evaluating attempted call setups [14].

Dropped Call Rate (DCR) is a crucial metric in mobile telecommunication networks, representing the percentage of calls that get prematurely terminated or dropped before completion [6]. It is a key indicator of network quality and customer satisfaction. High DCR can lead to a poor user experience, impacting the reputation of the telecom operator [15]. Understanding the factors influencing DCR and implementing effective strategies to minimize it are critical for maintaining a reliable and efficient mobile network. Mathematically, DCR is calculated using the following formula:

$$DCR = \left(\frac{Dropped\ Calls}{Total\ Attempted\ Calls}\right) \times 100 \qquad 2.$$

From equation 2 above, it is seen that DCR is primarily made of two components Dropped Calls and Total Attempted Calls

1. Dropped Calls: Dropped calls in mobile telecommunication networks occur when a phone call is terminated prematurely, causing inconvenience to users and reflecting negatively on the network's quality of service [16]. Understanding the causes, impact, and potential solutions for dropped calls is crucial for telecommunication operators to maintain a reliable and efficient network [17]. There are various factors that Causes Dropped Calls and they include Poor Signal Quality, Handover Failures, Network Congestion, High network traffic, Equipment or Software Failures, Malfunctioning network equipment, Call Setup Issues, Roaming and Interconnect Issues [5]. Dropped Calls have far reaching impacts on the networks performance which includes Customer Dissatisfaction, Financial Loss, Reduced Network Efficiency, and Negative Perception [6,8]. However there are viable avenues to reducing Dropped calls, theses avenues include Network Optimization, Handover Optimization, Capacity Planning, Advanced Technologies, Regular Maintenance, Quality of Service (QoS) Monitoring etc [18].

2. In mobile networks, the term "total attempted calls" refers to the total number of user-initiated call setup attempts made during a given period of time. This measure offers important information about the capability, effectiveness, and efficiency of the network in managing voice communication services [10]. Call setup is a multi-step process that begins with the caller placing the first call. In addition to allocating resources and processing the call request, the network also creates a communication channel between the calling and receiving parties. If it is successful, the call is connected; if not, there could be a call failure for a number of reasons [11,19]. Total Attempted Calls is influenced by a number of factors, including roaming, handovers, equipment problems, signal strength, and network congestion [1].

In general there are various factors that can influence Dropped Call Rate in a mobile telecommunication network and they include Coverage Issues, Handover Failures, Interference and Signal Quality, Capacity Constraints, Equipment and Network Failures, Call Setup Failures etc [20].

1.1. Previous related studies

Nigeria's mobile phone industry has seen significant growth over the years in terms of improved coverage and accessibility. More fascinating is the exponential increase in the numbers of internet users in Nigeria, in 2015 there were about 42.84 million internet users but in 2020 the number has grown to 96.84 million which is above 100% growth [14,15]. Despite the obvious expansion, Quality of Service (QoS) is still a problem. According to [21] increased Handover Failure Rate (HOFR) and inadequate network availability both within the communities and even when relocating were the main causes of the poor QoS. [1] stated that the Call Setup Success Rate, Call Setup Failure Rate (CSFR), Dropped Call Rate and Handover Failure Rate were the most important Key Performance Indicators (KPIs) used in ascertaining the efficiency of LTE network in terms of the quality of services rendered. Two of the most significant KPIs used by all mobile operators is the Drop Call Rate and Call Setup Success Rate; however, since there is no standard way to measure these parameter, different operators may use different approaches [18]. According to [12] most network issues arise from growing subscriber numbers and changing environmental conditions because of subscriber mobility and the intricacy of radio wave propagation. With the evolution of the network, RF optimization is an ongoing process that is necessary. Using the resources that are currently available, RF optimization is done to increase network performance. The authors of [20] described the calculation of DCR as the result of the division of Call Attempt data (number of calls entered during the observation period) divided by Call Drop during the observation and multiplied by 100 so that the data collected in the form of percentage refers to the Key Performance Indicator. The authors of [21] described Dropped Call as the inability of a mobile user's call to connect through the network successfully. In 2011, [19] described the calculation of CSSR as ratio of the assigned Evolved Packet System (EPS) bearers to the random access preamble requests related to data calls with excluded ghosts, signaling radio bearer drops during call set up caused by Evolved Packet Core (EPC) network problems. The data means that the LTE is only packet switched based network, i.e. there are not any circuit switched services as it is typical for example for GSM. The proposed modeling can help mobile operators to measure the data CSSR properly. The authors of [20] described the successful call set up to consist of two procedures. The first procedure is Random Access (RA) and connection establishment procedure which is used to create a signalling connection between the UE and the EUTRAN while the second procedure is initial context set up procedure to establish a radio resource connection and a connection to the core. In similar manner [21] in their studies showed that depending on the number of nearest neighbors (k value) used, the percentage of successful CSSR optimization with real data varies, when the value of k fluctuates, there is no tendency for it to go down or up.

2. Materials and method

This research designed to detect the dependencies of Call Setup Success Rate on Dropped Call Rate was observed for the four telecommunication operators in Bayelsa State, Nigeria and conducts comparative assessments to determine which network has the best Call Setup Success Rate and Dropped Call Rate. Cellular networks analyzed include MTN, Airtel, Globacom, and 9mobile. Materials used are

- Manager M2000 File Transfer Protocol (FTP): This distributed network file system standardizes file access and management through the use of an OSI application Layer 7 protocol. It defines and unifies, into a single protocol, standards for both file transfer and remote file access. It served as a tool for network data collection.
- Microsoft (MS) Excel tool box: This was employed to plot the data values to make the investigation's findings easier to comprehend and interpret.

The present study employs a methodology that entails a systematic approach to gather data from the Management Centers of the four operational mobile networks. The steps are as follows:

1. Data Analysis: Data set analysis was done to look into the QoS performance for every place under study. The Manager M2000 File Transfer Protocol was deployed at the Network Management Switching (NMS) to pull data from the network.

2.1. Determination of Average CSSR and DCR:

The average variable used in this study was previously assessed using the unprocessed data set that was acquired from the NMS. Using the MS-Excel toolbox, the monthly total average of CSSR and DCR was determined on a daily basis for a month.

2.2. Evaluation of Data Values

The QoS results from this paper's study were evaluated through performance analysis, with Call Setup Success Rate (CSSR) and Dropped Call Rate (DCR) serving as the index. For every one of the four network operators under examination, the performance index values were plotted against one another from the months of January, 2015 through December, 2021.

3. Result analysis

Effects of CSSR on DCR were studied. Statistical analysis (correlation and regression) were made and graphs plotted. The correlation between CSSR and DCR was done to establish a relationship between both parameters while the regression analysis was used in obtaining a prediction model between the parameters. In each graph plotted, the CSSR were the independent variables while the DCR were the dependent variables as described in Figures 1 to 4. The CSSR and DCR data used in this research spans from January 2015 to December 2021 (84 months) as shown in Tables 1 to 7.

Table 1 2015 CSSR and DCR

MONTH	CSSR				DCR			
	Airtel	9mobile	Globacom	MTN	Airtel	9mobile	Globacom	MTN
Jan'15	99.34	99.07	96.71	99.07	0.64	0	0.97	0.3
Feb'15	99.2	98.98	94.51	99.01	0.78	0.79	0.98	0.33
Mar'15	99.22	98.65	96.69	98.99	0.67	0.68	1.12	0.36
Apr'15	99.18	99.6	97.92	98.99	0.39	0.88	0.73	0.37
May'15	99.26	99.39	94.92	99.01	0.37	0.98	0.74	0.39
Jun'15	99.3	99.35	98.82	98.92	0.38	1.07	0.43	0.4
Jul'15	99.38	99.27	95.95	99	0.33	1.08	0.11	0.42
Aug'15	99.14	99.45	97.73	99	0.35	0.96	0.13	0.39
Sep'15	98.94	99.45	98.34	98.99	0.39	1.16	0.12	0.39
Oct'15	99.29	99.75	97.78	99.01	0.46	0.96	0.12	0.39
Nov'15	99.29	99.59	97.39	98.97	0.43	0.9	5.18	0.38
Dec'15	99.11	99.74	94.07	98.9	0.45	1.2	8.74	0.35

Table 2 2016 CSSR and DCR

MONTH	CSSR				DCR			
	Airtel	9mobile	Globacom	MTN	Airtel	9mobile	Globacom	MTN
Jan'16	98.95	99.83	94.49	98.93	0.42	0.98	16.99	0.43
Feb'16	98.59	99.78	98.05	98.82	0.32	0.72	10.27	0.46
Mar'16	99.34	99.92	95.09	98.87	0.3	0.85	18.52	0.21
Apr'16	99.38	99.89	97.61	98.74	0.29	0.64	5.87	0.24
May'16	99.36	99.92	98.01	99.32	0.33	0.77	5.51	0.19
Jun'16	99.38	99.87	92.81	99.6	0.33	0.69	5.63	0.18
Jul'16	99.35	99.2	97.01	99.57	0.34	0.68	2.59	0.19
Aug'16	98.75	99.28	97.57	99.54	0.5	0.76	1.05	0.22

Sep'16	99.47	99.53	98.85	99.58	0.33	0.68	0.95	0.18
Oct'16	99.44	99.45	98.75	99.58	0.29	0.74	0.97	0.2
Nov'16	99.38	99.42	98.89	99.64	0.3	0.69	0.87	0.24
Dec'16	99.48	99.21	98.82	99.63	0.29	0.74	1.05	0.15

Table 3 2017 CSSR and DCR

MONTH	**CSSR**				**DCR**			
	Airtel	9mobile	Globacom	MTN	Airtel	9mobile	Globacom	MTN
Jan'17	99.47	99.21	98.73	99.65	0.3	0.56	1.06	0.12
Feb'17	99.45	99.55	98.74	99.6	0.42	0.58	0.85	0.13
Mar'17	99.4	99.19	98.78	99.6	0.3	0.64	0.95	0.13
Apr'17	99.37	98.78	98.63	99.6	0.37	0.71	0.94	0.15
May'17	99.33	99.43	98.57	99.51	0.36	0.78	1.05	0.16
Jun'17	99.39	98.19	98.77	99.6	0.35	1.12	0.95	0.17
Jul'17	99.04	98.26	98.86	99.29	0.33	1.31	0.88	0.29
Aug'17	99.42	99.37	98.84	99.54	0.36	0.92	0.88	0.28
Sep'17	99.42	98.83	98.84	99.7	0.3	0.82	0.81	0.19
Oct'17	99.02	98.67	98.74	99.68	0.38	0.76	0.88	0.17
Nov'17	99.44	98.92	98.8	99.61	0.43	1.2	1.05	0.2
Dec'17	99.28	98.2	98.7	99.64	0.46	2.2	1.14	0.16

Table 4 2018 CSSR and DCR

MONTH	**CSSR**				**DCR**			
	Airtel	9mobile	Globacom	MTN	Airtel	9mobile	Globacom	MTN
Jan'18	99.31	99.34	98.55	99.63	0.39	0.67	1.41	0.17
Feb'18	99.55	98.96	98.67	99.7	0.31	1.31	1.44	0.14
Mar'18	99.09	99.02	98.65	99.32	0.31	0.89	0.21	0.12
Apr'18	98.85	98.89	98.71	99.48	0.39	1.86	0.8	0.13
May'18	99.54	98.67	98.79	99.64	0.32	1.43	0.84	0.12
Jun'18	99.52	98.05	98.72	99.54	0.21	3.02	1.03	0.19
Jul'18	99.47	98.06	98.85	99.66	0.37	2.27	0.77	0.15
Aug'18	99.47	99.51	98.6	99.77	0.27	0.5	1	0.04
Sep'18	99.47	99.71	97.19	99.66	0.31	0	0.65	0.14
Oct'18	99.31	99.21	98.46	99.62	0.34	1.03	1.25	0.14
Nov'18	99.38	99.05	98.42	99.7	0.32	0.94	1.14	0.13
Dec'18	99.41	99.43	98.26	99.62	0.33	0.76	1.63	0.12

Table 5 2019 CSSR and DCR

MONTH	CSSR				DCR			
	Airtel	9mobile	Globacom	MTN	Airtel	9mobile	Globacom	MTN
Jan'19	98.77	98.97	98.53	99.68	0.31	1.37	1.27	0.12
Feb'19	98.64	98.06	98.13	99.68	0.35	1	1.1	0.1
Mar'19	98.8	99.11	98.58	99.68	0.33	1.58	0.91	0.09
Apr'19	98.75	98.95	98.71	99.71	0.31	1.05	0.99	0.1
May'19	98.85	99.09	98.65	99.72	0.34	1.02	0.96	0.12
Jun'19	99.24	99.39	99.07	99.77	0.35	0.52	0.91	0.09
Jul'19	99.25	98.66	98.97	99.74	0.36	1.97	0.93	0.09
Aug'19	99.51	99.19	99.03	99.71	0.34	0.81	0.86	0.08
Sep'19	99.53	99.24	98.93	99.71	0.24	0.64	0.87	0.09
Oct'19	99.52	99.18	99	99.73	0.29	0.76	0.89	0.09
Nov'19	99.25	98.87	98.91	99.72	0.28	1.04	0.97	0.11
Dec'19	99.62	99.23	98.81	99.74	0.25	0.87	0.85	0.09

Table 6 2020 CSSR and DCR

MONTH	CSSR				DCR			
	Airtel	9mobile	Globacom	MTN	Airtel	9mobile	Globacom	MTN
Jan'20	99.5	98.72	98.89	99.75	0.43	0.42	0.47	0.41
Feb'20	99.24	99	98.9	99.68	0.6	0.62	0.41	0.39
Mar'20	99.68	99.62	99.07	99.65	0.5	0.48	0.37	0.42
Apr'20	99.47	99	98.96	99.67	0.48	0.44	0.39	0.44
May'20	99.5	98.84	98.99	99.72	0.53	0.49	0.39	0.46
Jun'20	99.49	99.79	99.01	99.7	0.27	0.62	0.31	0.11
Jul'20	99.47	98.95	99.06	99.72	0.31	1.01	0.29	0.11
Aug'20	99.53	98.7	99.1	99.71	0.25	0.78	0.27	0.1
Sep'20	99.58	99.65	99.12	99.7	0.25	1.01	0.26	0.1
Oct'20	98.84	99.66	99.08	99.67	0.32	0.81	0.27	0.11
Nov'20	99.31	99.27	99.07	99.65	0.25	1.04	0.27	0.11
Dec'20	99.54	98.35	99.04	99.69	0.27	1.13	0.29	0.1

Table 7 2021 CSSR and DCR

MONTH	CSSR				DCR			
	Airtel	9mobile	Globacom	MTN	Airtel	9mobile	Globacom	MTN
Jan'21	99.56	98.89	99.16	99.69	0.21	0.89	0.25	0.09
Feb'21	99.5	99.11	98.98	99.72	0.21	0.66	0.43	0.09
Mar'21	99.58	98.43	99.24	99.73	0.21	0.7	0.23	0.08
Apr'21	99.57	98.58	99.14	99.67	0.11	1.17	0.27	0.11
May'21	99.57	98.58	99.14	99.67	0.11	1.17	0.27	0.11
Jun'21	99.5	99.38	99.16	99.7	0.22	0.95	0.29	0.09
Jul'21	99.59	98.36	99.23	99.7	0.15	1.54	0.25	0.09
Aug'21	99.66	98.47	99.19	99.69	0.15	0.64	0.27	0.08
Sep'21	99.38	96.16	99.14	99.69	0.25	1.53	0.23	0.08
Oct'21	99.62	98.21	99.03	99.69	0.27	0.98	0.2	0.09
Nov'21	99.67	98.27	98.87	99.65	0.16	1.04	0.25	0.08
Dec'21	99.63	98.31	99.04	99.6	0.1	0.92	0.27	0.09

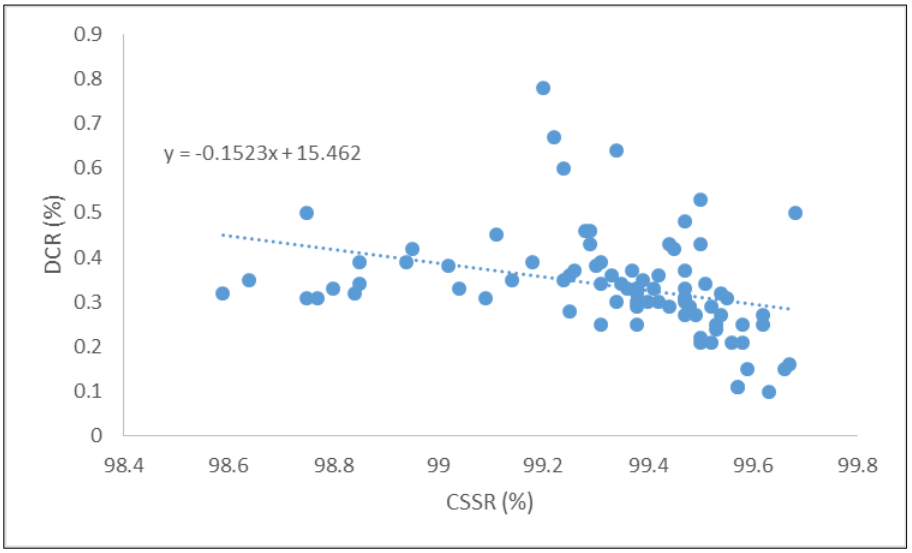

Figure 1 Graph of DCR against CSSR for Airtel network.

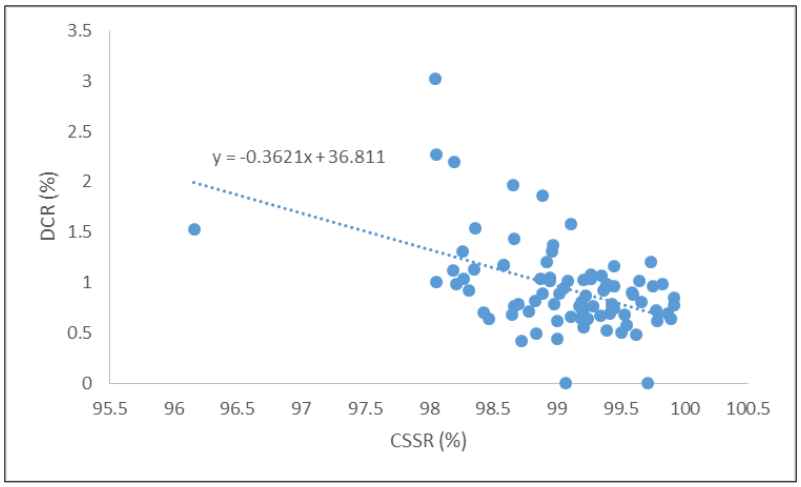

Figure 2 Graph of DCR against CSSR for 9mobile network.

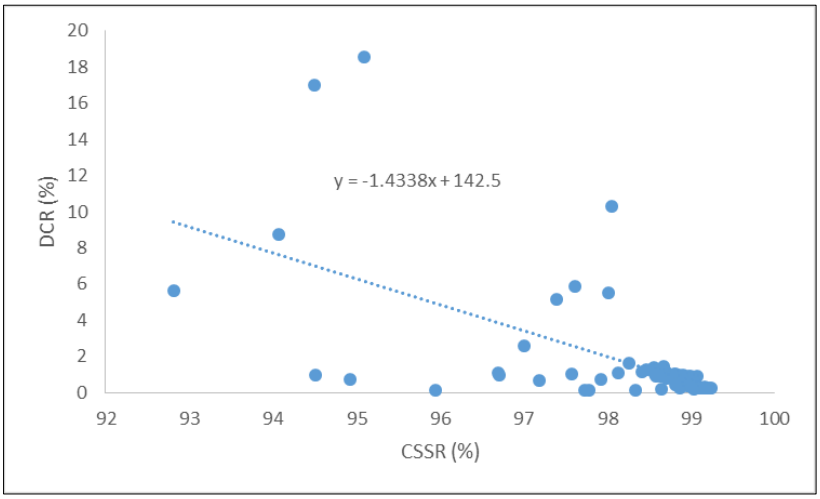

Figure 3 Graph of DCR against CSSR for Globacom network**.**

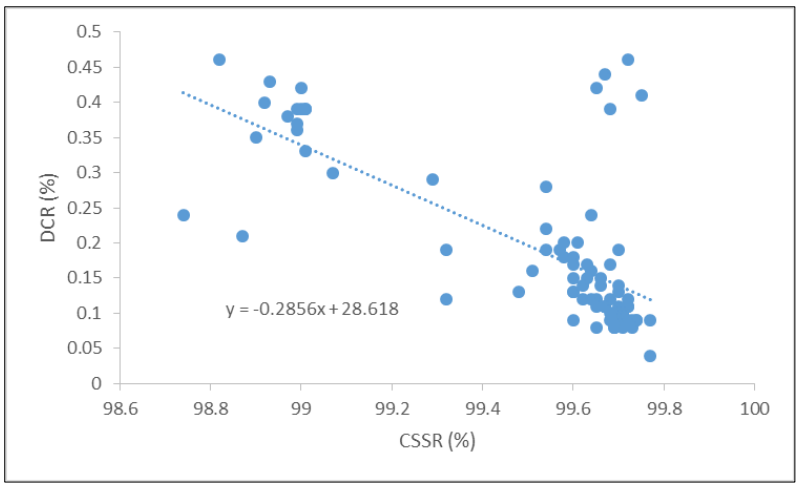

Figure 4 Graph of DCR against CSSR for MTN network.

4. Conclusion

This study deals with Comparing CSSR and DCR against industry benchmarks and competitor networks for the purpose of identifying areas for improvement and sets performance targets, It also determines the relationship between DCR and CSSR Four mobile networks operational in Yenagoa the capital city of Bayelsa State Nigeria. From the data obtained, the four networks performed well above the benchmark set by the regulating body Nigeria Communication Commission, however there is room for improvement as some of the networks had instances where their performance fell below the benchmark. Data from MTN was superior among the four networks and had the least variation within the period of investigation (2015 – 2021). Airtel's data was well above the benchmark all through the period under review and its variation was relatively small. The data from Globacome and 9mobile had wide ranges of variations and had instances where it fell below the benchmark, which call for improvement in order to maintain good Quality of service and customer satisfaction. Correlation coefficients obtained between DCR and CSSR were -0.34, -0.47, -0.60, -0.69 for Airtel, 9mobile, Globacome and MTN respectively. The maximum value of CSSR recorded in the 7 years period under review is 99.77% and it was in MTN while the least value recorded is 94.07% and it was in Globacom; on the other hand the maximum value of DCR recorded in the 7 years period under review is 18.52% and it was in March 2016 for Globacom while the least value recorded is 0.00% and it was in September 2018 for 9mobile. In the years 2017 and 2020 all the networks had values exceeding the NCC's benchmark all through. This affirms that it is possible for the networks to perform optimally if adequate measures are put in place for improved QoS.

Recommendation

To ensure optimal Call Setup Success Rate (CSSR) and Dropped Call Rate (DCR) in mobile telecommunication networks, it's essential to implement the following recommendations addressing different aspects of network performance:

- Radio Resource Management (RRM) Optimization: Fine-tune RRM algorithms and parameters to ensure efficient allocation and management of radio resources, minimizing interference and enhancing call setup reliability. Implement dynamic resource allocation strategies to adapt to changing network conditions and traffic patterns.
- Network Capacity Planning: Regularly assess and adjust network capacity to accommodate increasing subscriber numbers and usage patterns, particularly during peak hours. Utilize predictive modeling and traffic analysis to anticipate future demands and scale network resources accordingly.
- Dynamic Spectrum Management: Utilize dynamic spectrum management techniques to efficiently allocate and adapt frequency bands based on real-time network conditions. Implement interference mitigation strategies to reduce the impact of co-channel and adjacent channel interference on CSSR and DCR.
- Cell Planning and Optimization: Conduct regular drive tests and site surveys to identify coverage gaps and optimize cell configurations. Adjust antenna tilt, power levels, and sectorization to enhance coverage and reduce interference, improving CSSR and DCR.
- Handover Optimization: Optimize handover algorithms and parameters to facilitate seamless transitions between cell sites. Minimize handover failure rates by improving algorithms for better decision-making during handover scenarios.
- Quality of Service (QoS) Monitoring: Implement robust QoS monitoring systems to track CSSR alongside other relevant metrics, providing a comprehensive view of network performance. Set and regularly review QoS targets to maintain a high level of service quality.
- Load Balancing Strategies: Implement intelligent load balancing mechanisms to distribute traffic evenly across different cells and sectors. Utilize predictive analytics to identify potential congestion points and proactively balance network load.
- User Equipment and Protocol Optimization: Ensure compatibility with a wide range of user devices and optimize protocols to enhance the efficiency of call setup procedures. Regularly update network elements and user equipment to support the latest technologies and standards.
- Fault Detection and Rapid Response: Implement advanced fault detection mechanisms to identify and address network issues promptly. Develop automated response systems to mitigate the impact of faults on CSSR and DCR.
- Capacity Headroom Provisioning: Provision additional capacity beyond current demands to provide headroom for sudden spikes in traffic. Employ predictive analytics to anticipate capacity needs and proactively scale resources.
- Employee Training and Skill Development: Ensure that network operators and maintenance personnel are well-trained to troubleshoot and address issues promptly. Provide ongoing training to keep staff updated on the latest technologies and best practices.

By implementing these recommendations, mobile telecommunication operators can enhance their network's resilience, efficiency, and overall CSSR and DCR, leading to improved user satisfaction and a positive impact on the quality of service.

Compliance with ethical standards

Disclosure of conflict of interest

This work is free from any conflicts of interest.

References

[1] Emeruwa, C. (2024). "Statistical analysis of call setup success rate for 4 g networks in yenagoa-southern Nigeria". GSC Advanced Research and Reviews, 18(02), pp: 338–346. Article DOI: https://doi.org/10.30574/gscarr.2024.18.2.0053

[2] Galadanci G. S. M and Abdullahi S. B., (2018) "Performance Analysis of GSM Networks in Kano Metropolis of Nigeria", American Journal of Engineering Research (AJER) e-ISSN: 2320- 0847 pp. 69-79, www.ajer.org.

[3] Emeruwa, C. (2023). "Investigation of Received Signal Quality of 3G GSM Networks in Yenagoa – Southern Nigeria". Journal of Science and Technology Research 5(4) pp. 51-62, ISSN-2682-5821.

[4] Tekanyi, A.M.S.; Abdulkareem, H. A. and Muhammad, Z.Z. Analysis of GSM Network Quality of Service Using Call Setup Failure Rate and Handover Failure Rate Indices. 2nd International Conference of the IEEE Nigeria Computer Chapter: IEEEcomputconf'19: Ahmadu Bello University, Zaria, Nigeria, October 14 – 17, 2019 Proceedings.

[5] Jatin, Karishan Kumar (2016) ''Study and Analysis of Call dropping and Handover Problem in cellular system'' International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), ISSN: 2278 – 1323 Volume 5, Issue 6, pp1776-1

[6] Emeruwa, C and Omehe, N. N. (2024). "Analysis of Dropped Call Rate for Long Term Evolution Networks in Bayelsa State, Nigeria". World Academy of Science, Engineering and Technology International Journal of Electronics and Communication Engineering, Vol:18, No:4, pp: 63-68.

[7] Emeruwa, C. and Oduobuk, E.J. (2023). "Analytical Comparison of Path Loss Models for Radio Wave Propagation over Yenagoa–Southern Nigeria". Asian Journal of Physical and Chemical Sciences. Volume 11, Issue 2, Page 41-48, Article no.AJOPACS.100398, ISSN: 2456-7779

[8] Kollár, M. (2008). "Evaluation Of Real Call Setup Success Rate In GSM", Acta Electrotechnica etc Informatica Vol.8, No. 3, pp. 54–56. ISSN 1335-8243 © 2008 FEI TUKE

[9] Shoewu, O. and Edeko, F. O (2011) "Outgoing Call Quality Evaluation of GSM Network services in Epe, Lagos State". American Interbational Journal Of Scientific And Industrial Research" ISSN 2153- 649XZ (Am j. sci Ind. Res.) pp409- 417

[10] Emeruwa, C. and Ekah, U. J. (2022). "Improved Algorithm of Equation Error Model of Active Noise Control". Journal of Multidisciplinary Engineering Science and Technology (JMEST), Vol. 9 Issue 1, pp: 15067- 15072. ISSN: 2458-9403

[11] Ukhurebor K. E., Awodu O. M., Abiodun I. C. and Azi S. O. (2015). "A Comparative Study of the Quality of Service of GSM Network during Crowd Upsurge in University of Benin Nigeria", International Journal of Scientific & Engineering Research, Vol. 6, No. 10, ISSN 2229-5518.

[12] Iwuji, P.C. and Emeruwa, C. (2018). "Investigation of Signal Strength-Level Generated by Orient 94.4 FM Transmitter in Imo State, Nigeria". International Journal of Science and Research, Vol.7 Issue 5.DOI: 10.21275/ART20182892. Pp 1089-1094.

[13] Ekah, U.J. and Emeruwa, C. (2022). "Penetration Depth Analysis of UMTS Networks Using Received Signal Code Power". Journal of Engineering Research and Reports. 23(7): 16-25, Article no.JERR.91579, ISSN: 2582-2926

[14] Emeruwa, C. (2023). "Analysis of some weather variables' impacts on UHF and VHF receivers in Yenagoa Southern, Nigeria". World Journal of Advanced Research and Reviews, 19(02), 675–681. DOI: https://doi.org/10.30574/wjarr.2023.19.2.1552.

[15] Uquetan, U., I. Egor, A. O., Osang, J. E., Emeruwa, C. (2015). "Empirical Study Of Wind Energy Potential In Calabar, Cross River State, Nigeria". International Journal of Scientific & Technology Research Volume 4, Issue 10, Pp 113-121, ISSN 2277-8616

[16] Emeruwa, C. (2015). "Comparative Analysis of Signal Strengths of Some Cellular Networks in Umuahia Eastern Nigeria". Quest Journals, Journal of Electronics and Communication Engineering Research, Volume 2, Issue 10 (2015) pp: 01-05. ISSN(Online): 2321-5941

[17] Sheik M. A. K. and Shahabudeen F., (July-Dec., 2014). "A Study on Key Performance Indicators and their Influence on Customer Satisfaction in Call Centers", International Journal for Engineering Research (IJER). Serials Publications 11(2), ISSN: 0972-9380, pp. 1-6

[18] Osang, J. E., Egor, A. O., Uquetan, U. I., Eze, B. E., Emeruwa, C. and Pekene. D. B. J. (2016). "Investigation of the Relative Humidity Profile Variations in Calabar, Nigeria". International Journal of Scientific & Engineering Research, Volume 7, Issue 1, pp: 1134-1144, ISSN 2229-5518

[19] Idigo V. E., Azubogu A. C. O., Ohaneme C. O., and Akpado K. A. (2012). "Real-Time Assessments of Quality of service of Mobile Cellular Networks in Nigeria", International Journal of Engineering Inventions. Vol.1, No. 6, pp 64-68.

[20] Lawal B. Y., Ukhurebor K. E., Adekoya M. A. and Aigbe E. E. (2016) "Quality of Service and Performance Analysis of a GSM Network in Eagle Square, Abuja and Its Environs, Nigeria''. International Journal of Scientific & Engineering Research, ISSN 2229-5518 Volume 7, Issue 8, pp1992-2003

[21] Adedokun, I. O., Ogar-Abang, M. O., Egor, A. O., Osang, J. E., Akpe, R. I., Oba, J. O. and Emeruwa, C. (2021) "Empirical study of Cellular Network and Signal Strength in Calabar, Cross River State, Nigeria". International Journal of Advances in Engineering and Management (IJAEM), Volume 3, Issue 4, Pp: 157-186. www.ijaem.net ISSN: 2395-5252