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Impact of 5G Technology on Mobile Network Performance and User Experience in Nigeria

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Abstract

The transition from 4G to 5G networks necessitates a rigorous evaluation of 5G's impact on mobile network performance and user experience. This study investigates the claims of enhanced connectivity and higher speeds by conducting speed tests and surveys on MTN and Airtel 5G networks in Yenagoa, Bayelsa State, Nigeria. Utilizing a mixed-method approach, data on upload/download speeds, latency, and network strength were collected over 37 hours from April 29 to May 1, 2024, complemented by questionnaires from 88 respondents. Results indicate significant variability, with MTN peaking at 41.8 Mbps (upload), 72 Mbps (download), and 491 ms (latency), while Airtel reached 37.4 Mbps (upload), 30 Mbps (download), and 220 ms (latency). Pearson correlation analysis revealed weak relationships among performance metrics, suggesting independent optimization potential. Despite some improvements, 5G performance fell short of expectations, highlighting infrastructure and stability challenges. Recommendations include network upgrades and better traffic management to enhance user satisfaction and meet 5G's transformative potential.

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Introduction

The evolution of telecommunication from analogue systems, such as the telegraph, to advanced digital networks like 5G has revolutionised global connectivity. Initiated with 1G and progressing through 2G, 3G, and 4G LTE, each generation has enhanced data speeds, capacity, and multimedia capabilities. 5G, the fifth generation, promises unprecedented speed, reliability, and connectivity, potentially transforming sectors like healthcare, manufacturing, and education. The Nigerian Communications Commission (NCC) in exercise of its functions under the Nigerian Communications Act 2003 (the Act) developed the Draft Deployment Plan for 5G Technology in Nigeria. The National Policy on 5G Networks for Nigeria's Digital Economy was approved by the Federal Executive Council on the 8th of September, 2021. The National Policy includes a deployment plan to ensure that major cities across the country benefit from 5G technologies. It also seeks to make SG a major driver of our economy, a catalyst for smart cities in the country and a platform for the creation of jobs that support our digital economy.

The Policy is designed to achieve the following, amongst others:

i. to ensure effective deployment of 5G to cover major urban areas by 2025;
ii. to ensure the security of the 5G ecosystem and the protection of data;
iii. to ensure that international best practices and globally accepted standards and specifications are entrenched in Nigeria's 5G ecosystem; and
iv. to ensure that the required infrastructure needed for the successful deployment of 5G networks, such as data centres, power, etc, are catered for in the deployment strategies of 5G networks.

In Nigeria, mobile network operators (MNOs) such as MTN and Airtel are deploying 5G to address increasing data demands, yet their real-world performance remains underexplored. This study focuses on assessing 5G's impact on network performance metrics—upload/download speeds, latency, and coverage—and user experience in Yenagoa, leveraging quantitative speed tests and qualitative surveys. The research addresses the gap in localised 5G performance data, given Nigeria's recent network rollout and unique challenges like inconsistent power supply. The significance lies in providing stakeholders with empirical insights to optimise 5G deployment, enhancing competitiveness and validating technological advancements amidst global digital transformation.

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MTN has made tremendous progress in deploying its 5G network throughout Africa, with important launches in Uganda and Nigeria. According to PC Tech magazine in 2023, MTN became Uganda's first operator to offer 5G services, beginning with coverage in Kampala districts such as Lugogo and Bugoloobi. The launch is part of MTN Uganda's Ambition 2025 plan, which aims to improve digital connection to promote economic growth and innovation. The 5G network offers speeds up to 100 times faster than 4G and much lower latency, enabling sophisticated applications such as virtual reality, artificial intelligence, and IoT. This was also confirmed by Sbeglia (2023).

Similarly, MTN Nigeria has begun deploying its 5G network in states, including Lagos, Abuja, and Port Harcourt. This action is expected to help Nigeria's digital economy by increasing internet speed and connectivity for businesses and consumers. The network is being built in phases, with full countrywide coverage expected by 2025. This initiative corresponds with Nigeria's National Digital Economy Policy and is projected to make a substantial contribution to the global economy.

MTN's 5G plans are part of a larger push to use next-generation technologies to accelerate digital transformation and improve service delivery throughout Africa. These improvements are expected to open new opportunities in a variety of industries, including healthcare, education, and entertainment, by enabling more efficient and inventive digital solutions.

Airtel launched its 5G service in India in 2023 with the aim of providing faster and more reliable internet connectivity, which will enhance user experiences across various sectors, including healthcare, education, and entertainment. By introducing 5G, Airtel is poised to attract new customers and enhance its market share, fostering healthy competition in the Nigerian telecoms market. The launch of Airtel's 5G network aligns with Nigeria's digital transformation goals and aims to accelerate broadband adoption, furthering the National Broadband Plan (NNBP 2020–2025). The authorities anticipate achieving a broadband penetration rate of 90% by 2025, surpassing the initial target of 50% by the end of 2023 (Telecom Review Africa, 2023). The conceptual design of this research work is aimed at understanding the performance of 5G in Nigeria using the MTN 5G and Airtel networks

Fifth Generation (5G) technology, introduced globally in 2019, marks a significant advancement over predecessors, offering speeds up to 10 Gbps and latency as low as 1 ms, compared to 4G's 300 Mbps and 200 ms. Historical developments, including NASA's 2008 collaboration with M2Mi and South Korea's 2019 launch, underscore 5G's evolution through international efforts like the 3GPP. Studies by Robinson and Chiorlu (2019) and Ancans et al. (2017) highlight 5G's potential in the 4th industrial revolution, enabling applications such as autonomous vehicles and smart cities. Misra (2019) and Basin *et al.* (2018) identify challenges, including electromagnetic interference with weather forecasting systems and security vulnerabilities due to increased data volumes. In Nigeria, MNOs like MTN and Airtel are adopting 5G, building on a telecommunications history dating back to 1886, yet face hurdles such as power instability and high infrastructure costs (Agubor *et al.,* 2021). The ITU (2023) reports that Africa's 5G coverage remains at 6%, lagging global penetration of 38%, due to economic and regulatory constraints.. Further, Noohani and Magsi (2020) emphasise 5G's role in supporting low-latency applications like remote surgery, while Uvika and Ragini (2018) note its enhanced security via 5G SIM encryption. However, Attar et al. (2022) caution about the immature testing of 5G, potentially broadening attack surfaces with IoT proliferation. In the Nigerian context, Philip-Kpae et al. (2023) argue that 5G could drive economic growth, yet Okoye et al. (2023) highlight disparities in broadband penetration, with rural areas still reliant on 2G/3 G. El-Shorbagy et al. (2021) explore 5G's architectural implications, suggesting its integration into smart factories, while Beltozar-Clemente et al. (2023) project a $2.2 trillion global economic contribution by 2034. Literature gaps persist, particularly in localised performance data for Nigeria and user experience comparisons with 4G, necessitating this study to bridge these knowledge deficits with empirical evidence from Yenagoa.

Methodology

This study employed a mixed-method approach to evaluate 5G technology's impact on mobile network performance and user experience in Yenagoa, Bayelsa State, Nigeria. In this research, data collection was done, the statistical methodology used is the Pearson correlation, and all computations were done using the Microsoft spreadsheet. The data analysis methodology used in this study is a graphical representation and Pearson's correlation. The graphical representation is used to show the trends and draw inferences from the data collected.

The Pearson correlation, also known as the Pearson correlation coefficient or Pearson's (r), is a statistical measure that evaluates the strength and direction of the linear relationship between two continuous variables. Developed by Karl Pearson, it is widely used in

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statistics to assess how changes in one variable are associated with changes in another.
Pearson correlation is defined mathematically as:

$$r = \frac{\sum(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum(x_i-\bar{x})^2 \sum(y_i-\bar{y})^2}}$$

Where:
r = correlation coefficient
x_i = values of the x-variable in a sample
$\bar{x}$ = mean of the values of the x-variable
y_i = values of the y-variable in a sample
$\bar{y}$= mean of the values of the y-variable
r(df) = ##,
where N = Sample size,
Correlation was used to analyse the dataset. According to Smith and Johnson (2023), it determines the degree to which two variables change together or the degree to which two variables are related. The Pearson Correlation Coefficient is the most common technique that measures the relationship at a rating between -1 to +1. A correlation of +1 indicates a perfect positive linear relationship. As one variable increases, the other variable increases proportionally. -1 indicates a perfect negative linear relationship. As one variable increases, the other decreases proportionally. While the "0" suggests a weak or non-linear relationship between the variables. This will be displayed on a table developed by a Microsoft Excel spreadsheet, and the correlation between the speed and latency of the network will be considered.
Data collection spanned 37 hours from April 29 to May 1, 2024, using standardised tools like Ookla Speedtest to measure upload/download speeds (Mbps), latency (ms), and network strength on MTN and Airtel 5G networks. Measurements were taken hourly across diverse locations in Yenagoa to account for temporal and spatial variability. Concurrently, a questionnaire survey engaged 88 respondents to assess user satisfaction, perceived speed, and reliability. Questionnaires were issued to individuals of 18 (both male and female), bearing in mind location (urban-Yenagoa), income level and usage, defined by their technology adoption rate. The theoretical framework considered Enhanced Mobile Broadband (eMBB), Ultra-Reliable Low Latency Communications (URLLC), and Massive Machine Type Communications (mMTC) as key 5G attributes. Data analysis involved descriptive statistics for visualisation via Microsoft Excel graphs and Pearson correlation to quantify relationships between performance metrics. Hypotheses tested included significant improvements in speed and latency with 5G over 4G, validated under controlled environmental conditions using 5G-compatible devices.

Results

Internet upload speed influences how much data may be delivered from your computer or device to the internet. It can be used to share a photo, publish a video to a social media platform, or deliver a corporate presentation from your computer to many devices. The data presented provides upload speeds (in Mbps) at various times over three consecutive days: April 29, 2024, April 30, 2024, and May 1, 2024. Here is an analysis of the data for the MTN 5G network:
The graphical representation of the internet speed during this research period is show in Figure 1 below, which shows that on April 29, 2024, high upload speed was observed at 07:00: 41.80 Mbps, 09:00: 15.40 Mbps, 13:00: 17.60 Mbps, 15:00: 21.90 Mbps. Low Speeds were observed at 11:00: 0.00 Mbps, 22:00: 0.97 Mbps. There are several instances of very low speeds (near 0) throughout the day, indicating significant fluctuations and network downtime. Notable times with low speeds are 11:00, 16:00, 18:00, and 19:00. The day shows variability with speeds ranging from 0 to over 40 Mbps.
On April 30, 2024, high speeds were observed at 19:00: 25.20 Mbps, 20:00: 38.78 Mbps, 21:00: 41.80 Mbps, 22:00: 37.26 Mbps and low speeds at 07:00: 0.00 Mbps, 08:00: 0.00 Mbps, 09:00: 0.14 Mbps, 10:00: 0.00 Mbps, 11:00: 0.00 Mbps. The day starts with almost no upload speed until noon, followed by a gradual increase in speed. After 15:00, there is a significant improvement, peaking at 21:00 with 41.80 Mbps. The period from 19:00 to 22:00 shows consistently high speeds.
High speeds (10:18: 39.50 Mbps, 12:03: 33.00 Mbps, 13:33: 20.90 Mbps, 03:37: 40.30 Mbps) and low speeds (03:13: 0.50 Mbps) were recorded on May 1, 2024. Mostly in the late morning and early afternoon, high speeds are observed. At 03:13, the speed is noticeably low at 0.50 Mbps, and at 03:37, it increases significantly.
From general observations, the upload speeds show significant variability within each day and between different times of the day. This shows low level of consistency and high level of fluctuation and instability of the network's upload speed. This data suggests that while there are periods of high-speed connectivity, there are also critical times when the upload speed is significantly low, potentially affecting productivity of its users.
Meanwhile for the Airtel 5G network, the highest upload speed observed was 37.4Mbps at 9:00pm on day one and 8:00pm on day 3. The lowest upload

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speed was observed notably during non-business hours and early mornings, Upload speeds generally peak during business hours and early evening, with significant drops during late night and early morning hours. This is shown in Figure 2 below.

For day 1, Upload speeds are 1.59 Mbps at 6 a.m. but they quickly rise to 21.4 Mbps by 8 a.m. and reach their maximum of 25.9 Mbps by midday. This points to a regular morning peak, perhaps as a result of more user activity or network optimizations during the working day. Throughout the afternoon, upload speeds are constantly high, ranging from 23.8 Mbps to 25.8 Mbps between 1pm and 4pm. Also notable peaks can be seen at 7 p.m. (37.2 Mbps) and 9 p.m. (37.3 Mbps), which probably indicate that there is a lot of demand or network use in the evening.

Day 2's morning peak is similar to Day 1's, with speeds rising from 14.4 Mbps at 6 a.m. to 28.1 Mbps at 9 a.m. But after 10 a.m., speeds drastically decrease (5.18 Mbps), perhaps as a result of network congestion or other issues. With occasional swings, speeds stay average during the afternoon until noticeably dropping to extremely low levels (0.08 Mbps) by 5 and 9 p.m., suggesting possible network problems or maintenance windows. With occasional swings, speeds stay average during the afternoon until noticeably dropping to extremely low levels (0.08 Mbps) by 5 and 9 p.m., suggesting possible network problems or maintenance windows.

On day three, the speeds begin slowly and stay that way throughout, frequently peaking at 0.08 Mbps in the early morning and late evening. This implies that there may be network problems or extremely low demand at these hours. There are short bursts of increased activity or optimal network performance at 11 a.m. (5.38 Mbps) and 3 p.m. (7.75 Mbps), and 4 p.m. (9.46 Mbps) in the afternoon. After 6 p.m., speeds increase to 11.5 Mbps before peaking at midnight at 19.0 Mbps. This increase in speed may be the result of planned optimisations or less network congestion.

Peak upload speeds consistently occur during morning and early evening hours, correlating with typical business and leisure usage patterns. Early morning and late evening consistently show the lowest speeds across all days, suggesting periods of low demand or maintenance windows. Day-to-day variability is evident, with Day 3 showing consistently lower speeds overall compared to Days 1 and 2, potentially indicating differing network conditions or usage patterns.

Figures 1 and 2 show a graph of upload speed against time for MTN and Airtel, respectively, showing the information gathered as explained above. An upward trend was observed in the upload speed for the MTN network, while a downward trend was observed for the Airtel network.

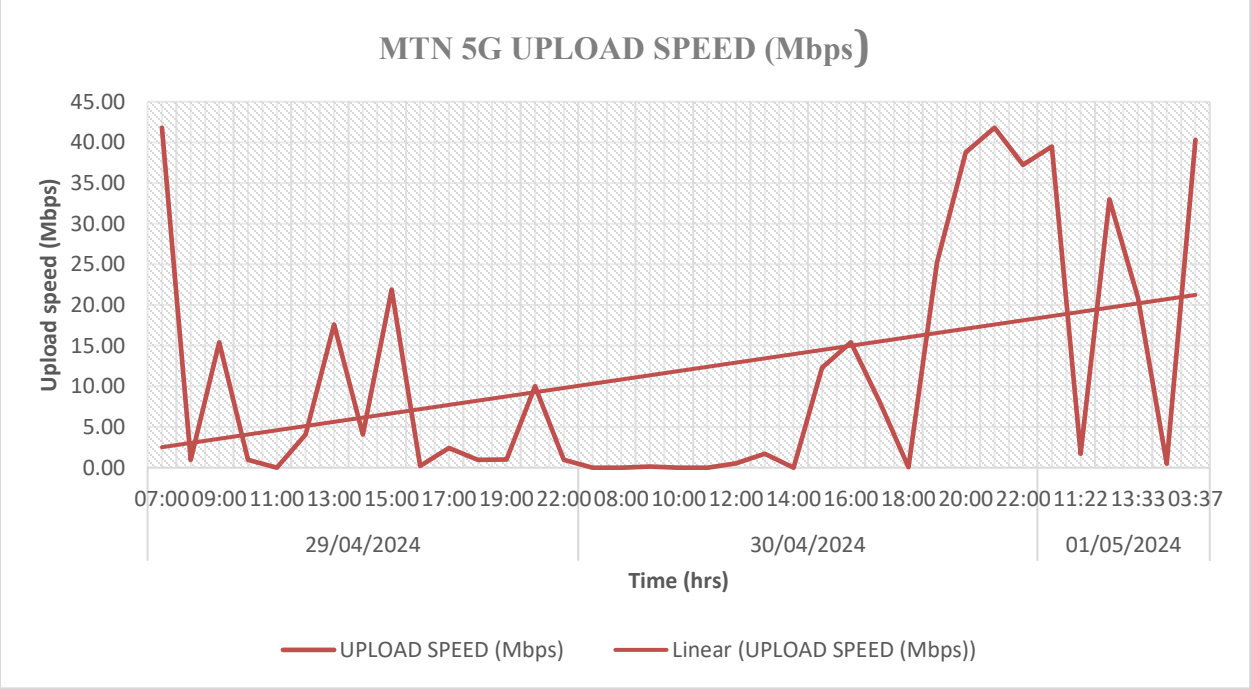

Figure 1: Upload speed for MTN 5G network in Yenagoa

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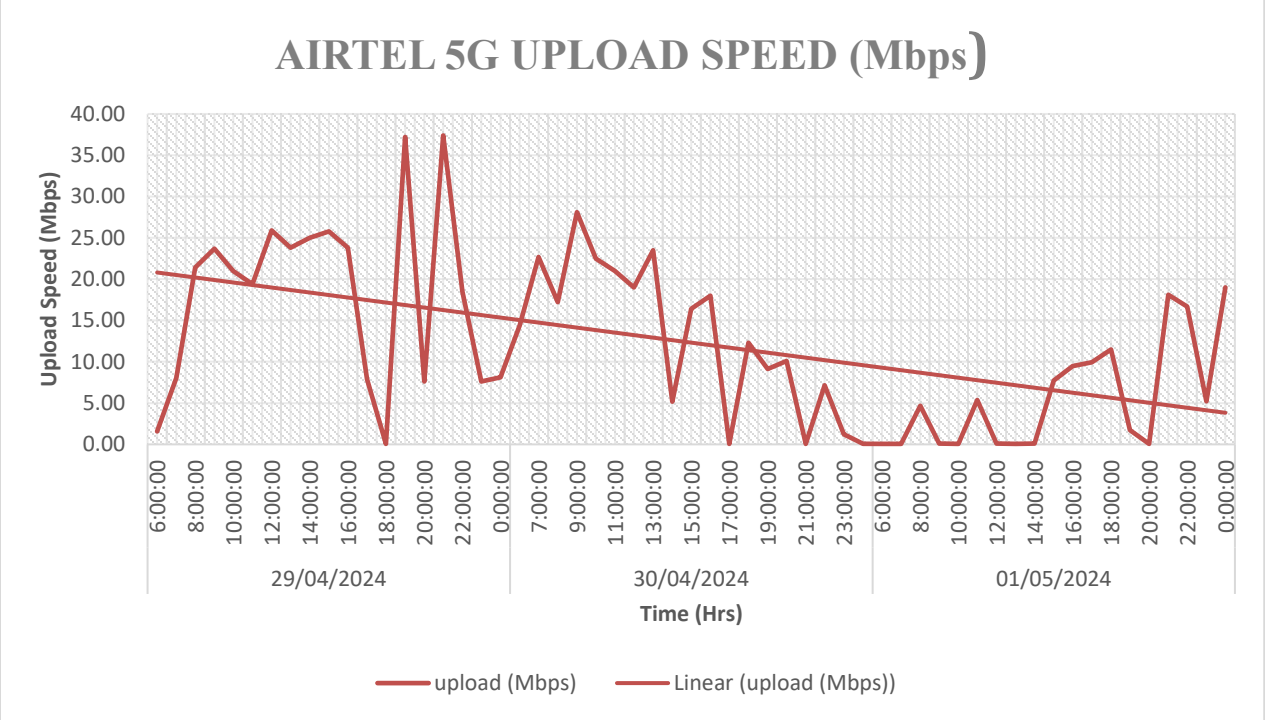

Figure 2: Upload speed for the Airtel 5G network in Yenagoa.

Download Speed Data Analysis

The download speed relates to how rapidly users can get text, photos, audio, video, and other material online. Many online activities involve downloading, such as perusing web pages, streaming video, and gaming. The ISP and data plan both influence download speed. The data reveals significant variability in download speeds, with certain times experiencing extremely high speeds (up to 72 Mbps) and other periods showing very low or zero speeds. This is shown in Figure 3 below. Notably, April 30th morning had prolonged periods of near-zero speed, which could indicate network issues or heavy congestion. May 1st shows an overall improvement in speeds during the recorded hours, suggesting a more stable network performance compared to the previous days. This analysis can help in identifying peak usage times and potential areas for network improvement.

According to the FCC Standard, broadband internet should have a minimum download speed of 25 Mbps for general home use. Also, Netflix, as a video streaming company, recommends that for streaming HD content, Netflix recommends a download speed of at least 5 Mbps is required, and for 4K UHD content, at least 25 Mbps. Gaming and streaming for a household with multiple devices using the internet simultaneously, a speed of at least 100 Mbps is often recommended, and for tasks such as video conferencing, cloud-based applications, and large file downloads, speeds of 50-100 Mbps or higher are advisable. According to OECD data, the average internet download speed in member countries is around 100 Mbps, but this can vary widely between countries, with some having averages exceeding 200 Mbps.

Based on our data gathered, the highest in the 37-hour period, which is 72Mbps, is suitable for general usage, but it is inconsistent and encourages poor user experience.

The trend observed for the Airtel network in these three days is shown in Figure 4 below. It shows that day one experienced multiple high peaks with occasional significant drops, suggesting variable network performance. The top of which is 30.00Mbps, which was experienced at 12:00noon, potentially indicating a period of lower network usage or optimisation. Day two exhibited lower speeds overall, compared to day one, with frequent drops indicating potential network issues. It peaked at 11.20Mbps by 6:00 am, while day three showed consistently low speeds with only a brief recovery in the evening.

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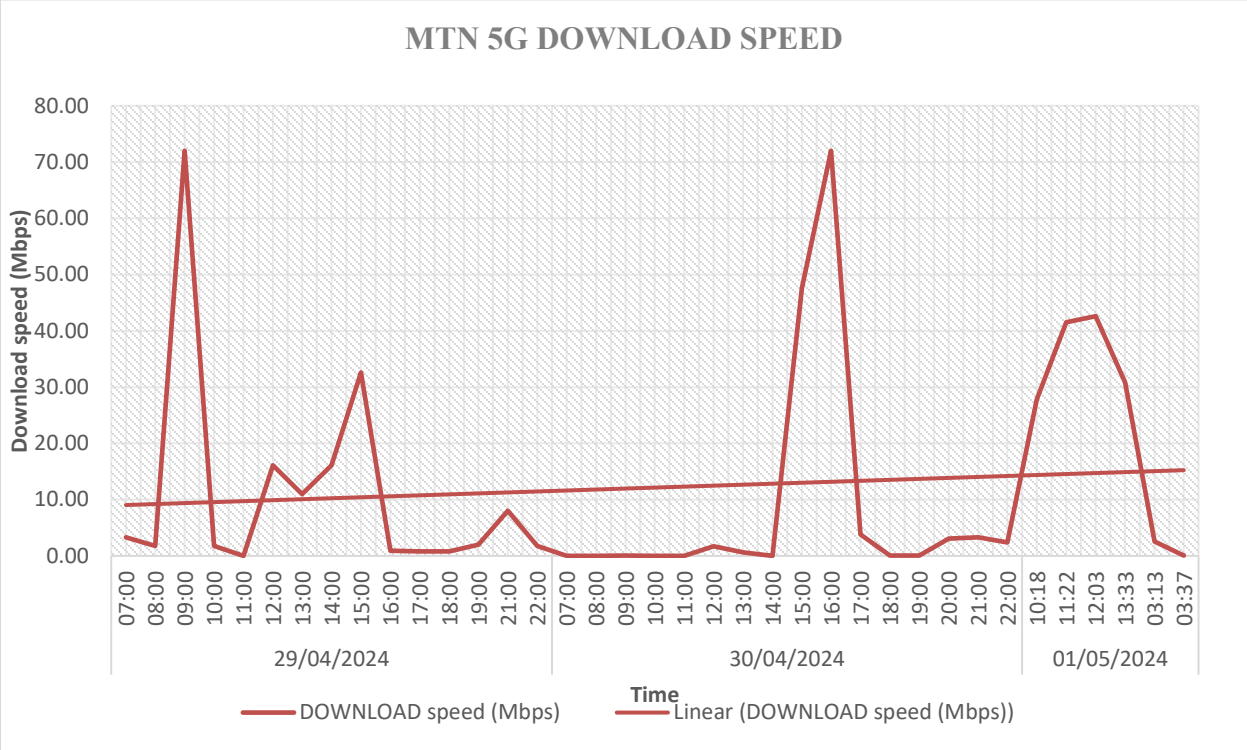

Figure 3: Download speed for MTN 5G network in Yenagoa.

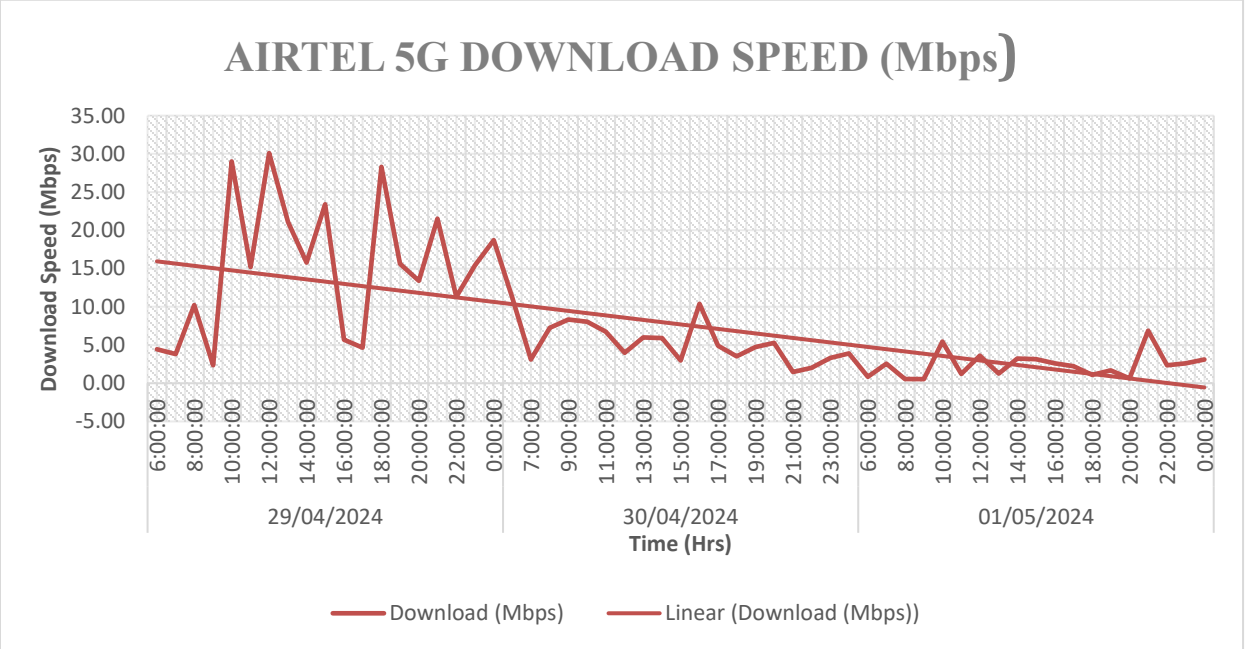

Figure 4: Download speed for the Airtel 5G network in Yenagoa.

Figure 3 and 4 are graphs showing the download speed plotted against time. Like the upload speed, an upward trend was observed on the MTN network and a downward trend for the Airtel network. This shows that there was more improvement in the MTN network than the Airtel network as time progressed.

Latency Data Analysis

This is the time required for a packet of data to move from one point to the next in a network system.

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Network latency is a significant internet connectivity issue that can be caused by several things that will dramatically impact a user's internet experience. Figure 3 below shows the latency of the MTN 5G network used for this study. The provided data shows latency (measured in milliseconds) at different times over the three consecutive days. It is a graph of the latency plotted against time.

Latency was as high as 491ms was recorded on April 29, 2024, and the lowest (0ms) was recorded on April 29 and May 1, 2024. This means that the days with high latency have some negative impact on web browsing, online streaming, and other parts of the user's experience. High latency may have caused delays in voice communication and video conferencing, leading to overlapping conversations and difficulty in maintaining a smooth dialogue. High latency slows down the transfer of data between systems, which can affect file transfers, backups, and data synchronisation tasks, and the applications hosted on the cloud may be less responsive, affecting productivity and user satisfaction. The network aims to keep latency as low as possible. Understanding and addressing high latency is crucial for maintaining the performance and reliability of applications and services, ensuring a positive experience for users, and supporting efficient business operations.

The latency experienced on the Airtel network is shown in Figure 6 below. The average latency experienced is 19.32ms on day one, 23.27ms on day two and 44.38ms in day three. Latency remained relatively stable throughout day one, with minor fluctuations. Day two experienced slightly higher average latency compared to April 29, with noticeable peaks in the late evening. Significant variability with extreme latency spikes at 6:00, 13:00, 19:00, and 20:00 was experienced on day three. The highest recorded during this period is 220ms on May 1 at 1:00 pm. MTN network experiences more latency than the Airtel network.

According to the general networking benchmark value, latency under 50ms means it is excellent for real-time applications, gaming, and interactive services. 50-100ms is generally acceptable for most applications, including web browsing and standard video streaming. 100-200ms may start to impact user experience in interactive applications and real-time communication, and above 200ms is generally considered problematic for most interactive applications, causing noticeable delays and degraded performance, some of which was experienced during this period.

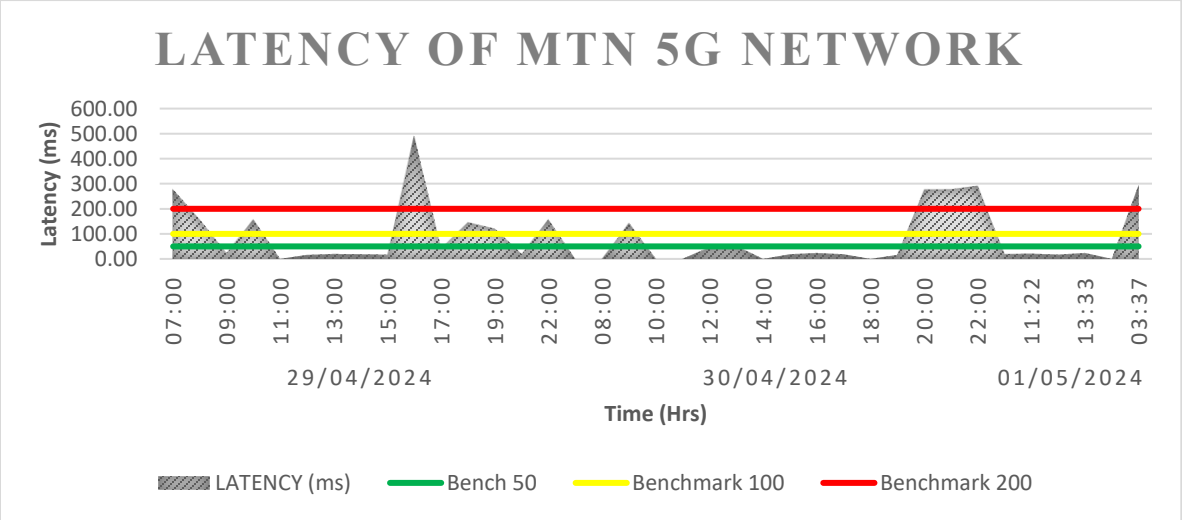

Figure 5: Latency for the MTN 5G network in Yenagoa.

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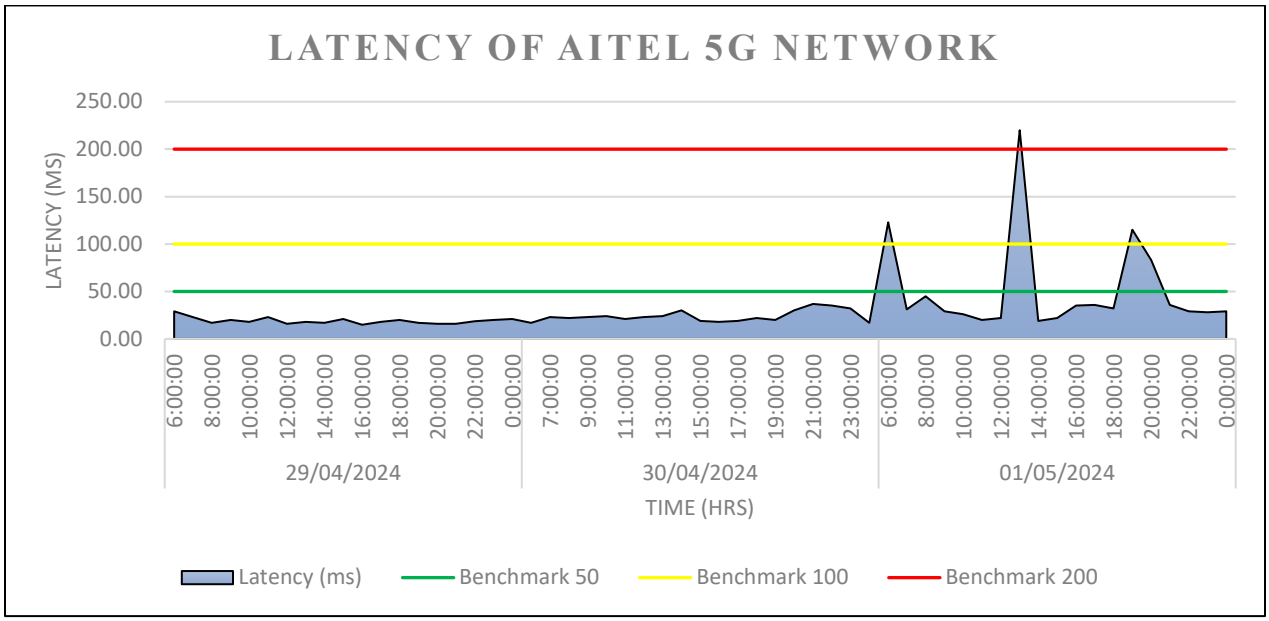

Figure 6: Latency for the Airtel 5G network in Yenagoa.

User Experience

Based on the data collected, Figure 7 shows the network strength during the period, which is a major impact on the user experience of the sample area.

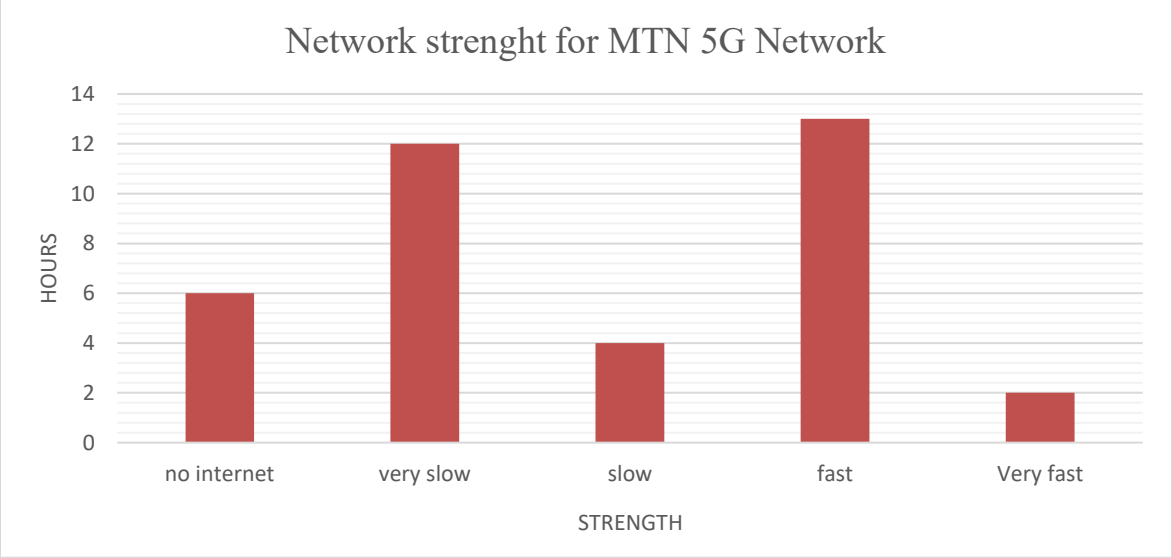

Figure 7: Network strength for the MTN 5G network in Yenagoa.

This shows that in thirty-seven (37) hours of data gathering, there was about six (6) hours without internet access, about twelve (12) hours with very slow internet, four (4) hours of slow internet, thirteen (13) hours of fast internet and just two (2) hours of reliable very fast internet service. On average, this shows that the 5G network is very poor and unreliable in the area of study. Web browsing will work, but the internet connection cannot handle multiple devices streaming HD videos at the same time. HD videos, video conferencing and gaming are very poor in the area.

As shown in Figure 8, the network strength of the Airtel 5G network is mostly slow for that time interval. It was observed that there were about 20 hours of slow network and 18 hours of very slow network in the area. It was also noticed that there was no network downtime as observed in the MTN network, and there was no period where the network strength was very

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weak. This shows the difficulty in doing heavy activities like streaming and transferring large files.

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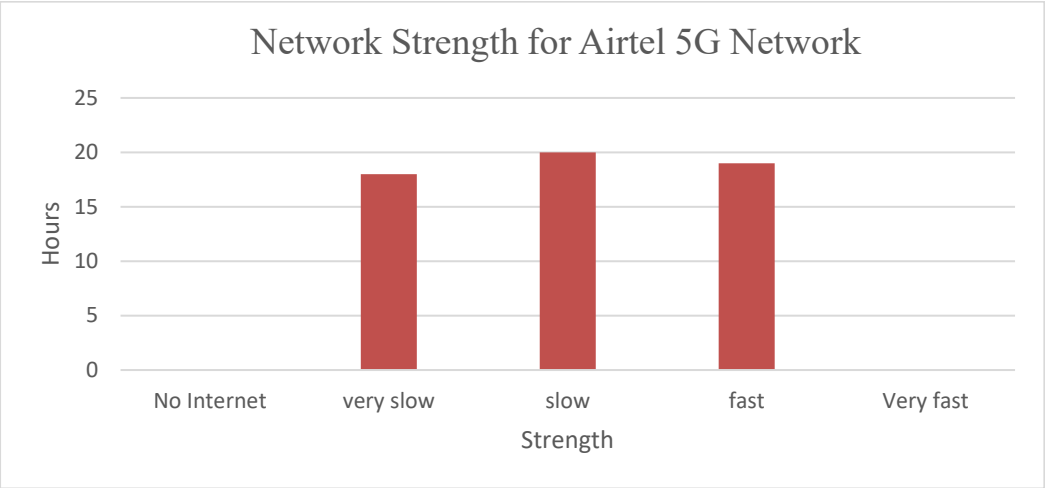

Figure 8: Network strength for the Airtel 5G network in Yenagoa.

Analysis of Questionnaire Responses

The objective of this section is to understand the user experience of the 5G network in Nigeria. This is done by gathering data using a questionnaire. Data was gathered from a sample size of 88 persons from various locations in the country, and below is the analysis of the responses gathered.

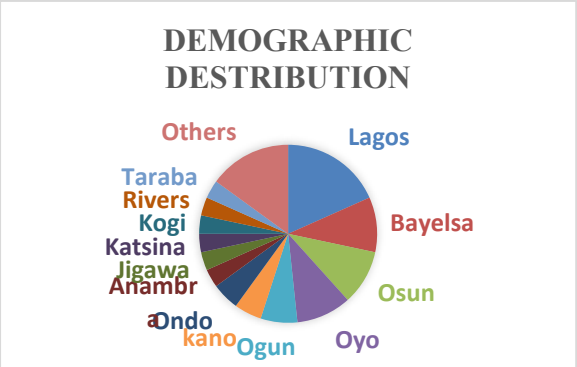

Figure 9: Demographic distribution of respondents

Based on the data gathered, it was observed that 31% of the respondents use a 5G network. 26% of the respondents use the MTN 5G network, and 9% of the respondents use the Airtel 5G network, which are available in these states. This makes an average of 31% who use the 5G network in the country, shown as a pie chart in Figure 10.

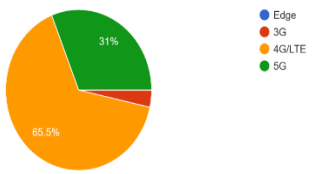

Figure 10: Mobile network distribution for the sample size.

From the data, it was observed that the 5G network is fast in the night and early hours of the day and gets slow during midday. This shows a large amount of traffic during the working hours of the day (peak network usage period). It was also noticed that network downtime occurs at least twice in week. This response to the network strength correlates with the data gathered during the speed test. Also, this makes it difficult to perform certain operations like video streaming during the peak period of the day.

93% of the respondents reside in Nigeria and are scattered across various states in the country, with Lagos ranking first, then Bayelsa state and Osun state.

Analysis of 37-hour speed test data revealed significant performance variability. For MTN 5G, upload speeds peaked at 41.8 Mbps, download speeds at 72 Mbps, and latency at 491 ms, with 6 hours of downtime and 12 hours of very slow internet. Airtel 5G recorded a maximum upload speed of 37.4 Mbps, a download speed of 30 Mbps, and a latency of 220 ms, with no downtime but 20 hours of slow and 18 hours of very slow service. Graphical representations (Figures 1- 6) showed an upward trend for MTN and a downward trend for Airtel across upload and download speeds. Questionnaire data from 88 respondents indicated 31% use 5G, with 29% noting significant improvements over 4G, though midday congestion and high latency (e.g., 491 ms for MTN) degraded experiences. Pearson correlation analysis (Tables 4.2-4.3) yielded weak relationships ($r = 0.21$ to 0.48 for speeds, -0.29 to -0.36 for latency), suggesting independent performance factors.

Discussion

The results underscore 5G's potential in Nigeria, with MTN and Airtel demonstrating peak speeds exceeding 4G benchmarks, yet consistency remains a challenge. High latency (491 ms for MTN, 220 ms for Airtel) exceeds the 50 ms threshold for real-time

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applications, impacting user satisfaction, as corroborated by 32% of respondents noting no significant 5G advantage. The upward trend in MTN's performance contrasts with Airtel's decline, possibly due to infrastructure disparities or traffic management. Weak correlations between speed and latency suggest that optimizing one metric may not address others, aligning with global findings on 5G's complex deployment dynamics (Misra, 2019). Nigeria's power instability and rural coverage gaps (ITU, 2023) further exacerbate these issues, limiting 5G's transformative promise. Compared to global averages (e.g., 100 Mbps download), local performance lags, highlighting the need for targeted infrastructure investments to realize economic and societal benefits.

The Speed tests conducted primarily measured the download, upload speeds, and Latency but did not fully capture other critical factors like jitter and network reliability, which can also impact user experience. This may not accurately reflect the performance of specific applications or services that users typically engage with, such as streaming, gaming, or video conferencing, which are also important aspects of user experience. For example, the speed requirement for different applications varies.

5G performance varies significantly based on location, distance from cell towers, and environmental factors like buildings and terrain. Speed tests conducted in different areas may produce inconsistent results, limiting the generalizability of findings. It can also be influenced by the type of device used. Not all devices are fully optimized for 5G, leading to variations in user experience that may not be fully captured.

The results are one-time snapshots of network performance. They may not account for fluctuations over time, leading to a potentially incomplete picture of 5G performance and user experience.

5G operates on different frequency bands (low, mid, and high), each offering varying speeds and coverage. Speed tests conducted might not differentiate between these bands, leading to mixed results that don't fully represent the user experience across different 5G implementations.

Finally, 5G technology is still evolving, with new developments and optimizations being introduced regularly. Speed test results could become outdated quickly, limiting their relevance in ongoing assessments of 5G user experience.

Conclusion

While 5G in Yenagoa shows considerable potential, current instability and latency issues hinder its effectiveness. Addressing these through enhanced infrastructure and policy support is crucial to harnessing 5G's full potential, positioning Nigeria as a digital leader in Africa.

Recommendations

Future research should expand to other Nigerian regions, incorporating jitter and reliability metrics to provide a holistic 5G performance profile. Longitudinal studies could track network evolution post-2025, assessing infrastructure upgrades. Exploring 5G's integration with IoT and telemedicine, as projected to contribute $2.2 trillion globally by 2034 (Beltozar-Clemente *et al.,* 2023), offers a promising avenue. Collaborative efforts with MNOs and regulators could develop cost-effective solutions for power and spectrum challenges.

Based on the data gathered in this research, the following recommendations may be considered to ensure improvement in the internet connection for the 5G network in Bayelsa. There is a need for improvement in network stability. This is necessary to prevent the drastic fluctuation experienced during the research period, especially during working hours when internet usage is at its peak.

A check on the network infrastructure could help the network provider identify why there are periods with no internet connection. Provision of better infrastructure and innovation can be used to combat this. To handle peak times, such as the dramatic spikes observed, the service provider should consider upgrading network infrastructure. This could include higher bandwidth connections, better routing equipment, or improved server capacities. Upgrading hardware, increasing bandwidth, and using more efficient routing protocols, are also recommended.

Prolonged periods of zero and extremely low speeds suggest possible network outages or significant congestion. Investigate the root causes of these outages, whether they are due to hardware failures, network maintenance, or other issues.

Implementing better traffic management policies could help in balancing the load during peak times to avoid drops in speed. This data suggests that while there are periods of high-speed connectivity, there are also critical times when the upload speed is significantly low, potentially affecting productivity. The service provider can implement load balancing techniques to distribute traffic more evenly across the network, preventing bottlenecks during peak hours.

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