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Applications of 5G Networks in Nigeria: The Journey so Far

Sowunmi Ibrahim Olaleye* and Oduroye Ayorinde Peter*Department Computer Science, Caleb University, Imota, Lagos, Nigeria****Corresponding author:** Sowunmi Ibrahim Olaleye, Department Computer Science, Caleb University, Imota, Lagos, Nigeria**Received Date:** June 19, 2025**Published Date:** August 04, 2025**Abstract**

The emergence of fifth-generation (5G) mobile networks marks a paradigm shift in the global digital landscape. Nigeria, as Africa's largest economy and most populous nation, is strategically leveraging 5G to drive technological innovation, enhance productivity, and promote inclusive development. This study presents a detailed exploration of the evolution of 5G deployment in Nigeria, tracing its development from policy formulation and early trials to current commercial rollouts. It provides an extensive literature-based review, highlights the diverse sectors where 5G has been introduced, and offers an in-depth discussion of the opportunities, challenges, and strategic pathways for sustainable adoption. The findings reveal that 5G applications are already being piloted across telecommunications, education, healthcare, agriculture, financial services, industry, and smart city initiatives. However, infrastructural constraints, high costs, and regulatory challenges persist. The paper concludes by recommending targeted investments, policy reforms, and inclusive strategies to harness the full potential of 5G for national development. This research relies solely on peer-reviewed sources and credible institutional reports to ensure originality and scholarly integrity.

Introduction

Fifth-generation mobile technology, commonly known as 5G, represents the most advanced stage in wireless communication networks. Technically, 5G refers to a set of standards and innovations that enable significantly faster internet speeds, extremely low latency, and the capacity to connect vast numbers of devices simultaneously [1]. Unlike earlier generations, 5G is not just an incremental improvement for mobile phone users; it is a transformative platform designed to support emerging technologies such as smart cities, autonomous vehicles, precision agriculture, and advanced healthcare systems. Globally, 5G technology represents a significant leap in mobile communication, enabling unprecedented data rates, ultra-low latency, massive device connectivity, and support for critical applications [1]. For developing countries

like Nigeria, the potential of 5G extends beyond enhanced connectivity—it promises to catalyze economic development, bridge digital divides, and foster innovation in sectors like healthcare, education, agriculture, and industry. According to the Nigerian Communications Commission (NCC), Nigeria's growing ICT sector contributes over 17% to GDP, indicating that investments in 5G could deliver substantial socio-economic benefits (NCC, 2021). In Nigeria, the meaning of 5G goes beyond technical definitions - it holds the promise of driving economic growth, improving public services, and bridging the digital divide. As the largest economy and most populous nation in Africa, Nigeria faces persistent challenges, including infrastructural deficits, uneven access to digital tools, and the need for more efficient governance. 5G is being deployed as a

means to address these issues by enabling innovative solutions tailored to local needs (Nigerian Communications Commission [NCC][2].

This paper addresses the following questions: How did Nigeria's 5G journey begin, and what are its milestones? Which sectors are adopting 5G, and what benefits and challenges have emerged? How can Nigeria accelerate inclusive 5G deployment? To answer these, a literature-based approach is adopted.

Literature Review: History of 5G Adoption in Nigeria

Early Research and Policy Framework (2018–2019)

Nigeria's interest in 5G was first articulated in policy discussions around 2018, influenced by global trends and a rising need for higher bandwidth [3]. Early research by C.K. Agubor and colleagues (2018) highlighted the benefits and challenges specific to Nigeria, identifying infrastructure deficits, policy gaps, and high deployment costs as barriers to be addressed.

Spectrum Allocation and Pilot Trials (2019–2020)

In late 2019, MTN Nigeria conducted the country's first 5G trial in partnership with Huawei and Ericsson, achieving download speeds exceeding 1.9 Gbps in Lagos and Abuja [4]. The trials also tested low-latency applications and demonstrated IoT use cases. Following this, in 2020, the NCC published its draft 5G deployment policy and set aside spectrum in the 3.5 GHz band for auction (NCC, 2021).

Licensing and Initial Deployment (2021–2022)

By December 2021, MTN and Mafab Communications won 5G licenses through NCC's public auction, committing to rollout timelines [5]. MTN launched commercial 5G services in September 2022, covering Lagos, Abuja, Port Harcourt, and Kano. Airtel Nigeria joined the 5G market in 2023 [6].

Current Status (2023–2025)

As of 2025, 5G services remain concentrated in urban centers. According to Ibanga et al. (2024), subscriber uptake is modest due to high costs of 5G-compatible devices and limited awareness. [4] note that sectoral adoption is picking up, particularly in education, healthcare, and financial services.

Nigeria Communication Commission (NCC) Feasibility Studies and Stakeholder Consultations on 5G Adoption in Nigeria

The Nigerian Communications Commission (NCC) has adopted a systematic and consultative approach to prepare the country for fifth-generation (5G) mobile technology deployment. This process involved commissioning detailed feasibility studies, conducting technical trials, and organizing extensive stakeholder consultations to ensure that 5G deployment is both technically sound and socioeconomically beneficial.

Feasibility Studies

In 2020, the NCC commissioned a comprehensive consultancy study titled Consultancy Study on 5G - The Evolved Telecommunication Technology of the Future. This study was designed to examine the readiness of Nigeria's telecommunication infrastructure for 5G and to recommend a roadmap for its deployment. The study assessed several critical factors, including spectrum availability, infrastructure requirements, global best practices, and the safety of radio frequency emissions. It also analyzed case studies from other countries and provided a framework for sustainable and phased implementation in Nigeria (Nigerian Communications Commission [NCC], [2]. The feasibility study found that while Nigeria had significant potential to deploy 5G, challenges such as inadequate fiber-optic infrastructure, high deployment costs, and public concerns over electromagnetic exposure needed to be addressed.

Pilot Trials

Before finalizing its strategy, the NCC oversaw technical pilot trials in 2019 in collaboration with MTN Nigeria and technology partners such as Huawei and Ericsson. These trials were conducted in Lagos, Abuja, and Calabar to test 5G network performance under real-world conditions. The tests demonstrated high data throughput of up to 1.9 Gbps, low latency, and the capability to support massive device connections [4]. The outcomes of these trials provided empirical data to support policy decisions and informed the NCC's understanding of Nigeria's specific technical needs and challenges.

Stakeholder Consultations

In line with its participatory regulatory philosophy, the NCC organized several stakeholder consultation forums between 2020 and 2021. These engagements brought together mobile network operators, government ministries, regulatory agencies, academic researchers, security agencies, and consumer advocacy groups. One of the most significant consultations took place in November 2021 to review the draft Information Memorandum (IM) for the 3.5 GHz spectrum auction. During these forums, stakeholders provided feedback on issues such as spectrum allocation, licensing conditions, rollout timelines, quality of service expectations, and environmental safety standards (NCC, 2021). These engagements ensured that the regulatory framework reflected the perspectives of all major actors in the telecommunications ecosystem and addressed public concerns about health and privacy risks associated with 5G [7].

Spectrum Coordination

A key milestone emerging from these consultations was the signing of a Memorandum of Understanding (MoU) between the NCC and the Nigerian Communications Satellite Limited (NigComSat) in May 2021. The MoU provided for the release and repurposing of portions of the C-band (3.4-3.9 GHz) spectrum for 5G deployment, while safeguarding satellite services that also use this band. This agreement was vital to secure the internationally

harmonized frequency band for early 5G rollouts in Nigeria [8].

Conclusion

The NCC's approach to 5G adoption reflects a balance between technical preparedness and stakeholder inclusivity. By commissioning feasibility studies, validating findings through pilot trials, and incorporating diverse stakeholder input, the NCC has laid the groundwork for a smooth and responsible rollout of 5G services in Nigeria.

Areas of 5G Introduction in Nigeria

Telecommunications

Telecommunication service providers have spearheaded Nigeria's 5G deployment. MTN and Airtel are the major operators currently providing 5G services, primarily in metropolitan areas such as Lagos, Abuja, Port Harcourt, and Kano. MTN's early trials in 2019 demonstrated peak download speeds of 1.9 Gbps and ultra-low latency suitable for real-time applications [4]. Commercial rollouts since 2022 have improved network capacity, reduced congestion on 4G networks, and enabled faster internet access for consumers and businesses. Moreover, 5G is enabling telecom companies to offer innovative services such as cloud gaming, high-definition video streaming, and advanced enterprise solutions that were previously unfeasible on 4G infrastructure [6].

Education

The education sector is leveraging 5G technology to revolutionize teaching and learning experiences. According to [9], Nigerian universities, such as Rivers State University, have successfully piloted augmented reality (AR) and virtual reality (VR) applications in STEM classrooms. These technologies allow students to engage with complex scientific concepts and simulations in immersive environments, enhancing comprehension and retention. Additionally, 5G supports hybrid learning models that combine in-person and remote education, addressing challenges of overcrowding and limited physical infrastructure in tertiary institutions. However, the high cost of 5G-enabled devices and insufficient rural coverage continue to impede equitable access to these innovations.

Healthcare

5G technology is creating transformative opportunities in healthcare delivery, particularly in remote and underserved regions. The International Institute for Academic Research & Development [10] documents early implementations of telemedicine platforms that utilize 5G's high bandwidth and low latency for real-time consultations between urban-based specialists and rural clinics. High-definition imaging, remote monitoring of chronic conditions, and even telesurgery demonstrations have become feasible through reliable 5G connections. These advances can potentially reduce the urban-rural healthcare gap, improve patient outcomes, and lower costs. Challenges remain, however, in scaling up these solutions nationwide due to infrastructure and training deficits.

Agriculture

Smart agriculture, powered by 5G, is gradually taking root in Nigeria's agrarian economy. Pilot projects in northern states employ IoT sensors connected over 5G networks to monitor soil moisture, temperature, and nutrient levels in real time (Global Scientific Journal, 2024). Farmers can use data analytics to optimize irrigation schedules, reduce input waste, and improve yields. Drones equipped with cameras and sensors conduct crop surveillance, detect pest infestations, and apply targeted treatments. These innovations not only increase productivity but also enhance sustainability by minimizing resource overuse. However, wider deployment faces challenges of high costs, limited awareness, and insufficient rural broadband infrastructure.

Financial Services and Industry

The financial services sector, especially fintech firms, benefits greatly from 5G's enhanced security, speed, and reliability. Faster mobile banking, secure blockchain transactions, and real-time fraud detection are being implemented, contributing to increased consumer confidence and transaction volumes [6]. In the industrial sector, manufacturers and logistics companies are piloting automation solutions, including industrial IoT, robotic process automation, and predictive maintenance systems that rely on 5G connectivity. These innovations enhance efficiency, reduce downtime, and improve supply chain visibility, though broader adoption is currently constrained by the high cost of 5G-compatible equipment.

Smart Cities

Lagos and Abuja are at the forefront of smart city initiatives underpinned by 5G technology. Intelligent traffic management systems use real-time data analytics to reduce congestion, optimize traffic flow, and improve commuter safety [4]. Surveillance systems connected over 5G enhance urban security by enabling high-definition, real-time monitoring. Energy management systems utilize smart grids and connected sensors to monitor consumption patterns and reduce waste. These early-stage projects demonstrate the potential of 5G to make Nigerian cities more efficient, sustainable, and livable. However, scaling up such initiatives will require coordinated investments, policy support, and improved digital literacy among the population.

Opportunities Offered by 5G

Nigeria's young, tech-savvy population and large market offer fertile ground for 5G-driven innovations. Improved broadband capacity can enhance national productivity, attract foreign investment, and position Nigeria as a regional ICT hub. In education and healthcare, 5G enables digital inclusion by reaching underserved areas with advanced services.

Challenges

Key challenges include insufficient fiber-optic infrastructure to support small-cell networks, high costs of deployment and devices,

inconsistent power supply, and regulatory bottlenecks [3, 5]. The digital divide between urban and rural areas threatens to widen without targeted interventions. Privacy and data security also require stronger regulatory frameworks as data volumes grow, especially in the face of widespread myths and misinformation that continue to hamper public acceptance of 5G [7].

Recommendations

1. Infrastructure investment: Expand national fiber backbone and support renewable energy solutions to improve network reliability.
2. Policy reforms: Streamline licensing and spectrum allocation processes, and provide incentives for rural deployment.
3. Affordability initiatives: Subsidize 5G-enabled devices and promote local assembly to reduce costs.
4. Capacity building: Train professionals and raise public awareness on the benefits and safe use of 5G technology.
5. Inclusive planning: Ensure equitable deployment that prioritizes education, healthcare, and agriculture in rural areas.

Conclusion

Nigeria's 5G journey reflects a measured but promising path toward digital transformation. Since initial trials in 2019, the country has rolled out commercial 5G services in urban centers, with emerging applications in education, healthcare, agriculture, and smart cities. While challenges persist, the benefits of 5G are clear and far-reaching. Strategic investments, inclusive policies, and collaboration between stakeholders can help Nigeria realize the full potential of 5G as a driver of sustainable development.

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Conflict of interest

No conflict of interest.

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