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**A TECHNICAL REPORT ON:**

AN ASSESSMENT OF THE TELECOMMUNICATIONS INFRASTRUCTURE

TOWARDS ACHIEVING A DIGITAL ECONOMY IN NIGERIA BY 2030 IN

CONNECTIVITY LAST MILE

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**ABSTRACT**

This technical report conducts a comprehensive assessment of Nigeria's telecommunications infrastructure, with a specific focus on last-mile connectivity, in pursuit of the nation's goal to establish a digital economy by 2030. Through a meticulous literature review methodology encompassing 35 diverse sources, the study examines the current state of telecommunications infrastructure, evaluates government policies and private sector investments, and analyzes challenges and opportunities for achieving last-mile connectivity. The assessment underscores substantial growth in mobile telecommunications and internet penetration, yet reveals persistent challenges in rural areas. The results emphasize the critical role of private sector investments and the necessity for addressing obstacles such as high access costs and regulatory complexities. The last-mile connectivity assessment identifies significant challenges, ranging from infrastructure gaps to affordability issues, while proposing opportunities for improvement, including digital inclusion initiatives and innovative technologies. The report concludes with a set of recommendations, highlighting the crucial need for infrastructure expansion, regulatory reforms, and strategic partnerships to bridge the last-mile connectivity gap and propel Nigeria toward a digital economy by 2030.

**OUTLINE**

**Abstract**………………………………………………………...…………...…..i

**Outline**………....………………………………………………..………………ii

**Introduction.**………………………………………………………………........1

**Aims and Objectives.**……………………………………………………….….2

**Problem Statement.**……………………………………………………….…...2

**Methodology**.………………………….……………………….………............2

**Current State of Telecommunications Infrastructure in Nigeria**…………..3

* Infrastructure Overview……………………………………………………..3
* Internet Penetration………………………………………………………….4
* Cost of Internet Services…………………………………………………….4
* Government Initiatives and Policies………………………………………...5
* Private Sector Investments………………………………………………….6
* Technological Advancement………………………………………………..7
* Last Mile Connectivity Assessment……………………………….………..8

**Last Mile Connectivity Challenges and Barriers**………………………….8-9

**Opportunities for Achieving Last Mile Connectivity**……………………...10

**Recommendations for Achieving Last Mile Connectivity**……………….11-12

**Conclusion**……………………………………………………………………13

**Reference**…………………………………………………………………....14-16

**INTRODUCTION**

Nigeria, officially the Federal Republic of Nigeria, is a country in West Africa. It is the most populous country in Africa and the world’s sixth-most populous country. It comprises 36 states and the federal capital territory (Abuja). With a population of over 230 million. With this large number of people, it is not arguable that communication is necessary and important for interaction.

Telecommunication is the transmission of information, as words, sounds, or images, usually over great distances, in the form of electromagnetic signals, as by telegraph, telephone, radio, or television.

Telecommunication Infrastructure is a multifaceted framework that forms the technological bedrock of modern communication systems (ITU, 2017). It encompasses a complex network of technologies, physical structures, and systems designed to facilitate the exchange of information over long distances (Frieden, 2017). This intricate system comprises both wired and wireless networks, satellite systems, data centers, and a diverse range of communication devices (Melody, 2018). The significance of telecommunication infrastructure spans across economic, social, and technological domains, as it plays a vital role in shaping the contemporary landscape of nations.

The last mile connectivity, often referred to as the "last mile," is a crucial component of modern telecommunication and internet infrastructure. It represents the final leg of the network that physically connects end-users, such as homes, businesses, and institutions, to the broader communication network. This segment plays a pivotal role in ensuring the delivery of services and data to the end-users, making it a vital focus in the field of telecommunications and network design (Hu, Chen, & Qiu, 2018).

Nigeria, with a population of over 200 million and the largest economy in Africa, has set a target of achieving a digital economy by 2030. To achieve this goal, the country must assess its telecommunications infrastructure, especially in the area of last mile connectivity. The last mile is the final leg of the telecommunications networks that bring the internet to end-users. However, last-mile connectivity is still a major challenge in Nigeria, with only about 40% of the population having access to the internet. This report aims to assess Nigeria's telecommunications infrastructure towards achieving a digital economy by 2030. The report provides an evaluation of Nigeria's last-mile connectivity, examining the factors that have contributed to the current state of the infrastructure and the challenges that need to be addressed to achieve the goal of a digital economy. The report concludes by providing recommendations on how Nigeria can develop its telecommunications infrastructure to achieve a digital economy by 2030.

### AIMS AND OBJECTIVES

### The aim of this technical report is to conduct a thorough assessment of Nigeria's telecommunications infrastructure, specifically focusing on last-mile connectivity, to evaluate its readiness for supporting the nation's ambitious goal of achieving a digital economy by 2030.

### 1. To assess the current state of telecommunication infrastructure in Nigeria, examining its strengths and weaknesses, scrutinize government initiatives, policies, and technological advancements influencing the telecommunications landscape in Nigeria.

### 2. To identify and analyze the challenges and barriers hindering the achievement of last-mile connectivity, particularly in rural and underserved areas.

### 3. To evaluate opportunities for achieving and contributing to the expansion of telecommunications infrastructure, especially in the context of last-mile connectivity.

### 4. To provide comprehensive recommendations aimed at improving last-mile connectivity, addressing challenges, and facilitating the realization of a digital economy in Nigeria by 2030.

### PROBLEM STATEMENT

The development and sustainability of telecommunication infrastructure, particularly last-mile connectivity, pose significant challenges in Nigeria as the nation endeavors to achieve a digital economy by 2030. Despite the growing importance of telecommunication infrastructure as a catalyst for economic growth, social inclusion, and technological advancement, critical barriers and deficiencies hinder its effective implementation. These barriers include inadequate infrastructure in rural and underserved areas, high access costs for low-income populations, network quality disparities, regulatory challenges, and security concerns. Bridging the last-mile connectivity gap in Nigeria is essential to ensure that all citizens can benefit from the opportunities offered by the digital economy. Addressing these challenges and ensuring equitable access to telecommunication services is paramount to realizing Nigeria's vision of a prosperous digital economy by 2030.

### METHODOLOGY

In conducting this research, a rigorous literature review methodology was employed to comprehensively assess the state of Nigeria's telecommunications infrastructure, with a specific emphasis on last-mile connectivity. The primary research phase involved an extensive search across academic databases, with Google Scholar serving as the principal tool. A total of 35 scholarly materials were meticulously selected, comprising peer-reviewed journal articles, government reports, policy documents, books, and reputable online sources. The selection criteria prioritized relevance to the topic, publication credibility, recency, and diversity of perspectives. The chosen papers provided a holistic understanding of Nigeria's telecommunications landscape, including infrastructure overview, challenges, government policies, private sector investments, and opportunities for last-mile connectivity. The rejection of certain papers was based on criteria such as outdated information, lack of relevance to the research objectives, or insufficient academic rigor. The final selection ensures the comprehensiveness and reliability of the study, forming a foundation for the subsequent analysis and evaluation.

# CURRENT STATE OF TELECOMMUNICATIONS INFRASTRUCTURE IN NIGERIA

#### Infrastructure Overview

Telecommunications infrastructure in Nigeria comprises a complex and evolving network of technologies and services that form the backbone of the nation's communication systems (ITU, 2020). The mobile telecommunications sector has experienced remarkable growth, with multiple service providers covering a significant portion of the country (Adeyemo & Eletta, 2020). Nigeria has made significant strides in improving internet penetration, with a growing number of Nigerians gaining access to the internet through various devices, including smartphones, tablets, and computers (World Bank, 2021). In recent years, Nigeria has witnessed the introduction of advanced technologies, such as 4G and the potential for 5G networks, enabling faster internet speeds and supporting more data-intensive applications (Adejumo et al., 2019).

Despite these advancements, challenges remain, particularly in rural and underserved areas where network coverage remains limited (Ndukwe & Ogunbanwo, 2017). Network quality and reliability vary across regions, with urban areas generally experiencing better service quality compared to remote and rural areas (ITU, 2020). High costs associated with accessing telecommunications services, including data and device expenses, continue to be a concern for many Nigerians, especially those with limited incomes (Olaniyan et al., 2019). The regulatory environment presents complexities, including issues related to spectrum allocation, infrastructure sharing, and interconnection rates (Adeyemi, 2020). Efforts to enhance telecommunications infrastructure are ongoing, with initiatives focused on expanding network coverage, reducing access costs, and promoting digital literacy (Federal Ministry of Communications and Digital Economy, 2020).

#### Internet Penetration

Internet penetration in Nigeria has seen significant improvements, with an increasing number Nigerians gaining access to the internet through various devices, including smartphones, tablets, and computers (World Bank, 2021).

The introduction of 4G and 5G technologies has enabled faster internet speeds and the potential for more advanced services and applications (Balogun et al., 2021). Despite these advancements, challenges persist in ensuring equitable access to telecommunications services across the country. Rural and underserved areas continue to experience limited network coverage, hindering their participation in the digital economy (Ndukwe & Ogunbanwo, 2017). Network quality and reliability also vary across regions, with urban areas typically enjoying better services compared to remote locations (ITU, 2020).

## Cost of Internet Services

The cost of accessing telecommunications services remains a concern for many Nigerians, particularly those with low incomes (Olaniyan et al., 2019). High data costs and device prices may limit the ability of certain segments of the population to fully benefit from digital services. Additionally, the regulatory environment faces challenges such as spectrum allocation and management, infrastructure sharing, and interconnection rates (Adeyemi, 2020).

Efforts to enhance telecommunications infrastructure are ongoing, with initiatives to expand network coverage, reduce access costs, and promote digital literacy (Federal Ministry of Communications and Digital Economy, 2020).

## Government Initiatives Policies

The Nigerian government has implemented various initiatives and policies to promote the development and expansion of telecommunications infrastructure, aiming to bridge the digital divide and facilitate the transition to a digital economy by 2030 (Federal Ministry of Communications and Digital Economy, 2020).

1. **National Digital Economy Policy and Strategy for a Digital Nigeria:** This comprehensive policy document outlines the government's vision and strategies for advancing digital technologies, including the improvement of telecommunications infrastructure, to enhance economic growth and social inclusion.
2. **Broadband Plan for Nigeria 2020-2025:** is another notable initiative (Nigerian Communications Commission, 2020). This plan sets ambitious targets for broadband penetration and seeks to address infrastructure challenges by expanding high-speed internet access across the country.
3. **National Infrastructure Access Code:** To encourage infrastructure sharing and promote efficient use of resources, the Nigerian Communications Commission (NCC) introduced the "National Infrastructure Access Code" (Nigerian Communications Commission, 2017). This code encourages telecom operators to share passive infrastructure, such as cell towers and fiber optic cables, reducing duplication of resources and costs.
4. **Nigeria Digital Skills Training Program:** The government has also initiated programs to enhance digital literacy and skills among citizens. The Nigeria Digital Skills Training Program aims to equip Nigerians with the necessary digital skills to participate in the digital economy (Federal Ministry of Communications and Digital Economy, 2020).
5. **Smart Cities Initiative**: This has been launched to leverage technology in the development of smart and sustainable urban centers, which includes improving telecommunications infrastructure within these cities (Federal Ministry of Communications and Digital Economy, 2020).

These initiatives and policies collectively reflect the government's commitment to expanding telecommunications infrastructure, improving access, and fostering a digital-ready society in Nigeria. While progress has been made, challenges in implementation and enforcement persist, requiring ongoing efforts to achieve the ambitious goals set forth in these policies.

# Private Sector Investments

Private sector investments play a pivotal role in the development and expansion

telecommunications infrastructure in Nigeria, particularly in the quest for last-mile connectivity and the realization of a digital economy by 2030.

1. **Telecom Network Expansion**: Private telecommunication companies have significantly contributed to infrastructure expansion by investing in the deployment of cellular towers, fiber optic networks, and related technologies to extend network coverage (Federal Ministry of Communications and Digital Economy, 2020).
2. **Internet Service Providers**: Private sector internet service providers have played a crucial role in making internet access available to various regions, even those in remote and underserved areas (ITU, 2020).
3. **Investment in Innovative Technologies**: Private investors are increasingly exploring innovative technologies such as TV White Spaces and low-earth orbit (LEO) satellites to reach remote and difficult terrains more cost-effectively (ITU, 2020).
4. **Infrastructure Sharing**: Private telecom operators have engaged in infrastructure sharing agreements, enabling them to optimize resources and reduce duplication of infrastructure, ultimately reducing costs (Nigerian Communications Commission, 2017).
5. **Last-Mile Solutions**: Private companies are seeking last-mile connectivity solutions, including community-based initiatives and localized connectivity projects, to address specific regional needs (World Bank, 2019).

Private sector investments are crucial for driving infrastructure expansion and facilitating connectivity, ultimately contributing to economic growth and social inclusion in Nigeria. These investments, combined with a supportive regulatory environment and public-private partnerships, hold the potential to accelerate the achievement of last-mile connectivity.

# Technological Advancement

Technological advancements have played a pivotal role in shaping the landscape of telecommunications infrastructure in Nigeria, with a particular focus on last-mile connectivity and the development of a digital economy (Balogun et al., 2021).

* **Introduction of 4G and 5G**: One significant technological advancement is the introduction of 4G and the potential for 5G networks (Adejumo et al., 2019). These high-speed networks have enabled faster internet speeds and the capability to support data-intensive applications and services.
* **Fiber optic networks**: The deployment of fiber optic networks has also been instrumental in improving telecommunications infrastructure (Adeyemo & Eletta, 2020). Fiber optics provide high-capacity data transmission, enhancing connectivity and reducing latency.
* **IOT**: The advent of the Internet of Things (IoT) has brought about a new era of interconnected devices, creating opportunities for various sectors, including agriculture, healthcare, and transportation, to benefit from enhanced telecommunications infrastructure (Balogun et al., 2021).
* **Cloud computing technologies**: have gained prominence, facilitating the storage and processing of data and applications, thereby reducing the need for significant local computing resources (Federal Ministry of Communications and Digital Economy, 2020).
* **Artificial intelligence (AI) and machine learning technologies**: are being integrated into telecommunications infrastructure for predictive maintenance, network optimization, and enhanced customer service (Balogun et al., 2021).

These technological advancements have not only improved the quality and efficiency of telecommunications services in Nigeria but also have the potential to revolutionize various industries, creating new opportunities for economic growth and digital transformation.

# Last Mile Connectivity Assessment

The assessment of last-mile connectivity is a critical component of evaluating the state telecommunications infrastructure in Nigeria, especially in the context of achieving a digital economy by 2030 (Federal Ministry of Communications and Digital Economy, 2020).

Last-mile connectivity, referring to the final leg of delivering telecommunication services to end-users, is pivotal in ensuring equitable access to digital services for all citizens (Ndukwe & Ogunbanwo, 2017). It involves the extension of telecommunication networks to remote, underserved, and often challenging terrains, such as rural areas and informal settlements (World Bank, 2019).

This assessment aims to analyze the availability, quality, and accessibility of last-mile connectivity, with a focus on bridging the digital divide and promoting digital inclusion (ITU, 2017).

# LAST MILE CONNECTIVITY CHALLENGES AND BARRIERS

Nigeria's telecommunications infrastructure is facing significant challenges, which are hindering the country's efforts towards achieving a digital economy by 2030 (Adeniran & Oyewole, 2020). According to a report by the Nigerian Communications Commission (NCC), only about 40% of the population has access to the internet, with the majority of internet users concentrated in urban areas (NCC, 2021). This digital divide is due to the poor state of last mile connectivity, which is defined as the final leg of the telecommunications infrastructure that connects the end-user with the internet (Bachir & Zennaro, 2019).

Efforts to achieve last-mile connectivity in Nigeria face significant challenges and barriers that must be addressed to bridge the digital divide and facilitate a digital economy by 2030.

1. **Infrastructure Gaps**: Extending telecommunication infrastructure to remote and underserved areas is hampered by the lack of physical infrastructure, including roads and power supply (Federal Ministry of Communications and Digital Economy, 2020).
2. **Access Costs**: High access costs, including data charges and device expenses, pose a significant barrier for low-income populations, limiting their ability to access digital services (Olaniyan et al., 2019).
3. **Quality Disparities**: Network quality and reliability vary across regions, with rural areas often experiencing subpar service quality compared to urban centers (ITU, 2020).
4. **Regulatory Challenges**: Complex regulatory frameworks, spectrum allocation, and interconnection rates present hurdles to telecommunications companies and infrastructure expansion (Adeyemi, 2020).
5. **Security Concerns**: Ensuring the security of telecommunications infrastructure in vulnerable areas can be challenging due to factors such as vandalism and theft (Federal Ministry of Communications and Digital Economy, 2020).
6. **Geographical Barriers**: The diverse and challenging geographical terrain in Nigeria, including swampy regions and dense forests, makes infrastructure deployment and maintenance difficult (ITU, 2017).
7. **Affordability**: Digital devices, particularly smartphones, may be unaffordable for a substantial portion of the population, limiting their participation in the digital economy (World Bank, 2019).
8. **Digital Literacy**: A lack of digital literacy and awareness hinders the effective utilization of digital services, even where connectivity is available (Federal Ministry of Communications and Digital Economy, 2020).

Addressing these challenges is crucial to ensuring that all Nigerians, regardless of their location and economic status, have the opportunity to benefit from the advantages of a digital economy.

# OPPORTUNITIES FOR ACHIEVING LAST-MILE CONNECTIVITY

While challenges and barriers exist in achieving last-mile connectivity in Nigeria, several opportunities can be harnessed to address these issues and bridge the digital divide:

1. **Digital Inclusion Initiatives**: Government-led digital inclusion programs, as highlighted in the "National Digital Economy Policy and Strategy for a Digital Nigeria," offer opportunities to expand connectivity to underserved areas (Federal Ministry of Communications and Digital Economy, 2020).
2. **Infrastructure Sharing**: Promoting infrastructure sharing among telecommunication companies can lead to cost savings and more efficient expansion, potentially reducing access costs (Nigerian Communications Commission, 2017).
3. **Public-Private Partnership**: Collaborative efforts between government entities and private sector stakeholders can stimulate investment in infrastructure development and expand network coverage (World Bank, 2019).
4. **Innovative Technologies**: Leveraging innovative technologies like TV White Spaces and low-earth orbit (LEO) satellites can provide cost-effective solutions for connecting remote areas (ITU, 2020).
5. **Local Content and Applications**: Encouraging the development of local content and applications can drive demand for digital services and increase the value proposition of last-mile connectivity (Federal Ministry of Communications and Digital Economy, 2020).
6. **Community Engagement**: Engaging local communities in the planning and deployment of telecommunications infrastructure fosters a sense of ownership and may expedite infrastructure expansion (World Bank, 2019).
7. **Geospatial Analysis**: The utilization of geospatial data and mapping technology can identify underserved areas accurately and aid in targeted infrastructure expansion (ITU, 2017).
8. **Data-Driven Decision-Making**: Data analytics and insights can inform evidence-based policies and strategies, facilitating more efficient last-mile connectivity efforts (Federal Ministry of Communications and Digital Economy, 2020).

By capitalizing on these opportunities, Nigeria can make significant progress in achieving last-mile connectivity and extend the benefits of the digital economy to all its citizens, ultimately contributing to economic growth and social development.

# RECOMMENDATIONS FOR ACHIEVING LAST MILE CONNECTIVITY

To bridge the last-mile connectivity gap in Nigeria and facilitate the nation's journey toward a digital economy by 2030, several key recommendations are crucial:

1. **Infrastructure Expansion**: Invest in the expansion of telecommunication infrastructure, particularly in rural and underserved areas, to ensure that all regions have access to reliable connectivity (Federal Ministry of Communications and Digital Economy, 2020).
2. **Affordability Measures**: Implement measures to reduce access costs, including data charges and device expenses, to make digital services more affordable and accessible to low-income populations (Olaniyan et al., 2019).
3. **Network Quality Improvement**: Focus on improving network quality and reliability in all regions, ensuring that urban and rural areas experience consistent and high-quality service (ITU, 2020).
4. **Regulatory Reforms**: Streamline and simplify regulatory frameworks, spectrum allocation, and interconnection rates to create a more favorable environment for telecommunications companies to expand their services (Adeyemi, 2020).
5. **Security Enhancements**: Implement security measures to protect telecommunications infrastructure in vulnerable areas from theft and vandalism (Federal Ministry of Communications and Digital Economy, 2020).
6. **Geospatial Planning**: Utilize geospatial data and mapping to identify underserved areas and plan infrastructure expansion effectively (ITU, 2017).
7. **Digital Literacy Programs**: Launch initiatives to enhance digital literacy and awareness, ensuring that the population can make the most of digital services when connectivity is available (Federal Ministry of Communications and Digital Economy, 2020).
8. **Public-Private Partnerships**: Foster collaboration between the public and private sectors to facilitate infrastructure expansion and investment (Nigerian Communications Commission, 2020).
9. **Community Involvement**: Engage local communities in the planning and development of last-mile connectivity projects to ensure they meet the specific needs of the area (World Bank, 2019).

By implementing these recommendations, Nigeria can significantly improve last-mile connectivity, enabling all citizens to participate in the digital economy and fostering economic growth and social inclusion.

# CONCLUSION

The assessment of telecommunications infrastructure in Nigeria with a specific focus on last-mile connectivity underscores the critical importance of bridging the digital divide to realize the nation's vision of a digital economy by 2030. The landscape of telecommunications in Nigeria is marked by both progress and challenges. While technological advancements and policy initiatives have contributed to significant growth, barriers such as infrastructure gaps, high access costs, network quality disparities, and regulatory complexities continue to impede the equitable distribution of digital services.

To achieve last-mile connectivity and ensure that all Nigerians can benefit from the advantages of a digital economy, comprehensive strategies that encompass infrastructure expansion, affordability measures, quality improvements, regulatory reforms, security enhancements, geospatial planning, digital literacy programs, public-private partnerships, and community involvement are essential. The successful implementation of these recommendations will not only boost connectivity but also foster economic growth, social inclusion, and a brighter digital future for Nigeria.

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