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Technical study on telecommunication and ICT infrastructure data, costs and analysis in Nigeria

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The analysis was undertaken by the ITU expert Eng. Dr. Jonathan Pinifolo under the framework of ITU work on promoting effective regulation, greater investment and innovative models for connectivity in underserved communities and for broader digital inclusion supported by the United Kingdom Foreign, Commonwealth and Development Office (FCDO).

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Please consider the environment before printing this report.

Foreword

I am pleased to present this technical study on telecommunication and information and communications technology (ICT) infrastructure data, costs and analysis in Nigeria.

A significant amount of the global population remains offline, with the figure much higher in least developing countries, particularly in Africa. Our research indicates that affordability is a significant enabler of connectivity. Coupled with that is the cost of investment required in broadband infrastructure to provide sufficient quality of service for the latest technology advancements and to reach underserved areas. However, to make services more affordable, from a private and public sector perspective, there needs to be a better understanding of the costs relating to telecommunication infrastructure to identify where efficiencies and new approaches could drive down such costs.

To support digital inclusion, we have been working with the United Kingdom Foreign, Commonwealth and Development Office (FCDO) Digital Access Programme in Brazil, Indonesia, Kenya, Nigeria and South Africa. The partnership with FCDO has been aimed at understanding how universal connectivity could be achieved, particularly in underserved areas. Efforts have focused on supporting governments with regulatory analysis, capacity development, tools and frameworks, and analysis relating to infrastructure provision.

As part of this work, the technical research carried out in Nigeria provides valuable insights into the major cost drivers in Nigeria's telecommunication industry and market. It also provides insights on the impact of effective policy making, regulation, improved investment, and innovative models for connecting public entities such as hospitals and schools in underserved areas and for broader digital inclusion in Nigeria.

Dr Cosmas Luckyson Zavazava
Director of the Telecommunication Development Bureau
International Telecommunication Union

Executive summary

This study on telecommunication and ICT infrastructure data, costs and analysis provides insights into the supply-side conditions of telecommunication infrastructure and Internet service delivery in Nigeria. The focus of the work was to look at the relevant microeconomic indicators and complementary infrastructure data to provide insights into the pattern and factors of telecommunication and ICT infrastructure construction, maintenance, and service delivery costs, and to provide clear recommendations for telecommunication business and policy in Nigeria.

This study analyses the costs of connecting to the Internet and providing Internet services in Nigeria for fibre-optic network connectivity, microwave links, mobile broadband cellular links, and cellular communications. The analysis has focused on the capital expenditure (capex) of telecommunication equipment, including cost elements such as taxation and licence fees in addition to operational expenditure (opex) in terms of network operation and maintenance costs, including recurring licensing fees.

In terms of report structure, section 1 sets out the background and scope, focusing on key assumptions used and key stakeholders involved. Section 2 looks at the study approach with a specific emphasis on research methodology and scenarios on cost analysis while section 3 analyses the capex and opex for mobile network operators, infrastructure companies, Internet service providers and satellite network operators. Section 4 considers the regulatory framework, especially the key policy instruments affecting the cost of doing business. Section 5 presents recommendations, and the overall conclusions.

The information presented here, builds on and complements the ongoing work of ITU on connectivity and infrastructure mapping and analysis. This technical study has a significant link to universal connectivity as ICT infrastructure remains key to bringing everyone online by 2030. This work will therefore help to shape infrastructure strategies to bring meaningful connectivity to the underserved or unconnected communities.

The study shows clearly that lower capital and operating costs can be achieved by creating a conducive regulatory framework of laws, policies, guidelines and an enabling environment in Nigeria and shows how the development of telecommunications is largely driven by elements such as the costs associated with infrastructure sharing, taxation, electricity availability, ands right of way charges.

Acronyms and abbreviations

ATC	American Tower Corporation
BTS	base transceiver station
DAP	Digital Access Programme
DWDM	dense wavelength division multiplexing
EPC	evolved packet core
UK FCDO	United Kingdom Foreign, Commonwealth and Development Office
FTTH	fibre-to-the-home
GSMA	Global System for Mobile Communications Association
ICT	information and communications technology
IP	Internet protocol
ISP	Internet service provider
ITU	International Telecommunication Union
Mbit/s	megabits per second
MNO	mobile network operator
NCA	Nigerian Communications Act
NCC	Nigerian Communications Commission
NFVI	network functions virtualization infrastructure
POP	points of presence
QoS	quality of service
RUBI	Rural Broadband Initiative
SIM	subscriber identity module
USF	universal service fund
USPF	universal service provision fund
VAS	value added service
VAT	value added tax
VSAT	very small aperture terminal

Table of contents

List of figures and tables

Figures

Tables

1. Introduction

The focus of this project was to conduct a study of the supply-side conditions of telecommunication and ICT infrastructure and Internet service delivery in Nigeria. This exercise focused on the cost structure for telecommunication infrastructure deployment in Nigeria for four main categories of telecommunication services providers, namely, mobile network operators, Internet service providers, infrastructure companies and satellite network operators. The project also covered microeconomic data in respect to the cost of telecommunication infrastructure construction, maintenance, and Internet service delivery from which recommendations on relevant policy, regulatory and industry changes that can facilitate the lowering of the costs were provided.

The telecommunication and ICT infrastructure costs analysis was conducted using a combination of acquired data and key assumptions:

Capital costs (capex): Reference input capital costs were obtained from equipment suppliers and infrastructure projects undertaken by operators including mobile network operators, Internet service providers, infrastructure companies and satellite network operators.

Operating costs (opex): The reference data for these was derived from actual costs and through a number of assumptions. Operational cost overheads were also considered and where relevant included in the opex calculations. For example:

- a fixed overhead covering all support costs not directly attributable to a core network component or to premises connection;
- a fixed overhead covering all support costs for infrastructure information systems.

Stakeholders: Engagement with industry was a key part of this assignment. It assisted in ensuring that the costs for the network infrastructure elements were fully representative of local supply conditions, and that the recommendations from this project are in line with international best practices. The engagements were also an important mechanism of verifying that a transparent and objective data sourcing environment was created during the exercise. The initial plan included meetings with the Nigerian Communications Commission (NCC), mobile network operators, Internet service providers, infrastructure companies and satellite operators in order to get a thorough understanding of the major cost elements of the telecommunication network infrastructure and the corresponding operational costs from the supply side realm. The objective of the project was presented through virtual meetings with 9Mobile, IHS and Astramix Limited, and they made their comments regarding the project and sought clarity in some areas. The questionnaires were shared after the meetings.

The data collection exercise was followed by a validation workshop held on 24 October 2023 and attended by key stakeholders of the telecommunication industry in Nigeria, including the Nigeria Communications Commission. The validation workshop provided a platform where the much-needed data from the primary sources was acquired through discussion. In addition to the telecommunication service providers, the validation workshop was also attended by ICT service users. This contributed to an understanding of how the telecommunication data services cost is perceived from the demand side. Through this workshop, policy-makers, regulators, private sector stakeholders and academia had an opportunity to share their experiences and explore possible solutions and opportunities to lower supply side cost of telecommunication infrastructure.

2. Study approach

Primary and secondary research methodologies were used to gather data and required information. Virtual meetings to validate information were held with telecommunication service providers ranging from mobile network operators to Internet service providers and infrastructure companies. Data on radio access networks, transmission networks, power, levies, spectrum fees among others, were collected through appropriate survey instruments to understand connectivity requirements, existing telecommunication and complementary infrastructure and costs of telecommunication infrastructure construction, maintenance, and Internet service delivery. Data collection instruments such as questionnaires, attached as Annexes 1-4, were developed and shared with the service providers who were interviewed.

In addition, qualitative information was obtained from the ITU-FCDO roundtable and technical workshop, which was held from 23 to 24 August 2022 in Abuja, Nigeria under the theme "*Building capabilities for sustainable and inclusive digital transformation in Nigeria*" where stakeholders discussed key legal and regulatory factors that contribute to the cost of network infrastructure deployment in Nigeria[1].

The secondary research method principally focused on online research, which involved a review of relevant publications, analysis of existing ITU and GSMA literature and other reports[2] to provide cost data for various network infrastructure elements. In addition, the project research team used the following sources of information in compiling this report:

- publicly available cost models;
- publicly available information on the websites of the national regulatory authority and network operators;
- information from research reports and data services.

Also considered were reports such as the State of Broadband[3] that were reviewed to determine the relevant Telecommunication Infrastructure, Annual Tariff Policies Survey of ITU that is focused on tariff rates models, tariff policies and methodologies on calculating various telecommunication rates in various Member States. This served as a benchmark for the Nigeria telecommunication industry.

Further, the secondary research also focused on ITU infrastructure cost literature in all the three categories of telecommunication service provision listed above. Secondary research also focused on ITU prices literature in all the five highlighted categories namely fixed broadband, mobile data and voice low-usage, mobile data and voice high-usage, mobile broadband, and mobile cellular low usage.

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1 ITU-FCDO Roundtable and Technical Workshop: Building capabilities for sustainable and inclusive digital transformation in Nigeria

2 https://www.itu.int/en/ITU-D/Statistics/Documents/publications/prices2022/ITU_Price_Brief_2022.pdf, https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Documents/Publications/ITU%20Costing%20and%20Pricing%20paper_web%20%28002%29.pdf , https://www.itu.int/en/mediacentre/backgrounders/Pages/affordability.aspx , https://www.gsma.com/spectrum/wp-content/uploads/2020/11/Effective-Spectrum-Pricing-Africa.pdf , https://www.gsma.com/sotir/ , https://www.gsma.com/spectrum/wp-content/uploads/2019/09/Impact-of-spectrum-prices-on-consumers-Technical-Report.pdf , https://dataintelo.com/report/global-telecom-ict-infrastructure-market/ , https://www2.deloitte.com/us/en/pages/technology-media-and-telecommunications/articles/telecommunications-industry-outlook.html.

3 The State of Broadband Report 2022 - Broadband Commission

In general, the project used all available ITU data for Nigeria[4] during the overall technical and financial analysis including the ITU Broadband Connectivity Toolkit[5]. The World Telecommunication/ICT Indicators database 2023 (27th edition/July 2023) was also reviewed to evaluate statistics such as fixed-telephone networks, quality of service, revenue, prices, mobile-cellular telephone subscriptions, Internet (including fixed-and mobile-broadband subscription data), traffic, staff, investment, and statistics on ICT access and use by households and individuals.

Study limitations

The study did not account for supplementary operational costs associated with site security and insurance. Preserving the physical security of data centres and fortifying against potential risks or unforeseen events is essential to Internet infrastructure. The expenses linked to implementing robust security measures and procuring insurance coverage to alleviate potential risks were not taken into consideration.

Cost analysis by scenario

Total cost profiles were developed using input cost data based on different licence categories and services, validated against actual data from international projects and component vendors. Capital expenditure (capex) and operating expenditure (opex) were included. A stakeholder engagement meeting was held to validate the cost model findings and gain feedback from a focus group of key operators and interested related parties with valuable knowledge and 'real life experience' of the digital communications infrastructure. Total cost of ownership was calculated using opex based on a 30-year 'minimum life expectation' of physical infrastructure assets and an 8-year expectation for active equipment components. A weighted average cost of capital (WACC) was applied to all opex with a discount rate of 9.3 per cent.

Approach to the ITU cost analysis

This exercise followed a bottom-up cost model, which is built from a set of basic inputs (e.g., demand, coverage, geographical and technical information). Based on these inputs, the bottom-up model sets out a network that fulfils coverage and capacity requirements using technical engineering algorithms. The network costs are then calculated as the product of the number of network elements and their unit cost.

As indicated in the ITU Guidelines on cost modelling (2021)[6], this approach does not reconcile exactly with operator financial accounts, but it can be designed to accurately represent operations in a given country. Therefore, a bottom-up model allows the calculation of forecasts, what-if analyses, different scenarios, and so forth. However, non-network costs that are associated more with human resources than with investment (especially retail costs) can be difficult to model through a bottom-up approach. Unlike a top-down model, a bottom-up model can be developed by both regulatory authorities and operators, as they require less data from the operators. This is the reason why this model was adopted for this study as it was more applicable to the key output of telecommunication infrastructure data, costs, and analysis in Nigeria.

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4 Exploring sustainable solutions for digital connectivity in schools and communities in Nigeria: *ITU-FCDO Roundtable and Technical Workshop: Building capabilities for sustainable and inclusive digital transformation in Nigeria 23-24 August 2022*

5 https://docs.google.com/spreadsheets/d/1a7Tt2pQxBa0KnerYiVcfyptqoa4ihmvxHDW2Q8uKimA/edit#gid=0

6 Guidelines on cost modelling: Economic policies and methods of determining the costs of services related to national telecommunication/ICT networks (ITU-D Question 4/1), 2021

The major cost elements being focused on in this exercise are:

- network costs (capex and opex);
- licence and spectrum fees;
- general and administrative costs;
- cost of capital.

Network capex: Network capex includes the investment made by network operators for installing and commissioning the network. Typical cost elements include:

- network core equipment purchasing (for example, switches), including related software;
- network infrastructure (for example, network buildings, ducts);
- supporting IT systems such as network operations support systems;
- one-off fees for subcontracted network services (for example, leased line activation charges);
- installation costs associated with the items above.

Network opex: Network opex includes the recurrent costs associated with operating the network. Typical cost elements include:

- network personnel;
- outsourced maintenance services;
- power (electricity and fuel);
- recurrent charges for subcontracted network services (for example, leased lines, dark fibre);
- network sites rentals.

Licences and spectrum fees: Licence costs and spectrum fees represent a significant cost to telecommunication operators. They have different purposes:

Licences are related to the permission required to sell telecommunication services, and they can take the form of annual and/or one-off fees. Both options have been considered in the models. These are non-network common costs under general and administrative costs.

Spectrum fees represent the rental of a resource that is essential for the network, and they can take the form of annual and/or one-off fees. Both options have been considered in the models. They include both spectrum associated with wireless access and microwave spectrum for transmission. These fees are commonly considered as a network common cost.

General and administrative costs: General and administrative costs are associated with management activities and are common for network and commercial activities, specifically, offices and related costs and general administration costs.

Cost of capital: The cost of services needs to consider a reasonable amount of return on the invested capital an operator would be able to earn in a competitive market. To estimate this reasonable amount of return, NCC uses weighted average cost of capital (WACC), which is defined as the sum of the weighted cost of equity and debt. These weights are based on the market value of debt and equity, respectively.

Stakeholder webinar

A webinar was held in October 2023 to explore data and infrastructure mapping and validation of telecommunication/ICT infrastructure data, costs and analysis in Nigeria and marked a milestone in addressing the challenges of Internet connectivity in Nigeria. The depth of discussions, the wealth of insights, and the diverse expertise contributed to a comprehensive understanding of the complexities and intricacies within the telecommunication industry. The recommendations and insights generated during this meeting served as a foundation for future efforts to enhance Internet connectivity in Nigeria and, potentially, inspire innovative solutions for similar challenges elsewhere. The importance of reliable and affordable Internet services cannot be overstated in today's interconnected world, and the outcomes of this meeting have the potential to make a meaningful impact on the lives of Nigerian citizens and beyond.

Furthermore, the meeting highlighted different projects and initiatives that contribute to addressing connectivity gaps, such as the role of the Huawei RuralStar solution. The collaborative approach between MTN Nigeria and Huawei has expanded 3G and 4G network coverage in rural areas by deploying the Huawei RuralStar solution. This initiative was highlighted for its potential to unlock significant social and economic benefits by giving rural residents access to the Internet, communications, and online services.

Key insights

The discussions and analyses at the validation meeting led to several key insights and recommendations:

- Prioritising the optimisation of procurement processes can substantially contribute to cost reduction when acquiring ICT/telecommunication infrastructure.
- Investment in infrastructure deployment, particularly in underserved and remote areas, is imperative to ensure universal access to the Internet. Emphasizing the importance of regular maintenance and repairs is crucial for long-term cost management and the uninterrupted provision of Internet services.
- Effective management of operational expenses is a pivotal element in achieving financial sustainability for Internet and service providers.
- The implementation of robust cybersecurity measures is a non-negotiable requirement for protecting network infrastructure and preserving user trust.
- Policymakers should address the issue of taxation on infrastructure sharing to encourage more efficient resource utilisation and reduce costs.
- RuralStar deployment represents a transformative approach to closing the digital gap and unlocking significant social and economic benefits in rural areas.
- Ensuring a reliable power supply from the grid for the telecommunication industry.
- Raising awareness of the benefits of telecommunications to reduce infrastructure vandalism.

3. Cost and technology analysis

3.1 Mobile network operator infrastructure

3.1.1 Base station deployment

The statistics on mobile infrastructure deployment among MNOs and ISPs shows that the number of base stations has increased from 114 412 to 127 294[7] from December 2021 to December 2022 across all states in Nigeria, representing an increase of 11.25 per cent in 2022[8]. By the end of December 2023, the total number of base stations was expected to reach 141 614 further indicating a robust expansion of mobile connectivity across Nigeria. This increase in base stations deployment can be largely attributed to the deployment of towers in previously unserved areas through the InfraCo initiative, a public-private partnership model aimed at accelerating infrastructure development. Additionally, regulatory interventions promoting infrastructure sharing have played a crucial role in facilitating this growth, enabling more efficient use of existing resources and encouraging private sector participation in expanding the network roll out. These efforts are helping to improve mobile coverage, especially in rural and underserved areas, ensuring more people have access to reliable mobile services and enhancing overall connectivity throughout Nigeria.

The table below provides a detailed breakdown of base station host towers according to the operator. This breakdown categorizes the number of towers deployed by each operator, offering insight into the distribution of Tower infrastructure across all the States.

Table 1: Tower operators

Reference no.	Name of operator	Number of towers owned
1	Glo	8 550
2	MTN	286
3	EMTS	86
4	Airtel	61
5	IHS	18 925
6	ATC	8 270
7	Pan African Tower	764
8	East Castle	113
9	ColoPlus	139
10	Extended Networks	42
11	MPS Technologies	648

[7] https://www.rroij.com/open-access/brief-overview-of-nigeria-telecommunication-network.php?aid=91582; https://www.telecompaper.com/news/nigeria-reaches-53-460-3g-and-4g-base-stations-fibre-networks-reach-54- 725-km--1369672

[8] NCC 2023 Year End Performance Report

Table 1: Tower operators (continued)

Reference no.	Name of operator	Number of towers owned
12	Seal Tower	24
13	Tydacomm	3
14	EM Towers	3
15	Infraworks	3
16	Atlas Towers	1
17	Infratel	12
18	Union Tower	51
20	Vanu Wireless	3
21	African Mobile Networks Limited	1 326
22	CREI Networks	40
23	Communications Towers	6

3.1.2 Base station cost analysis

Nigeria has made significant strides in expanding telecommunication infrastructure, achieving an impressive 77.52 per cent coverage of 4G networks across the country giving high-speed mobile Internet access to a substantial portion of the Nigerian population.

However, there is a noticeable disparity in 4G network coverage between urban and rural areas. Urban centres enjoy a robust and reliable 4G network, while rural areas lag behind in terms of coverage. This discrepancy arises from the marked disparity in the prevalence of 4G-capable devices between these two settings. A greater density of people who own and use smartphones and other 4G-compatible devices live in urban areas. This concentration of 4G-ready devices makes it more financially attractive for network operators to invest in expanding and improving 4G coverage in urban areas. The higher likelihood of a large customer base in urban areas ensures that operators can anticipate a faster and more secure return on their investments in these areas, and the financial outlay for establishing and maintaining 4G and 5G network infrastructure is a critical factor. On average, the cost of 4G base station equipment with three sectors providing 360-degree coverage is estimated to be around USD 135,934.06, which includes the necessary hardware and technology for delivering 4G services. Additionally, the installation and commissioning of a 4G base station comes at an approximate cost of USD 4,907.38, covering the expenses associated with setting up and activating the base station.

For those contemplating 5G technology, the costs are also a pivotal consideration. A single sector 5G base station equipment, which forms the foundation for the next generation of mobile connectivity, carries a price tag of roughly USD 65 550. The installation and commissioning costs for a 5G base station are estimated to be around USD 4 907.38. These amounts represent substantial investment in the infrastructure required to deliver innovative 5G services to consumers.

It is essential to note that the costs provided here are based on a thorough analysis of quotations from base station suppliers and responses from mobile network operators (MNOs). However, costs associated with installation and commissioning of base stations can vary significantly based on several factors, including the chosen contractor, project specifics, and regional dynamics.

Table 2: Cost of base stations

Cost of Deploying Radio Access Network					
Base station	Equipment cost per site (USD)	Installation and commissioning cost per site (USD)	Operation and maintenance per 1 year (USD)	Taxation (import tax)	Total cost of ownership for 1 year
4G	135 934.06	4 907.38	6 796.70.00	7 476	155 114.14

Source: Huawei (equipment vendor)

To ensure fairness and equitable access to the radio frequency spectrum, NCC has implemented a systematic approach for assigning spectrum bands. This approach is designed to create a level playing field for all interested operators and stakeholders in the telecommunication industry. NCC achieves this goal by employing a competitive auction process for frequency bands suitable for LTE (Long-Term Evolution) and 5G technologies. In this process, the spectrum is assigned to the operator willing to pay the highest price.

In the context of LTE technology in Nigeria, several frequency bands are earmarked for its deployment, and these bands play a crucial role in enabling high-speed wireless communication services. LTE technology in Nigeria uses 2 600 MHz, 800 MHz, 700 MHz, 1 800 MHz, 900 MHz and 2300 MHz frequency bands. Table 3 below summaries spectrum assignments for LTE.

Table 3: LTE spectrum assignment

Operator	Assigned 4G frequency band
MTN	700MHz, 900MHz/1800MHz, 800MHz and 2.6GHz
Glo	700MHz, 900MHz/1800MHz and 2.6GHz
9Mobile	900MHz/1800MHz
Airtel	900MHz/1800MHz and 2.6GHz
NTel	900MHz/1800MHz
SMILE	800MHz
SPECTRANET	2.3GHz
BITFLUX	2.3GHz

Source: NCC frequency assignment tables

Table 4: 5G spectrum assignment

Operator	Assigned 5G frequency band[9]
MTN	3500 – 3600 MHz
Airtel	3400 – 3500 MHz
MAFAB	3700 – 3800 MHz
Not assigned	3600 - 3700 MHz

Source: NCC frequency assignment tables

5G spectrum plan

In line with global trends, through NCC, the Nigeria Federal Government has licensed 5G Spectrum to MTN, MAFAB and Airtel. .[10]

Table 5: 5G future spectrum band plan

Frequency bands
600MHz
2300 - 2400 MHz
2500 - 2690 MHz
3300 - 3400 MHz
UPPER 6GHz
26GHz
38GHz
42HGz

Figure 1: Example of 4G base station

Source: ITU

[9] https://www.gsma.com/spectrum/wp-content/uploads/2021/09/spec_ssa_5g_iot_report_09_21.pdf
[10] https://www.ncc.gov.ng/accessible/documents/918-draft-deployment-plan-for-5g-network-in-nigeria/file

3.1.3 Microwave backhaul deployment

To backhaul services from base station to the nearest fibre-optic point of presence or data centres, MNOs deployed microwave links that serve as backhaul or access transport network. The statistics reveal that microwave radio link deployment among network operators decreased from 290 626 km[11] to 288 947.48 km cumulatively. Table 6 summarises microwave links deployed by each MNO allocation as reflected in the national frequency plan[12]:

Table 6: Microwave links deployed by mobile network operators

Name of MNO	Total microwave deployed in km as of 2020	Total microwave deployed in km as of 2021	Total microwave deployed in km as of December 2022
MTN	96 994	85 551	80 074.59
AIRTEL	74 241	77 095	81 352.00
GLO	61 731	71 540	71 061.46
9MOBILE	39 249	39 760	48 957.69
NTEL	4 554	4 534	4 553.74
SMILE	2 948	2 948	2 948.00
Total	**289 426**	**290 626**	**288 947.48**

MTN and Airtel deployed more microwave links from 2020 to 2022 compared to other mobile network operators.[13] However, deployment of fibre-optic networks by operators particularly in urban areas has seen some microwave links being decommissioned, which would account for the lower numbers.

3.1.4 Microwave link deployment costs

Microwave links play a pivotal role in modern telecommunications, primarily serving as a critical connectivity solution for MNOs and Internet service providers (ISPs). These technologies are employed to establish high-capacity communication channels between various network components, most notably between base stations and data centres. The use of microwave links becomes particularly significant in scenarios where traditional fibre-optic infrastructure is either unavailable or not cost-effective, and this is especially prevalent in rural areas. Radio microwave links offer a realistic solution that considers both geographical challenges and the need for cost-effective, high-capacity network connectivity. These technologies are essential tools for MNOs and ISPs as they work to bridge the digital divide and bring the benefits of modern telecommunications.

On average, the one-year total cost of ownership for access to microwave links, backhaul microwave links, backbone optical equipment and metro equipment amount to USD 25 684.24,

11 https://ncc.gov.ng/accessible/documents/1095-2022-year-end-performance-report/file
12 https://ncc.gov.ng/accessible/documents/627-nfmc-national-frequency-allocation-table/file
13 NCC 2021 Year End Subscriber Network Data Report; https://www.ncc.gov.ng/statistics-reports/reports-publications

USD 52 900.37, USD 119 969, and USD 14 397.25, respectively.[14] Table 7 summarises the cost of transmission equipment used for backhaul services from point of presence to data centres.

Table 7: Cost of deploying transmission equipment

Cost of deploying transmission equipment						
Microwave	Cost of equipment (one-off payment in USD)	Cost of installation and commissioning (one-off payment in USD)	Cost of Spectrum per year (USD)	Operation and maintenance cost per year (USD)	Taxation (5.5%) (import tax in USD)	Total cost of ownership per year (USD)
Access link (2+0) 600 M 0.6m	17 606.86	6 200	319	590	968.38	25 684.24
Backhaul microwave (4+0) 2000 M 0.9m	43 101.77	6 200	638	590	2 370.60	52 900.37
DWDM/ OTN	101 393.26	11 500	NA	1500	5 576.63	119 969.89
Metro access routers	9 950.00	2 400	NA	1500	547.25	14 397.25
Metro aggregate routers	70 000.00	9 800	NA	1500	3 850.00	85 150.00
Core routers	243 508.32	6 000	NA	1500	13 392.96	264 401.28

The cost values mentioned are the result of a rigorous evaluation of several factors through a two-fold approach, which involved analysing quotations from a diverse range of equipment suppliers and gathering data through in-depth interviews with MNOs.

Quotations from equipment suppliers: This analysis involved soliciting quotations from multiple equipment suppliers. These suppliers are responsible for providing the essential hardware and technology components required for the deployment of a robust telecommunication/ ICT services. These quotations encompassed a wide array of equipment and infrastructure, including core routers and various backbone elements, such as dense wavelength division multiplexing (DWDM) infrastructure, which is crucial for transmitting large volumes of data over long distances, and it is a cornerstone of modern high-capacity networks.

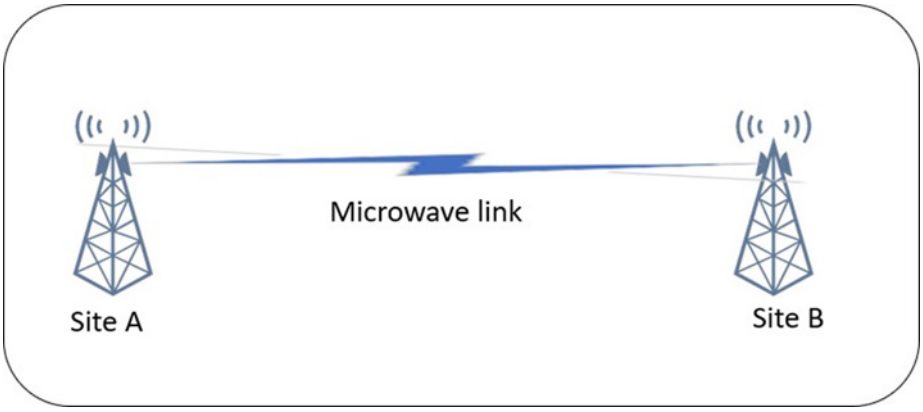
Oral interviews with MNOs: The second component of the analysis involved conducting oral interviews with MNOs. These interviews sought to gain insights directly from the key industry players who operate and manage these networks. MNOs play a pivotal role in shaping the

[14] Supplier quotations

telecommunication landscape, and their input provided invaluable information regarding the costs and expenditure involved in deploying and maintaining transport network infrastructure.

The conclusion of this analysis revealed a significant finding. A substantial portion of the capex associated with the transport network could be attributed to the deployment of core routers and the establishment of backbone active elements, such as DWDM infrastructure. The analysis indicated that these elements accounted for approximately 68 per cent of the overall capex required for building and maintaining the transport network.

Figure 2: Example of microwave link



Source: ITU

3.1.5 Fibre-optic deployment by mobile network operators

Most of the fibre-optic infrastructure in Nigeria is privately owned by MNOs. As such, most of this infrastructure carries traffic generated on their mobile networks. Due to the high cost of deploying new optical fibre, most of this infrastructure is deployed in select urban centres where operators are sure of a return on investment.

As of December 2021, the total terrestrial optical fibre deployed by MNOs reached 47 128.7 km[15]. From the statistics, MTN topped the list of MNOs that deployed terrestrial optical fibre, followed by Airtel. MTN deployed 14 612 km of terrestrial optical fibre, Airtel deployed 14 454 km, GLO deployed 13 233 km, 9Mobile deployed 3 679.09 km, and NTEL deployed 180 km. Table 8 provides a summary of terrestrial optical fibre deployed by MNOs:

Table 8: Terrestrial fibre-optic deployment

Name of MNO	Total terrestrial optical fibre deployed in km
MTN	14 612
Airtel	14 454
GLO	13 233
9Mobile	3 679.09
NTEL	180
Total	**46 158.09**

[15] https://www.thisdaylive.com/index.php/2022/07/14/mtn-globacom-lead-in-mobile-infrastructure-deployment- 21st-century-frontrunner-in-fixed-infrastructure-deployment/

3.1.6 Submarine fibre-optic deployment by mobile network operators

As of December 2021, the total length of deployed submarine fibre-optic cables reached 27 818.3 km, representing a notable increase from 25 128.3 km recorded in 2020. This growth reflects ongoing advancements and investments in telecommunications infrastructure to meet the rising demand for high-speed internet. The expansion of these submarine cables is the result of collaborative efforts led by NCC, the Association of Submarine Cable Operators of Nigeria and various ISPs. Together, they have worked tirelessly to enhance and extend internet connectivity, ensuring that remote and underserved areas are better integrated into the global digital economy.

The deployment of these submarine cables has been achieved through collaborative efforts between Mobile Network Operators (MNOs) and Internet Service Providers (ISPs), who have partnered with various stakeholders. These partnerships have been instrumental in establishing vital Submarines cables systems that connect Nigeria to World. Key submarine cable systems involved in this progress include the MainOne cable, AT-3 cable, GLO-2 cable, Africa Coast to Europe Cable System, West Africa Cable System, Equiano cable, and the Nigeria Cameroon Submarine Cable System[16].

Fibre-optic deployment in Nigeria is costly mainly due to the high cost of right of way as different states charge different prices per linear metre. Despite efforts from government to ensure that all state governments align with the approved NGN 145[17] per linear metre for the deployment of optical fibre across states, some states still charge as much as NGN 6 500 per linear metre. Inconsistencies in right of way charges across the states has negatively impacted roll out of fibre-optic infrastructure.

Table 9: Fibre-optic deployment cost

Cost of deploying optical fibre							
Fibre-optic deployment	Number of core	Cost of 48 core fibre-optic cable per km (USD)	Cost of deploying optical fibre per km (USD)	Unit operating and maintenance per km per year (USD)	Right of way per km (USD)	Taxation (import tax in USD)	Total cost of ownership per year (USD)
Underground fibre	48 652D	1 606.65	21 766.78	233.7343	14 330.44	88.37	36 419.32
Overhead fibre	49 652D	1 606.65	9 814.69	114.2134	14 330.44	88.37	24 347.71

The analysis also reveals the high cost of deploying underground optical fibre compared with overhead fibre because it is labour intensive due to the civil work involved.[18] In addition, right of way costs contribute about 36 per cent of capital expenditure of fibre-optic deployment in some states that are charging NGN 6 500.00 per linear metre.

16 https://www.submarinenetworks.com/en/stations/africa/nigeria
17 https://www.ncc.gov.ng/technical-regulation/research/956-challenges-of-technology-penetration-in-an-infrastructure-deficit-economy-nigeria-perspective
18 https://nairametrics.com/2019/09/24/nigeria-needs-100-billion-annually-to-fix-infrastructural-deficit-financeminister/

3.1.8 MNO model cost structure

When coming up with a model for deploying a mobile network, the study looked at two categories of key network components, the core network cost elements and the radio access network cost elements. The radio access network was further analysed based on the area of deployment, urban or rural, as well as the cost of deploying a green field 4G network using a shared infrastructure. In each scenario, key assumptions are outlined.

a) Cost of deploying core network for MNO

In this cost analysis, the following key assumptions were made:

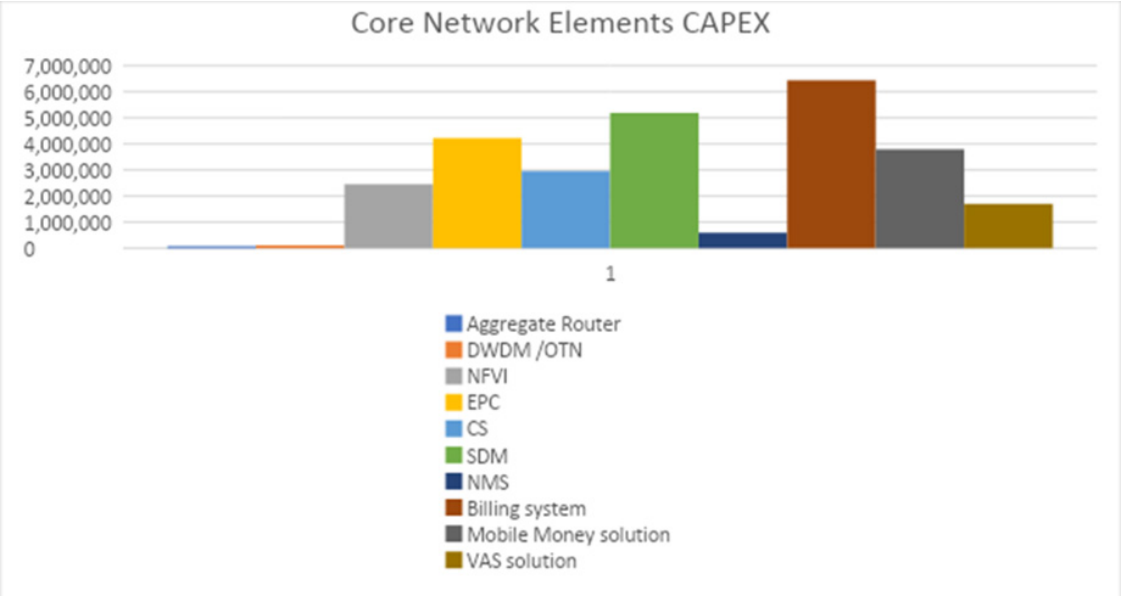
- the MNO has the existing data centre where the core network elements will be deployed or will use the data centre provided through the InfraCo initiative;
- the MNO has existing power infrastructure or will use power provided through the InfraCo initiative;
- the MNO will deploy one aggregate router; and
- the MNO will deploy one DWDM at the data centre.

Table 10 and Figures 3 and 4 present the overall capex and opex required to deploy and maintain a core network for an MNO.

Table 10: Cost of core network elements

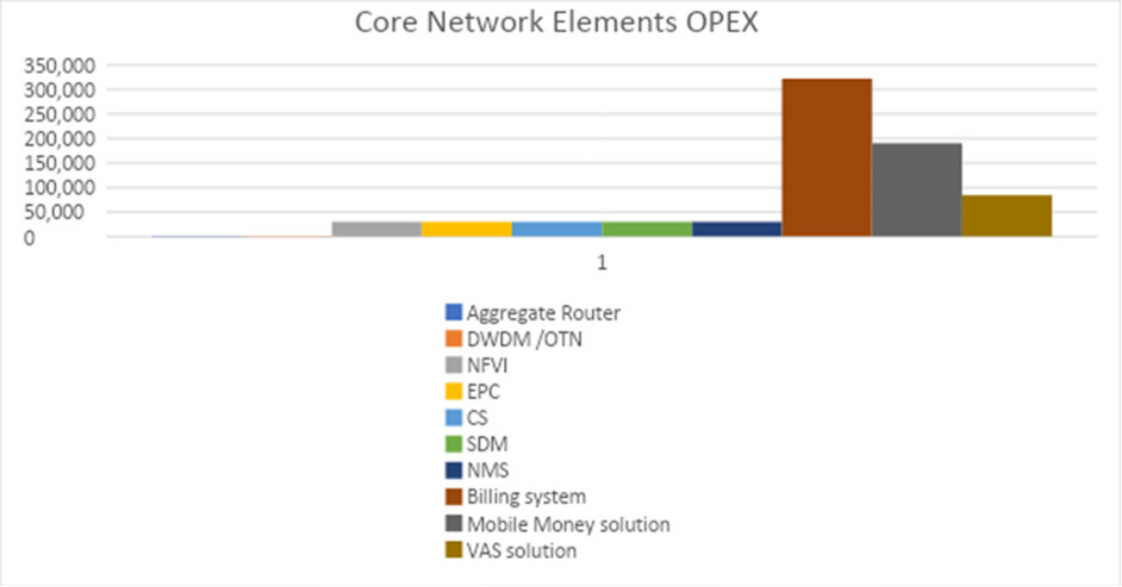
Cost of deploying core network for MNO		
Element	CAPEX USD (unit cost)	OPEX USD (unit cost)
Aggregate router	83 650.00	1 500.00
DWDM /OTN	118 469.89	1 500.00
Network functions virtualization infrastructure (NFVI)	2 454 111.49	29 735.00
EPC	4 230 550.00	29 735.00
CS	2 954 949.50	29 735.00
SDM	5 200 350.31	29 735.00
Network management system	592 385.43	29 735.00
Billing system	6 439 542.81	321 977.14
Mobile Money solution	3 800 000.00	190 000.00
Value added service (VAS) solution	1 696 332.46	84 816.62
Total Cost	**27 570 341.90**	**748 468.76**

Figure 3: Core network element capex



Source: ITU

Figure 4: Core network element opex



Source: ITU

b) Cost of deploying 4G site in urban areas

In this cost analysis, the following key assumptions were made:

- the MNO will procure land where the 4G site will be deployed;
- the MNO will use one access microwave link to connect the 4G base station to the nearest fibre-optic point of presence;
- the proposed site is 1 km away from the fibre-optic point of presence or data centre, hence only 1 km of overhead optical fibre will be deployed;
- the MNO will deploy one DWDM to connect to the data centre;

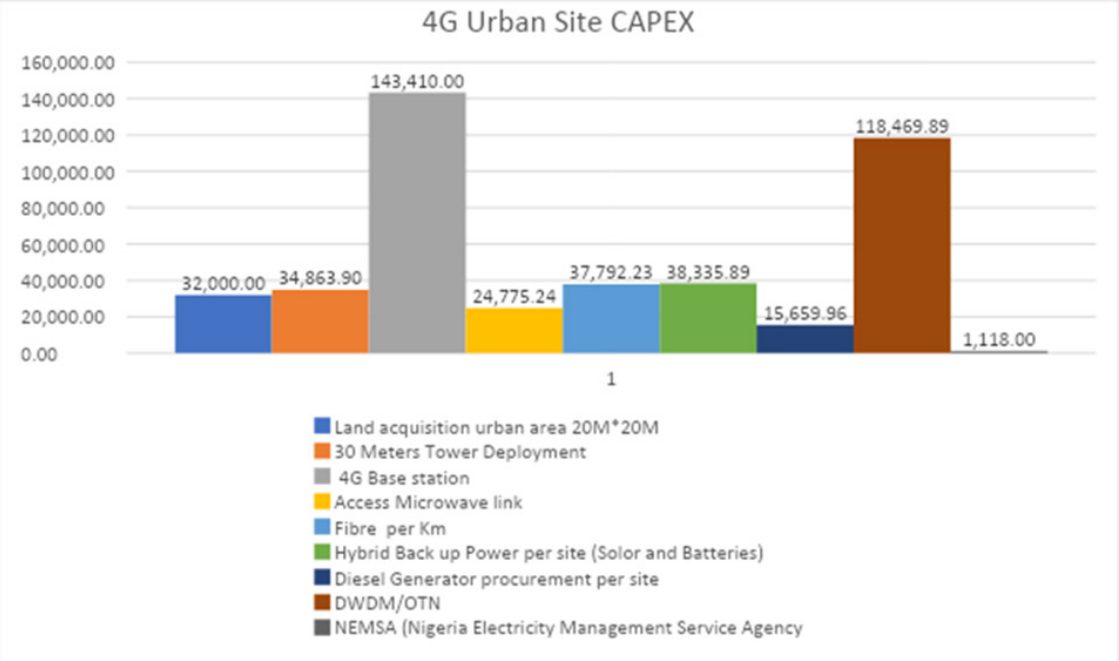
- the MNO will deploy its own power infrastructure.

Table 11 and Figures 5 and 6 present the overall capex and opex required to deploy and maintain a 4G site in urban areas.

Table 11: Cost of deploying 4G urban site

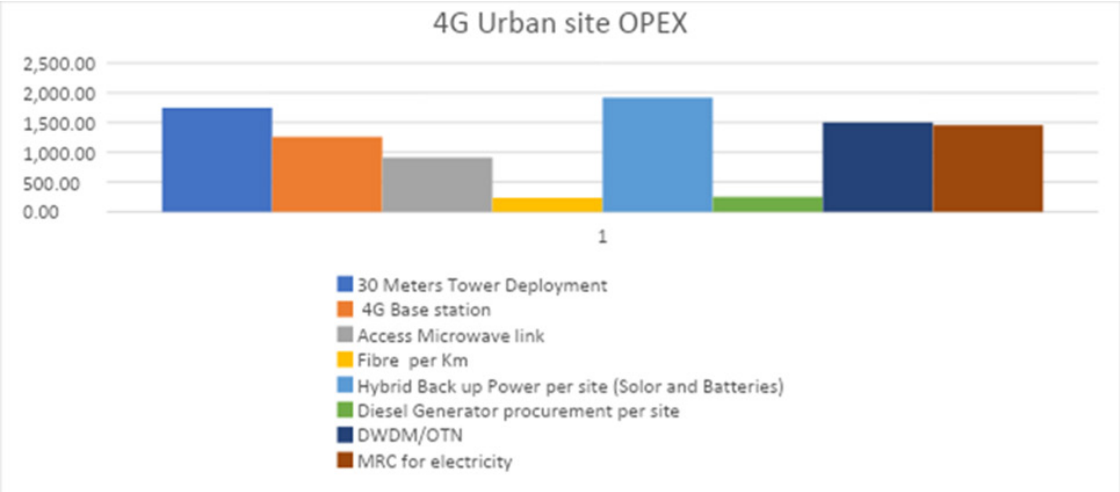
Item	CAPEX USD (unit cost)	OPEX USD (unit cost)
Land acquisition in urban area (20M*20M)	32 000.00	
30 Metre tower deployment	34 863.90	1 743.19
4G base station	143 410.00	1 256.00
Access microwave link	24 775.24	909.00
Optical fibre per km	37 792.23	233.73
Hybrid back up power per site (Solar and Batteries)	38 335.89	1 916.79
Diesel generator procurement per site	15 659.96	254.00
DWDM/OTN	118 469.89	1 500.00
NEMSA (Nigeria Electricity Management Service Agency)	1 118.00	
MRC for electricity		1 458.33

Figure 5: Capex for 4G urban site



Source: ITU

Figure 6: Opex for 4G urban site



Source: ITU

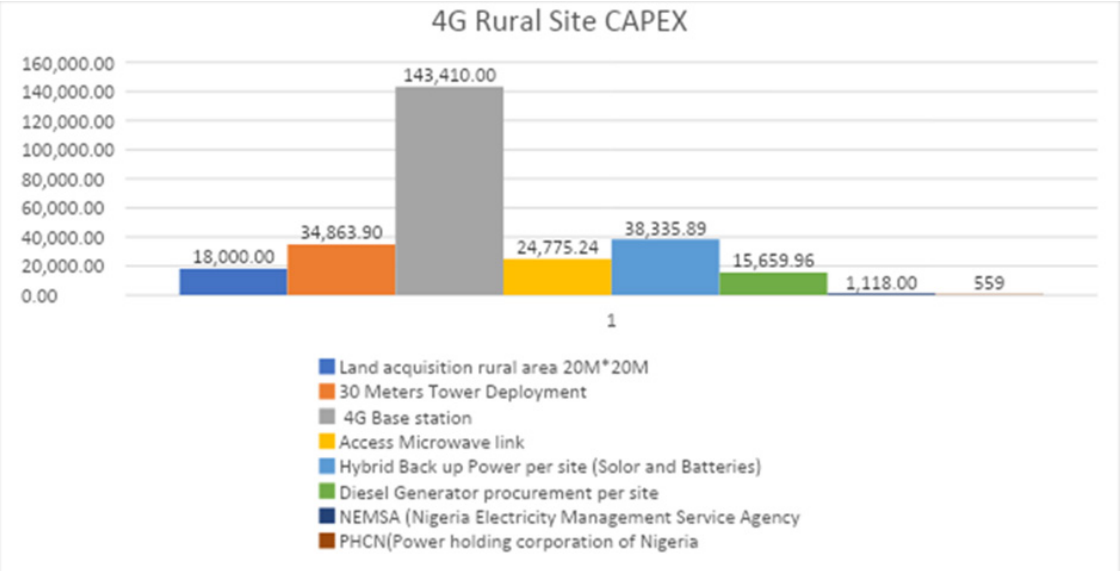
c) Cost of deploying a 4G site in rural areas

Table 12 and Figures 7 and 8 present the overall capex and opex required to deploy and maintain a 4G site in rural areas.

Table 12: Cost of deploying a 4G rural site

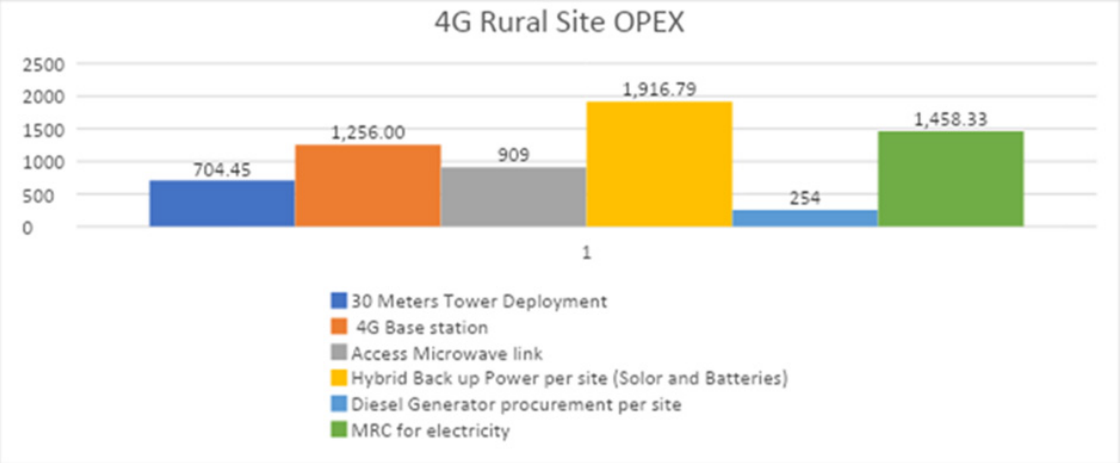
Item	CAPEX USD (unit cost)	OPEX USD (unit cost)
Land acquisition in rural area (20M*20M)	18 000.00	
30 Metre tower deployment	34 863.90	704.45
4G base station	143 410.00	1 256.00
Access microwave link	24 775.24	909.00
Hybrid back up power per site (solar and batteries)	38 335.89	1 916.79
Diesel generator procurement per site	15 659.96	254.00
NEMSA (Nigeria Electricity Management Service Agency)	1 118.00	
PHCN (Power holding corporation of Nigeria)	559.00	
MRC for electricity		1 458.33

Figure 7: Capex for 4G rural site



Source: ITU

Figure 8: Opex for 4G rural site



Source: ITU

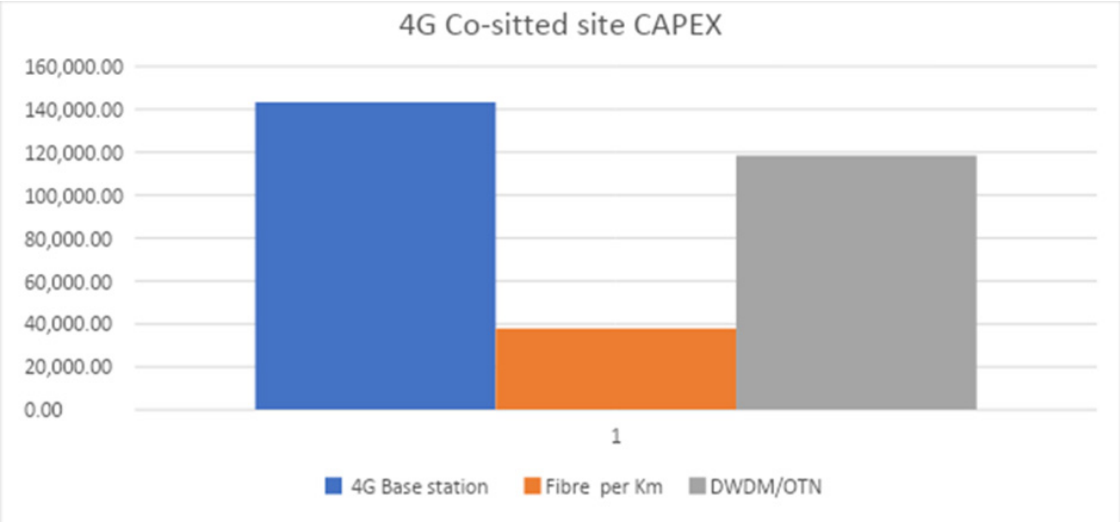
d) Cost of deploying 4G site using infrastructure sharing

Similarly, in this cost analysis, the following key assumptions were made:

- the MNO will use a tower space provided through the InfraCo initiative;
- the MNO will lease 1 km of data optical fibre to backhaul services from the proposed site;
- the MNO will deploy one DWDM to connect the new site to the data centre;
- the MNO will use the power infrastructure provided through the InfraCo initiative.

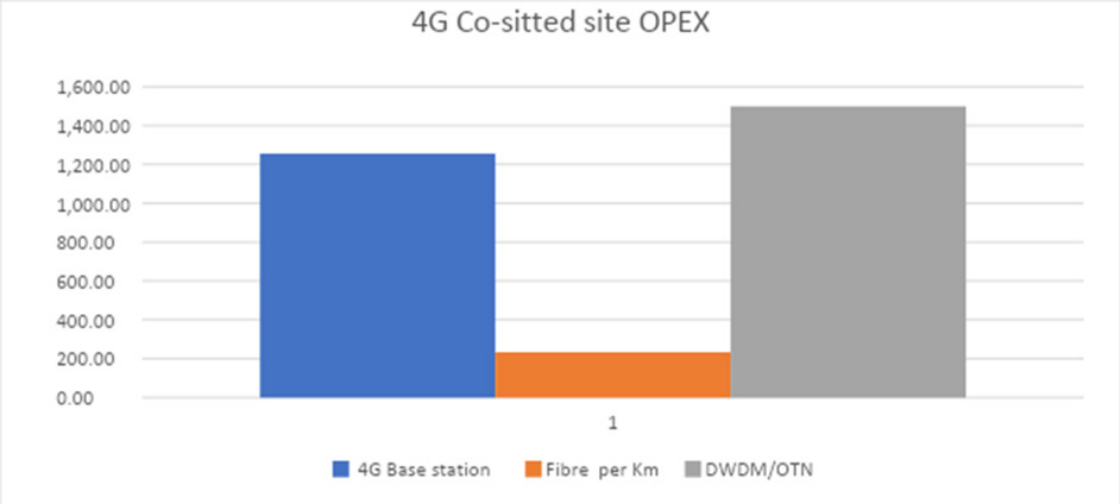
Figures 9 and 10 present the overall capex and opex required to deploy and maintain a co-located 4G site for an MNO.

Figure 9: Capex for co-located 4G site



Source: ITU

Figure 10: Opex for co-located 4G site



Source: ITU

As detailed in the data provided above and Table 13, core network elements are a huge cost component. It has also been noted that it costs more to deploy 4G network infrastructure in urban areas than in rural areas. It has further been observed that infrastructure sharing would greatly reduce both the capital and operating costs for an MNO as it costs far less to provide 4G services using an infrastructure sharing arrangement.

Table 13: Total cost of deploying a 4G site

Component	CAPEX (USD)	OPEX (USD)
Core network	27 570 342	748 469
4G in urban areas	446 425.11	9 271.04
4G in rural areas	276 721.99	6 498.57
4G co-located	299 672.12	2 989.73

3.1.9 Taxation for telecommunication companies

The following is the list of taxes for telecommunication companies in Nigeria. This is one of the major contributors to operational expenditure for telecommunication companies in Nigeria.[19]

The taxation rates presented in this section were accurate as of 2022, based on the most reliable data available at the time of compilation. However, tax policies are subject to periodic revisions influenced by economic, regulatory, and fiscal considerations. Consequently, some of the rates outlined in this report may no longer reflect the prevailing taxation framework. We kindly advise readers to refer to the relevant authorities or official sources for the most up-to-date tax rates applicable at the time of reference.

a) Corporate income tax

Corporate income tax is imposed on company profits from all sources. The rate of tax is 30 per cent of the total profit of a company.

b) Value added tax (VAT)

Value added tax is governed by the Value Added Tax Act. VAT is a consumer tax paid when goods are purchased, and services rendered. VAT is charged at a rate of 5 per cent.

c) Capital gains tax

Capital gains tax is governed by the Capital Gains Tax Act and is charged at a flat rate of 10 per cent of chargeable gains.

d) Tertiary Education Trust Fund

The Tertiary Education Trust Fund is imposed on all companies registered in Nigeria. The rate of the tax is 2 per cent of assessable profit. The due date for filing returns is the same as that of companies income tax and petroleum profits tax. The fund supports rehabilitation, restoration, and consolidation of tertiary education in Nigeria.

e) Stamp duties

Stamp duties are governed by the Stamp Duties Act. It is administered on written documents only. A Commissioner of Stamp Duties adjudicates the amount of duty payable on an instrument. Adjudication is the process of determining the correct amount of duty payable on an instrument.

f) National Information Technology Development Levy (NITDL)

The levy is governed by the National Information Technology Development Agency Act and is charged at the rate of 1 per cent of profit before tax. Among others, companies liable to pay the levy are:

- GSM service providers and all telecommunication companies;
- cyber companies and Internet providers.

The due date for filing return and payment of the levy is the same as the companies income tax.

[19] https://www.firs.gov.ng/wp-content/uploads/2020/11/TAX-TYPES-AND-RATES.pdf

g) Nigerian Police Trust Fund

This tax is applied in line with Nigeria Police Trust Fund Act of 2019. The Act imposes a levy of 0.005 per cent on the operating business in Nigeria based on profit before tax.

h) Customs duties

The import duties on telecommunication equipment are calculated as a percentage of the CFI value (a summation of the cost of equipment, freight, and insurance). Each type of equipment has a unique percentage of import duties allocated usually (5% to 35%) and VAT of 7.5 per cent.

i) Other taxes

These are paid by telecommunication companies that are not regulated by a fixed percentage of profit include;

- tenement rates/ land use charge;
- employee compensation scheme;
- National Housing Fund;
- signage fees;
- business premises registration fees;
- town planning and building permits;
- infrastructure maintenance charges;
- aviation clearance permit fees;
- environmental impact assessment/audit fees.

3.2 InfraCo network infrastructure

3.2.1 Tower deployment

As of December 2022, a total of 34 862 towers were recorded from co-location and infrastructure operators across Nigeria. The analysis of towers reveals that some states recorded more towers than others due to the total population and socio-economic activities. The highest number of towers was recorded in Lagos with 5 851 towers and the lowest number of towers were recorded in Zamfara State with 283 towers. Out of 34 862 towers recorded, IHS Nigeria Limited manages 16 853 towers[20] and American Tower Corporation (ATC) manages 7 563, Globacom Limited manages 8 742, Emerging Telecommunications Markets Services manages 192 towers, Airtel Networks Limited manages 61 towers, Alliance Towers Limited manages 46 towers, Eastcastle Infrastructure Limited manages 76 towers, MTN Communications Nigeria PLC manages 565 towers, PAN African Tower Limited manages 763 towers and Merit Telecoms Limited manages 1 tower.[21]

[20] IHS_Towers_Annual_Report_2021
[21] https://ncc.gov.ng/accessible/documents/1095-2022-year-end-performance-report/file

Table 14: Co-location operators and number of towers

Co-location operator	Number of towers
Merit Telecoms Limited	1
Alliance Towers Limited	46
Airtel Networks Limited	61
East castle Infrastructure Limited	76
Emerging Telecommunications Markets Services	192
MTN Communications Nigeria PLC	565
PAN African Tower Limited	763
ATC Wireless Infrastructure Limited	7 563
Globacom Limited	8 742
IHS Nigeria Limited	16 853
Total	**34 862**

In order to enhance the accessibility and reliability of various sites, particularly in situations characterized by adverse weather conditions, natural disasters, or areas plagued by an erratic power grid, infrastructure development companies have implemented a crucial initiative that involves the provision of backup power solutions. Deployment of backup power ensures seamless operation of critical infrastructure, services, and facilities even when faced with challenging and unpredictable circumstances. In areas where the primary power grid is notoriously unreliable, ensuring consistent access to electricity is a significant challenge. Infrastructure development companies recognize that reliable backup power sources are necessary to close this gap, and they use a range of backup power solutions to achieve these goals, including diesel generators, solar power, and battery systems. Hybrid approaches that combine these technologies are also utilized to maximize efficiency and reduce operational costs. This effort is crucial for preventing service outages and maintaining connectivity. Infrastructure development company commitments to providing backup power solutions reflects their dedication to maintaining the functionality of vital infrastructure and services under adverse conditions. These efforts are not only about improving availability but also about ensuring the resilience and reliability of critical ICT/telecommunication services in the face of unforeseen events and unreliable power grids.

While diesel generators are essential for providing backup power, running them for extended periods can lead to increased operational costs due to factors such as fuel consumption, frequent maintenance, environmental compliance, fuel logistics, depreciation, and efficiency losses.

For example, IHS Nigeria Limited invested in hybrid power solutions that combine diesel generators with solar and/or battery systems in more than 9 000 sites. Table 15 shows the number of towers managed, number of generators, and annual expenses on diesel.

Table 15: Number of towers and generators owned by infrastructure companies

InfraCo	Number of towers managed	Number of generators	Annual expenses on diesel (USD)
IHS	16 700	16 000	48 695 652.17
ATC	7 400	6 000	18 260 869.57
INT Towers Limited	16 330	16 300	49 608 695.65
IHS Towers NG Limited (Nigeria)	969	9 000	27 391 304
Total	**41 399**		

3.2.2 Tower deployment costs

It has been noted that the cost of deploying lattice towers is expensive particularly due to civil works. Taller lattice towers are more expensive to deploy. Table 16 shows the cost of procuring and deploying 30 m, 40 m and 50 m lattice towers.

Table 16: Tower deployment costs

Tower deployment costs					
Tower height	Purchase price per tower (USD)	Cost of tower construction (USD)	Operation and maintenance per year (5% of purchase price)	Taxation (import tax, 5.5% of purchase price)	Total cost of ownership for 1 year (USD)
30 m	14 089	20 000	704.45	774.90	35 568
40 m	15 724	23 000	786.20	864.82	40 375
50 m	21 207	26 000	1 060.35	1 166.39	49 434

3.2.3 InfraCo model cost structure

Table 16 shows an InfraCo model cost structure where the following key assumptions were made:

- the InfraCo will procure 20 m x 20 m land in the rural area where the tower will be constructed;
- the InfraCo will deploy a 30 m tower;
- the InfraCo will deploy 1 km of overhead fibre;
- the InfraCo will provide power from grid as well as backup power.

Table 17: InfraCo deployment costs

Item	CAPEX USD (unit cost)	OPEX USD (unit cost)
Land acquisition in urban area (20M*20M)	32 000.00	
30 Metre tower deployment	34 863.90	1 743.19
Overhead optical fibre per km	37 792.23	233.73
Hybrid back up power per site (solar and batteries)	38 335.89	1 916.79
Diesel generator procurement per site	15 659.96	254.00
NEMSA (Nigeria Electricity Management Service Agency)	1 118.00	
PHCN (Power holding corporation of Nigeria)	559.00	
MRC for electricity		1 458.33

As noted above, a major cost contributor of both capital operational expenditure is the backup power followed by the optical fibre itself and the tower deployment.

3.3 ISP network infrastructure

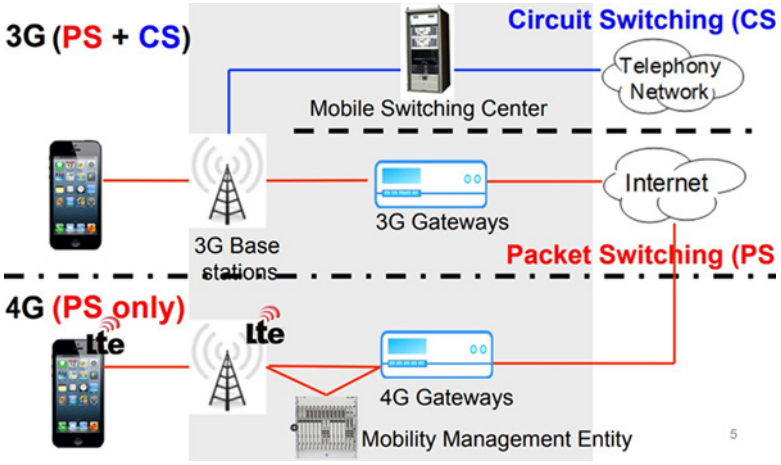
ISPs use different technologies to connect base stations located at customer premises to the data centre. Nigeria has over 127 licensed ISPs.[22]

a) Internet connection using mobile broadband

Apart from MNOs, some ISPs, such as Smile Communications, use LTE technology to provide Internet access. 3G, 4G and 5G technologies are used as access links and customers use any Internet enabled device to connect to the mobile broadband network. In some cases, broadband routers are used to connect to the nearest 3G or 4G/5G base station and broadband routers connect to Internet enabled end user devices. Mobile broadband connectivity is ideal for customers that are within the coverage area of 3G/4G/5G base stations. Figure 11 shows Internet connectivity using mobile broadband.

[22] https://ncc.gov.ng/accessible/documents/1095-2022-year-end-performance-report/file

Figure 11: Mobile broadband network



Source: ITU

Advantages of connecting to the Internet using mobile broadband

Portability: Mobile broadband connectivity enables the end user to access an Internet connection from anywhere as long as there is a signal and a SIM card that enables access to a network.

Ease of connectivity: A great advantage of connecting via mobile broadband is the ability to access the Internet on various devices. A SIM card gives access to the Internet on devices such as tablets, smartphones, or laptops using Wi-Fi. Mobile broadband connectivity allows multiple users to access the Internet simultaneously, so it is cost-friendly compared to fixed line broadband connections.

Disadvantages of using mobile broadband Internet

Cost: Mobile broadband is often more expensive than the other forms of broadband.

Speed: Although a mobile broadband connection possesses high speed capability, it cannot always be guaranteed as it depends on the availability of wireless resources and the number of users connected.

b) Internet connectivity using optical fibre

Optical fibre is widely acknowledged as the gold standard for Internet connections due to its ability to transmit data at extremely high speeds and over long distances. It offers low latency, high bandwidth, and exceptional reliability. When available, fibre-optic infrastructure delivers a superior online experience, supporting activities such as streaming, online gaming, video conferencing, and large data transfers seamlessly. Optical fibre is deployed in various ways, either overhead or underground, depending on the terrain and local conditions. Overhead deployment typically involves attaching fibre-optic cables to utility poles or existing structures, while underground deployment involves burying the cables in conduits or trenches. The choice of deployment method depends on factors such as terrain, existing infrastructure, and local regulations. Deploying optical fibre in Nigeria, as in many other African countries, comes with its set of challenges.

While optical fibre provides the best Internet connections, the deployment of fibre-optic networks in Nigeria is challenging and expensive. Overcoming these challenges requires

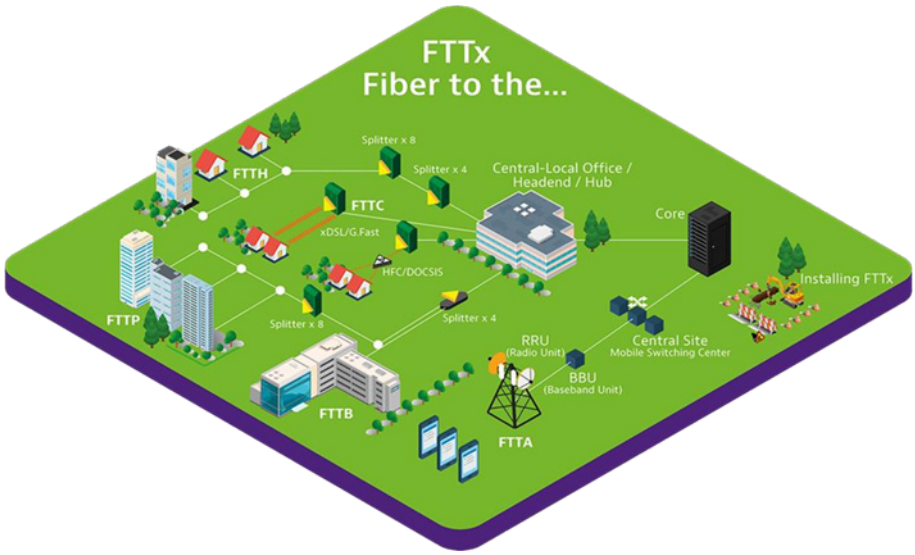
collaboration between governments, private sector entities, and regulatory bodies to facilitate the expansion of this critical digital infrastructure, ultimately benefiting the nation's socio-economic development.

By December 2022, a substantial 77 235.5 kilometres of optical fibre, encompassing both terrestrial and submarine installations, had been deployed in Nigeria. This extensive network of optical fibre is fundamental to modern telecommunications, it enables high-speed data transmission and Internet connectivity across diverse regions. Terrestrial fibre-optic cables and network infrastructure are deployed on the surface or buried underground, while submarine networks are laid beneath the ocean or large bodies of water to facilitate international and long-distance communication. Of the total fibre-optic network, 49 367.2 kilometres were terrestrial, connecting urban and rural areas, supporting domestic communication, and providing high-speed Internet access to various communities.[23]

Among the entities involved in this extensive fibre-optic network, MTN stood out as a major player in both on-land and submarine deployments. As of December 2022, MTN had the largest share of terrestrial fibre-optic deployment, totalling an impressive 14 612 kilometres. This vast network enables MTN to deliver robust telecommunication services and high-speed Internet connectivity to many regions. MTN also has a significant 17 984 kilometres of submarine fibre-optic networks that enables international connectivity and intercontinental data transmission. It plays a critical role in supporting global communication and data exchange, particularly for regions separated by large bodies of water.[24]

Figure 12 illustrates a network model where customers are connected to the Internet using optical fibre.

Figure 12: Fibre-optic fixed broadband[25]



Source: ITU

[23] Akhalumeh, P. & Ohiokha, F., 2013. The Place of Physical Infrastructure in Realizing Nigeria's Vision 20:2020. International Journal of Management and Sustainability, 2(7), pp. 127-137

[24] https://ncc.gov.ng/accessible/documents/1095-2022-year-end-performance-report/file

[25] https://orhanergun.net/broadband-network

FTTX deployments

Fibre to the home/building (FTTH) subscriptions represent a significant milestone in the advancement of high-speed Internet access. FTTH technology involves the direct deployment of fibre-optic cables to residential or commercial properties, ensuring ultra-fast and reliable Internet connectivity for end-users. As of December 2022, several key operators, namely ipNX, MTN, and 21st Century, were actively involved in FTTH deployments. ipNX, a prominent player in the telecommunication industry, has installed an impressive 18 925 kilometres of FTTH infrastructure. This substantial network of fibre-optic cables has brought high-speed Internet directly to homes and buildings, contributing to improved digital experiences for people and business. The significant length of FTTH deployment by ipNX highlights their commitment to providing state-of-the-art connectivity solutions to their customers. MTN, a major telecommunication conglomerate, has also played a notable role in the FTTH segment. By the end of December 2022, MTN had deployed 5 415 kilometres of FTTH infrastructure. This deployment reflects MTN dedication to expanding its services beyond traditional mobile networks and bringing ultra-fast Internet directly to households and businesses, thereby enriching the digital ecosystem. 21st Century, another telecommunication operator, has also made a significant impact by deploying 303 kilometres of FTTH infrastructure. While the length of their deployment may be relatively modest in comparison to the larger players, it is important to recognize that every step toward expanding FTTH coverage contributes to the broader goal of delivering high-quality, direct-to-premises Internet access.

The cumulative efforts of ipNX, MTN, and 21st Century has resulted in a total of 24 643 kilometres of FTTH infrastructure.[26] This comprehensive network covers a considerable geographical area, connecting a multitude of homes and buildings to ultra-fast Internet services, and fostering digital inclusion. As the demand for high-speed Internet connectivity continues to grow, the expansion of FTTH networks is expected to continue. Operators are likely to focus on increasing coverage, enhancing service quality, and exploring innovative technologies to meet the evolving digital needs of consumers.

3.3.1 ISP model cost structure

When coming up with a model for deploying an ISP, a segmented approach was considered where two components were analysed with corresponding assumptions. The components were cost of deploying ISP core network and cost of connecting broadband Internet customer.

Cost of deploying ISP core network

In this cost analysis, the following assumptions were made:

- the ISP has an existing data centre where the core network elements will be deployed or will use a data centre provided by InfraCos;
- the ISP has an existing power infrastructure or will use power provided by InfraCos;
- the ISP will deploy one aggregate router;
- the ISP will deploy one DWDM at the data centre;
- the ISP will deploy one firewall.

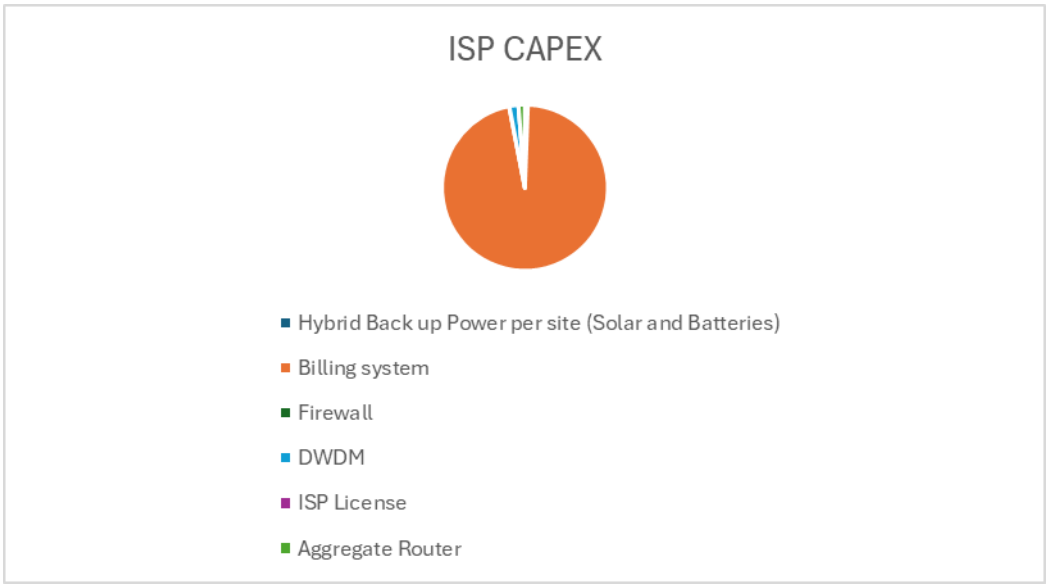
[26] https://ncc.gov.ng/accessible/documents/1095-2022-year-end-performance-report/file

Table 18 and Figures 13 and 14 show the overall capex and opex required to deploy and maintain an ISP core network.

Table 18: ISP deployment costs

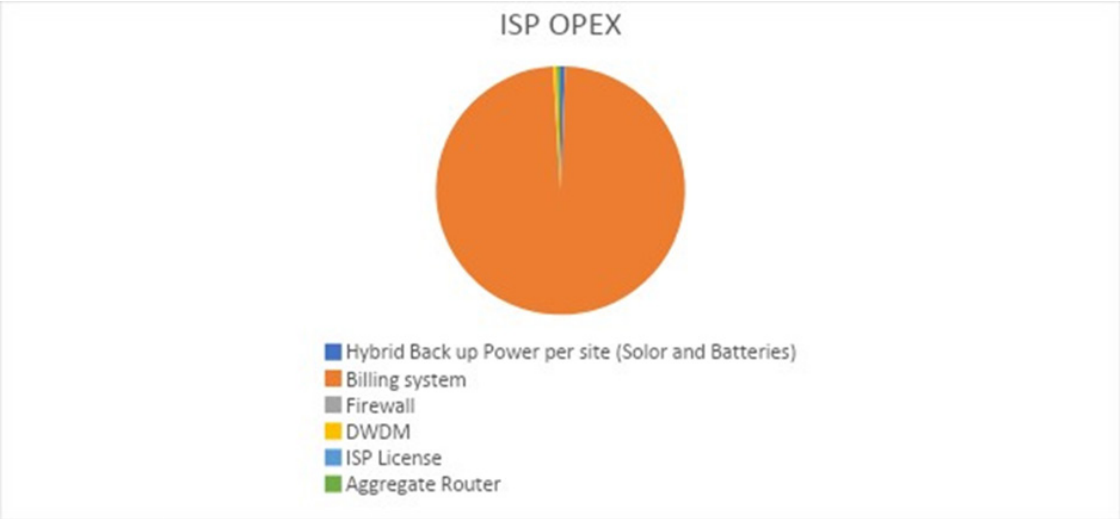
Item	CAPEX (unit cost in USD)	OPEX (unit cost in USD)
Hybrid back up power per site (solar and batteries)	38 335.89	1 916.79
Billing system	6 439 542.81	321 977.14
Firewall	2 749.57	137.48
DWDM	118 469.89	1 500.00
ISP licence	1 086.96	
Aggregate router	83 650.00	1 500.00

Figure 13: Capex for ISP model



Source: ITU

Figure 14: Opex for ISP model



Source: ITU

Cost of connecting broadband Internet customer

When analysing this segment of the ISP network cost, the following assumptions were made:

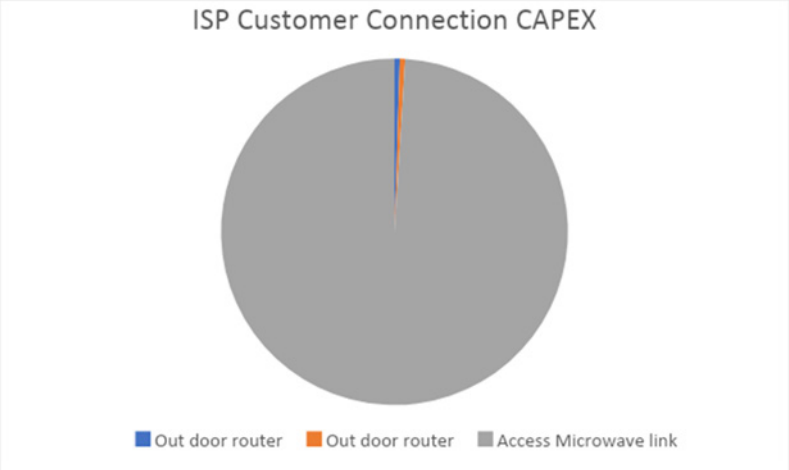
- backup power will not be required;
- one access microwave link will be deployed to connect the base station sitting at the customer premises;
- the active elements will use the customer's power.

Table 19 and Figure 15 show the overall capex and opex required to connect an Internet service customer.

Table 19: ISP cost to customer connection

Item	CAPEX (Unit cost in USD)	OPEX (Unit cost in USD)
Outdoor router	123.21	6.16
Outdoor router	123.21	6.16
Access microwave link	24 775.24	909.00

Figure 15: Capex for ISP customer connection



Source: ITU

This shows that a major contributor of both capex and opex is cost of the microwave link access.

3.4 Satellite network infrastructure

Satellite broadband deployment is a revolutionary approach to delivering high-speed Internet access to remote and underserved areas, often beyond the reach of traditional terrestrial broadband infrastructure. It leverages a network of orbiting satellites to transmit and receive data signals, offering a wide range of benefits and playing a critical role in bridging the digital divide. One of the most distinctive advantages of satellite broadband is its global reach. Regardless of geographic location, satellite broadband can provide Internet connectivity to users in urban, suburban, rural, and even isolated areas. This global coverage is particularly valuable in regions where laying physical cables or building ground-based infrastructure is impractical or cost-prohibitive. Satellite broadband serves as a solution for overcoming geographical barriers, such as mountains, deserts, oceans, and remote regions, where it may be logistically challenging to deploy terrestrial networks. It ensures that people living in these areas have access to reliable and high-speed Internet, which is essential for communication, education, healthcare, and economic opportunities. Deploying a satellite broadband network is relatively quick compared to building terrestrial infrastructure, which can take years. Once the necessary satellites are in orbit and ground stations are established, the service can be rolled out to remote areas in a matter of months. This rapid deployment is invaluable in emergency situations, disaster response, and in providing immediate connectivity in remote communities.

GlobalTT, Starlink Internet Services Limited, Link Communications and Coollink are among the authorized space segment operators in Nigeria. The Nigerian Communications Commission, pursuant to its powers under Section 2 and Section 70 (2) of the Act, developed the Commercial Satellite Communications Guidelines[27] for the telecommunication sector in Nigeria. Currently Nigeria has 85 space stations authorized by Nigerian Communications Commission[28]. The landing permit does not authorize space segment operators to provide satellite based communications services directly to last mile users but can provide services to local telecommunication operators licensed by NCC to provide services for last mile users.

[27] https://www.ncc.gov.ng/docman-main/legal-regulatory/guidelines/819-guidelines-on-commercial-satellite-communications-2018/file

[28] https://www.ncc.gov.ng/technical-regulation/space-services

Satellite network providers

Coollink is an Internet service provider and system integrator with points of presence across all thirty-six states of Nigeria. It provides high-speed and affordable Internet connection anywhere in Nigeria using satellite and very small aperture terminal (VSAT) solutions. The broadband service is beamed from satellites that provide higher data speeds than most terrestrial services such as 3G and 4G broadband. Equipment prices may vary depending on the location. The standard equipment kit, including a 74 cm satellite dish, the modem and a 1W BUC-Radio, costs USD 93.[29]

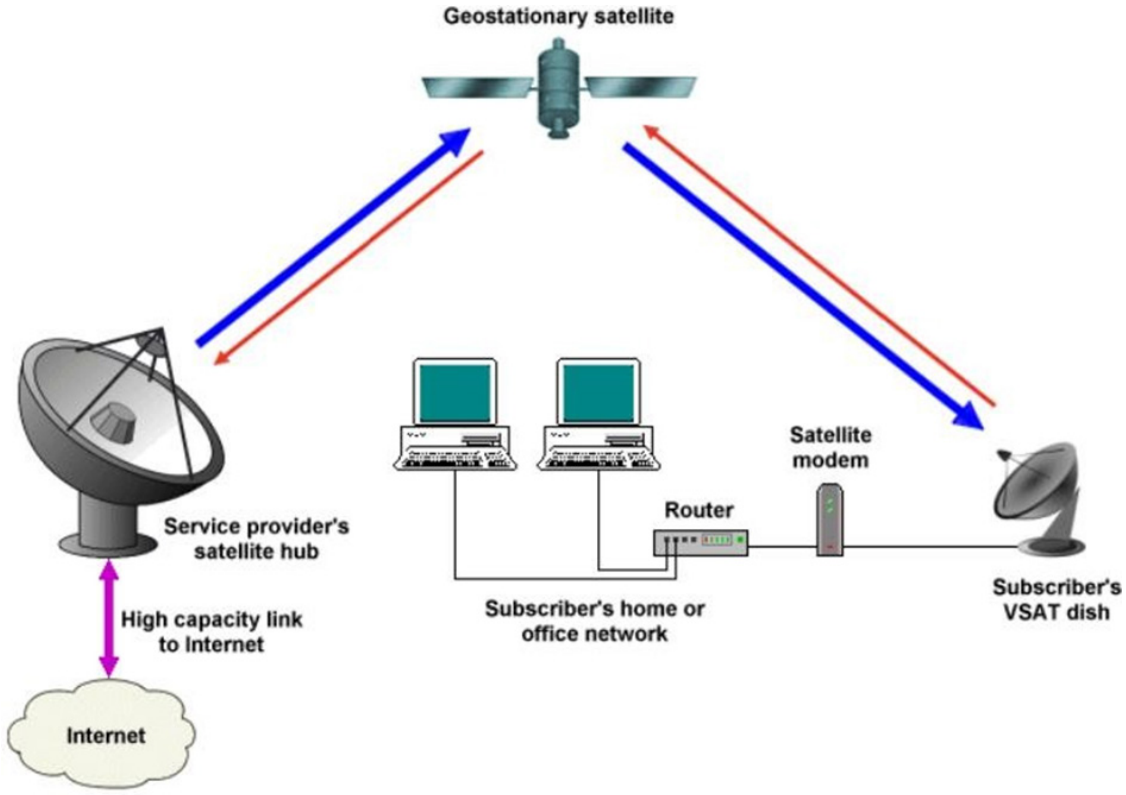
Starlink SpaceX is a fast-growing satellite Internet provider in Nigeria. In terms of connectivity costs, Starlink charges a one-off fee of USD 659 and a monthly charge of USD 99. Starlink provides high-speed, low-latency broadband Internet across the globe. Using advanced satellites in a low orbit, Starlink enables video calls, online gaming, streaming, and other high data rate activities that have not historically been possible with satellite Internet. The advertised download speeds are between 100 Mbit/s and 200 Mbit/s and latency is claimed to be 20 ms in most locations.[30]

Link communications systems (LCS) business VSAT services delivers full and unlimited Internet access over satellite connection to any place in the world. LCS business VSAT services support data, voice, and video applications. This modern satellite Internet access is designed to keep users connected to the Internet backbone through LCS teleports. LCS business VSAT service works through a small VSAT terminal and a modem that serves as a satellite router. Through this setup, end users can connect to a geosynchronous satellite and on to the teleport for Tier-1 Internet backbone connections.

Global TT is a Belgian communications company that offers satellite Internet access for both business and individual users. With coverage provided by T11n, T12v, NSS-12, Arabsat 5C, AzerKosmos 1 and the Yahsat AY satellite stations, the company offers Internet services almost anywhere in Africa, Europe, and the Middle East.

29 https://www.coollink.ng/konnect-nigeria/unlimited40/
30 https://isp.today/en/list-of-all-services/NIGERIA,toic-5

Figure 16: Satellite fixed broadband



Source: ITU

Advantages of connecting unserved areas using satellite:

- it is suitable for rural or remote areas that cannot fulfil cabling requirements;
- satellite Internet offers negligible Internet outages thus providing better connectivity;
- it is available everywhere because satellite broadband does not rely on cables for backhauling traffic.

Disadvantages of connecting unserved areas using satellite:

- satellite connection is always more expensive for the same speed, compared to other fixed broadband access technologies;
- satellite Internet can be slower;
- it is less reliable than cable or fibre-optic Internet.

3.4.1 Satellite broadband cost analysis

Table 20: Satellite broadband costs

Cost of deploying satellite broadband[31]					
Cost of equipment (USD)	Monthly recurring charges (USD)	Bandwidth	ISP licence for 5 years (USD)	Taxation (import tax, 5% of CFI)	Total cost of ownership for 1 year (USD)
659.00	99.00	200 Mbit/s	1 086.961[32]	36.245	1 881.20

3.4.2 Satellite broadband model cost structure

Table 21 shows the overall capex and opex required to deploy a satellite broadband service and that the major contributors of capital expenditure are the cost of VSAT and the ISP licence.

Table 21: Costs for model satellite ISP

Item	CAPEX (unit cost in USD)	OPEX (unit cost in USD)
Cost of VSAT	695.25	99.00
ISP licence in 5 years	1 102.34	0
Indoor router	123.21	0

3.4.3 Power Infrastructure analysis

According to the World Bank Group, just over 60 per cent of the Nigeria population had access to electricity in 2022, with access in the urban population rising to 89 per cent, and access in the rural population at 27 per cent. In 2020, 77 per cent of Nigeria's electricity generation was derived from gas. Hydroelectric power is ranked second, accounting for about 21 per cent of Nigeria's power production. Nearly 36 400 gigawatt hours of electricity were generated in Nigeria in 2021. According to feedback received from one of the mobile operators, the availability of electrical power from the main grid per year, and depending on the location in the country, is not more than 40 per cent. Due to the instability of electricity power from the grid, telecommunication operators are forced to operate their equipment on backup power, which has a cost implication. The longer the hours the operator uses backup power, such as a diesel generator, the higher the cost of operation. Figure 17 illustrates the volume of electricity by source in Nigeria. [33]

[31] https://electronicsdesk.com/satellite-internet.html
[32] https://www.ncc.gov.ng/licensing-regulation/licensing/fees-pricing#individual-license
[33] https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=NG ; https://www.worlddata.info/africa/nigeria/energy-consumption.php ; https://www.usaid.gov/powerafrica/nigeria

Figure 17: Generated power capacity

Source: ITU

3.4.4 Electricity cost analysis

The current state of the electricity supply in Nigeria remains a challenge, especially in light of the increasing electricity demand from the growing population. The production of electricity falls significantly short of demand due to various industry challenges, including a lack of diversified energy sources, financial constraints, and regulatory issues across the entire value chain. Despite some improvements, a considerable number of households remain without access to the national grid, and those connected often experience unreliable service. Table 22 shows the cost of electricity from the national electricity grid.

Table 22: Electricity cost

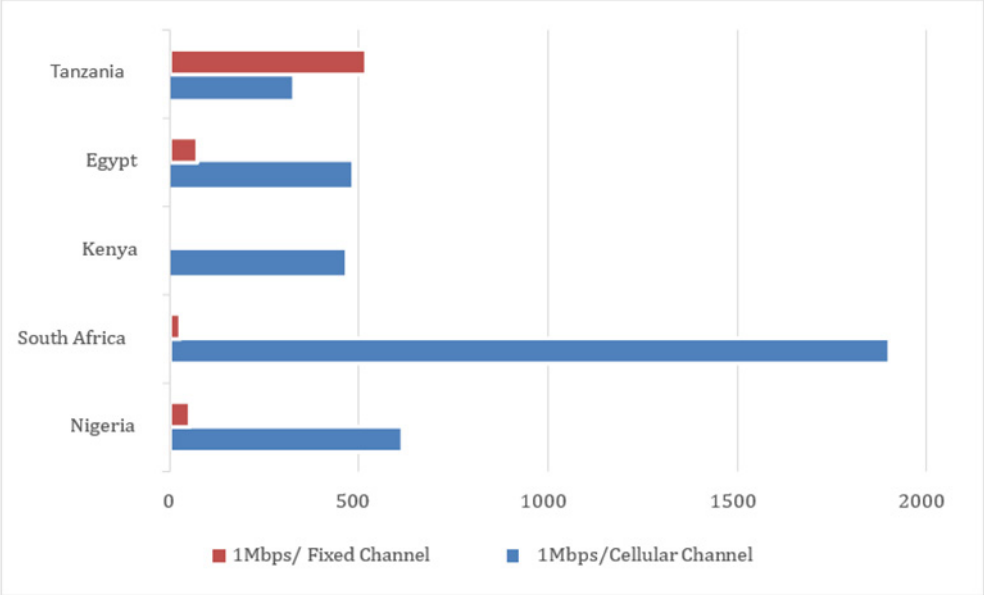
Cost of electricity from the grid[34]	
Item	Cost (USD)
NEMSA (Nigeria Electricity Management Service Agency	1 118
NERC (Nigerian Electricity Regulations Commission)	559
MRC	1 458

3.5 Internet services costs

The annual rent of 1 Mbit/s VSAT channel costs 574.25 USD in Nigeria, 720.84 USD in Egypt, and 618.95 USD in Kenya, 606.39 USD in Tanzania and in South Africa it costs 606.39 USD. Figure 18 shows the annual rent cost for a 1 Mbit/s cellular channel and a 1 Mbit/s fixed channel to the Internet.

[34] Cost of Electricity from Grid

Figure 18: Internet services costs: annual rent



Source: ITU

3.6 Broadband coverage

According to data from one mobile network operator, Nigeria still uses a blend of 3G and 4G technologies to provide mobile broadband services and 2G technology is still prevalent in all states. 4G network coverage is widely available in some states including Lagos, Federal Capital Territory followed by Rivers, Oyo, Ogun, and Kano, while other states such as Katsina, Niger, Borno and Nasarawa predominantly rely on 3G technology to access mobile broadband services.

4. Regulatory framework affecting capex and opex of telecommunication infrastructure

The policy and regulatory framework governing Internet connectivity in any country plays a crucial role in enabling and promoting the deployment of new services, particularly in unserved and underserved communities. However, regulatory barriers can also pose challenges to infrastructure expansion. The cost of building, operating, and maintaining telecommunication networks is significantly influenced by these policies, highlighting the importance of a well-structured regulatory approach.

In this regard, the Guidelines on Technical Specifications for the Deployment of Infrastructure in the Nigerian Communications Sector 2023[35], issued by the Nigerian Communications Commission (NCC), introduce key updates that impact the sector. These Guidelines establish standardized technical specifications to ensure uniform requirements for deploying telecommunications infrastructure, thereby enhancing network resilience and interoperability. They also provide clear provisions on Right-of-Way (RoW), outlining procedures and cost structures for obtaining permits to lay fibre-optic cables and other critical network components. Additionally, the Guidelines set out environmental and safety standards to promote sustainable infrastructure deployment in compliance with environmental regulations and public safety considerations. Furthermore, they encourage infrastructure sharing and co-location among service providers, which optimizes costs and expands network reach.

Key components of the policy and regulatory framework include:

- infrastructure sharing framework;
- taxation regime;
- universal service provision fund;
- frequency spectrum pricing;
- quality of service framework;
- Nigerian Communications Act, 2003;
- National ICT policy;
- licensing framework;
- competition practices framework;
- Internet governance.

In line with the main objective of the project, the analysis below focuses on those policy areas directly affecting cost of telecommunication infrastructure (supply-side), specifically: infrastructure sharing framework, taxation regime, universal access and universal service framework, accelerated mobile phone expansion, rural broadband infrastructure initiative, and spectrum pricing regulations.

Infrastructure sharing framework

Infrastructure sharing plays a vital role in expanding affordable connectivity by enabling multiple operators to utilize existing network assets under specific conditions. This approach fosters competition, broadens consumer options, and allows operators to extend their networks without incurring the full cost of developing independent backhaul infrastructure.

[35] https://www.ncc.gov.ng/media/1014/view

In recognition of its importance, the Nigerian Communications Commission (NCC) strengthened the regulatory framework for infrastructure sharing through amendments to the Guidelines on Colocation and Infrastructure Sharing in 2021. These revisions introduced provisions for active infrastructure sharing, reinforcing a policy environment that supports efficient resource utilization and network expansion. Notably, this advancement aligned with national broadband development goals and was achieved ahead of the expected implementation timeline.

Among other functions stipulated under section 4(o), of Nigerian Communications Act, 2003,[36] NCC shall encourage, promote and provide regulatory guidelines for infrastructure sharing amongst licensees. This policy reduces costs. The principal objective of the NCC guidelines on co-location and infrastructure sharing[37] is to establish a framework within which access providers and access seekers can negotiate co-location and infrastructure sharing arrangements:

- to minimize capex on supporting infrastructure and to free more funds for investment in core network equipment;
- ensure that the incidence of unnecessary duplication of infrastructure is minimized or completely avoided;
- promote fair competition through equal access being granted to the installations and facilities of operators on mutually agreed terms;
- ensure that the economic advantages derived from the sharing of facilities are harnessed for the overall benefit of all telecommunication sector stakeholders;
- encourage access providers and access seekers to pursue a cost-oriented policy with the added effect of a reduction in the tariffs chargeable to consumers;
- protect the environment by reducing the proliferation of infrastructure and facilities installations.

Furthermore, NCC recognizes the importance of adhering to the infrastructure sharing principles captured in section 3(1) of the Guidelines on Technical Specifications for the Installation of Telecommunications Masts and Towers of 2009: "The siting of masts and towers shall take cognizance of provisions of the Act and be guided by provisions of the Collocation and Infrastructure Sharing Guidelines of the Commission in such a way as to minimise their number, protect and promote public safety, and mitigate adverse visual impacts on the community. To reduce the visual impact of towers and structure, Stealth and/or camouflage design of towers and antennas are encouraged."

Similarly, the Nigerian national broadband plan mandates different government agencies to promote FTTx (x=[b]uilding, [c]urb, [t]ower and [h]ome) network infrastructure sharing as a last mile solution with a 'dig-once' policy. This is the most effective and future proof last-mile approach and, in combination with wireless configurations (indoors), leads to quality of service and class of service improvements to customer experience. To facilitate the efficient use of spectrum and accelerate multi-operator coverage presence, the plan also obliges NCC, Federal Ministry of Communications and Digital Economy, and other government agencies to implement the regulatory framework on active infrastructure sharing and to ensure that infrastructure deployment is not slowed or impeded.

[36] https://ncc.gov.ng/documents/128-nigerian-communications-act-2003/file
[37] https://www.ncc.gov.ng/docman-main/legal-regulatory/guidelines/992-guidelines-on-collocation-and-infrastructure-sharing-2021/file

In the same vein, Section 14(1) of the Telecommunications Networks Interconnection Regulations[38] affirms the NCC commitment to ensure that infrastructure sharing and co-location is enforced: "Where a licensed telecommunications operator has the right to install facilities on, over or under a private land or take advantage of a procedure for the expropriation or use of property, the Commission shall encourage the sharing of such facilities and property with other licensed telecommunications operators, in particular, where other licensed telecommunications operators do not have access to viable alternatives."

NCC also conducted a study to assess the current level of competition in the co-location and infrastructure sharing segment of the Nigeria telecommunication sector. Seventy-eight licensees are currently operating in that market segment. The study aimed at enabling NCC to have insightful and evidence-based facts to understand the dynamics at play and ensure the continuous growth of the co-location and infrastructure sharing segment of the telecommunication market. This is a priority for NCC, given the critical role played by this segment of the telecommunication ecosystem in ensuring robust services.[39]

Taxation regime: According to a research paper published on the NCC website, there are over forty different taxes and levies that telecommunication companies remit to different state and local government agencies.[40]

Like all other incorporated entities in Nigeria at the federal level, telecommunication companies are required to pay taxes such as the companies income tax, the capital gains tax, withholding taxes, stamp duty, National Industrial Training Fund, Employees Compensation Scheme, the Tertiary Education Trust Fund, National Housing Fund contributions, contributory pension schemes, and customs duties.

According to the SB Morgen report "Inside Nigeria's Subnational Fiscal Crisis", besides the common taxes, there are also telecommunication sector-specific taxes and levies such as the annual operating levy paid to NCC by all telecommunication licensees, the National Cybersecurity Fund, the National Information Technology Development Fund (NITDF) levy and right of way charges. The report cites Kogi State, where telecommunication companies are made to pay up to 41 levies by the state government, which includes levies such as annual right of way renewals, social services contribution, employee economic development levy, mast site premises renewal, fire service yearly renewal, payment of environmental levy, failure to submit an environmental impact assessment report, failure to register industry, failure to submit environmental audit report every two years, storage of petroleum products and radioactive materials without written permission from the Kogi State Environmental Protection Board, failure to comply with setbacks to roads, power lines, and rivers/streams, and dumping of toxic or hazardous substances or harmful waste without Kogi State Environmental Protection Board approval.

Notwithstanding the wide range of taxes, another issue concerns the right of way along certain infrastructure, with both state and federal governments often insisting on collection of these charges, which continues to create problems for telecommunication companies. The National Economic Council right of way guideline, developed in 2013, set NGN 145 as a right of way charge per metre for laying fibre-optic network in Nigeria. However, some states arbitrarily

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38 https://www.ncc.gov.ng/docman-main/legal-regulatory/regulations/329-regulations-for-telecommunications- networks-interconnection-2/file

39 https://sciencenigeria.com/ncc-moves-to-strengthen-colocation-infrastructure-sharing-market-segment/

40 Compendium on Taxes, Levies and Fees by State Governments on Telecoms Operators in Nigeria and its Effect on The National Digital Economy Agenda

set their own charge, departing from the agreed fee charge. For instance, according to data sourced from NCC, Osun state has the highest right of way charge of NGN 6 850 per linear metre followed by Lagos state with NGN 6 263, Ogun state NGN 5 351, Kwara state, among others, charge telecommunication operators NGN 5 500 per linear metre.

In addition to all these taxes, levies, and fees, the Federal Government of Nigeria announced plans to implement a 5 per cent excise duty tax on telecommunication services such as calls, SMS, and Internet services, which was later suspended by the Federal Government. When making the announcement of the suspension, the Minister of Communications and Digital Economy, acknowledged that the telecommunication industry is already overburdened by excessive and multiple taxations, which would likely adversely affect the sector if the government failed to take any precaution.[41]

A clear impact of such a taxation regime, which could yield unintended outcomes such as multiplicity of taxes to telecommunication companies, is the degradation of network quality. As reported in the SB Morgen report, this mostly occurs when state authorities, in a bid to enforce compliance in payment of taxes, lock up or deny them access to critical facilities of telecommunication operators for refuelling, maintenance or fault resolution. This leads to congestion and other deficiencies of service quality. For example, telecommunication operators in Kogi State issued a warning[42] that in a bid to force operators to pay more taxes and levies, the shutting down of several critical telecommunication sites by the state government through its internal revenue service agency could lead to a communications blackout in as many as eleven states. However, the national ICT policy reflects the urgent need to address the occurrence of multiple regulation and taxation, where players in the ICT sector are subjected to various rules, regulations, and taxes, for the same aspect of a service provider operation by different tiers and agencies of government (federal, state and local). This tends to discourage investors, threaten investments and potentially deprive the sector of the necessary funding for ICT improvement and expansion.

Universal access and universal service framework: The universal service fund (USF) and similar subsidy programmes can help improve the availability and affordability of broadband for both unserved and underserved areas. Historically focused on basic telephony services in remote areas, USFs are today being adapted to promote the adoption of broadband, by subsidizing content, devices, services, and digital training, as well as infrastructure development. In many cases, USFs can kick-start the market, encourage network operators to expand their reach and provide connectivity to unserved areas.

In the context of Nigeria, section 114 of the Nigerian Communication Act, 2003, established a universal service provision fund (USPF) to help promote the widespread availability and usage of network services and application services throughout Nigeria by encouraging the installation of those services to institutions in unserved, underserved areas, or for underserved groups within the community as stipulated under Section 112 of the Act. In addition, Section 115 of the Act established the Universal Service Provision Board, which is mandated to supervise the management and utilization of the USPF and to provide broad policy direction.

Similarly, the Universal Access and Universal Service Regulations, 2007, were drafted to provide a framework for the design and implementation of a system of universal access and universal

41 https://leadership.ng/federal-govt-bows-to-pressure-suspends-proposed-5-tax-on-telecom-services/
42 https://guardian.ng/technology/telecoms-blackout-imminent-in-abuja-nine-states-as-kogi-state-shuts-sites/

service provision pursuant to the relevant sections of the Nigerian Communications Act, 2003. Part I, Section (2) of the 2007 regulations states that "The ultimate objectives of the system of universal access and universal service provision described in sub-paragraph (1) of the regulation are to:

- Promote greater social equity and inclusion for the people of Nigeria; and
- Contribute to national economic, social, and cultural development of Nigeria."

The regulations further provide the methodology and economic criteria to be used for selecting the types of projects that are eligible to receive financing from the USPF. Commercially unprofitable projects are eligible to receive financing from the USPF and are a primary focus of the USP Board. Commercially profitable projects are also eligible to receive financing from the USPF however these projects shall only receive financing where the USP Board determines that there are strong social, economic, or other strategic development reasons for undertaking such projects.[43]

Among other sources, contributions to the USPF comprises:

- monies appropriated by the National Assembly;
- contributions from annual levies from licensees;
- gifts, loans, aids, and such other assets that may from time to time specifically accrue to the USPF.[44]

Telecommunication operators in Nigeria are mandated to contribute 2.5 per cent of net operating revenue to NCC. When the USPF was established, it received a 40 per cent share of the annual operating fees assessed by NCC on operators. The funding comes from NCC, and the fund is appropriated by the National Assembly.[45] The Nigerian USPF funding model is well aligned with most USFs as they are typically funded through some form of contribution mechanism from telecommunication service providers/operators. In most cases, the operator contributions are in the form of a levy based on a percentage of annual operating revenues. In some countries, the USF fee is not a separate fee, but a portion of an overall annual regulatory fee. In addition to operator levies, there are frequently other sources of funds including but not limited to, licensing fees, full or partial proceeds from spectrum auctions, direct contributions from government budgets, contributions from international agencies such as the World Bank and regional development banks.

Since its inception, USPF has rolled out several initiatives including one which is more relevant to the project under the banner of the connectivity programme. The connectivity programme comprises telecommunication infrastructure projects that are implemented through a public private partnership (PPP) model. They are subsidized by the USPF but implemented, owned, and operated by operators and service providers. They provide the platform on which the access projects thrive.[46] As one of its guiding principles, the USPF makes it obligatory for operators/service providers to share all infrastructure supported by the USPF with other operators/service providers at reasonable prices, in line with the USPF guiding principles of accessibility, affordability and availability. The USPF gives priority to programmes and projects that are self-sustaining, and which do not require subsidies on a continuous basis and enforces compliance with quality-of-service standards with respect to all projects. Under this initiative,

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43 UA/AS Regulations Section 46(d)(iii)
44 Section 114 of Nigerian Communications Act, 2003
45 USF Report
46 https://www.uspf.gov.ng/programmes/connectivity

there are some notable individual programmes as outlined below with distinctive objectives aimed at partially or wholly meeting the supply side cost for the telecommunication services provision.

Accelerated mobile phone expansion: The objective of this programme is to subsidize the deployment of base transceiver stations (BTS) and other passive infrastructure in underserved and unserved communities in Nigeria to achieve 100 per cent coverage of local government areas in Nigeria. This infrastructure is expected to support the extension of voice services to unserved and underserved areas.[47] The project is implemented through subsidies that are determined and awarded through a competitive bidding process through which operators compete for the available subsidies to deploy and operate the stations.

Rural broadband infrastructure initiative: The Rural Broadband Initiative (RUBI) project[48] aims to address the lack of a robust and resilient communications infrastructure in urban and rural areas of Nigeria by providing sustainable wireless broadband networks in underserved or unserved areas that will enable fast and reliable Internet services for commercial, residential, educational, government, healthcare and other agencies and groups.[49]

Spectrum pricing regulations: A primary goal of spectrum pricing regulations is to assign this scarce and valuable resource to those who will use it more efficiently to deliver the maximum benefit to society. A well- designed auction by government will assign spectrum at a market-determined price to operators that value it most, thus incentivising them to use it efficiently through investment in widespread, high-quality mobile networks.[50]

As provided under Section 123 of the *Nigerian Communications Act, 2003*, the Nigerian Communications Commission (NCC) developed the *Frequency Spectrum (Fees and Pricing, etc.) Regulations 2004*[51] to guide the management and pricing of spectrum resources. These Regulations are designed to support the government's telecommunication infrastructure development policies and advance universal service objectives across Nigeria.

According to Section 5(1) of these 2004 regulations, NCC issues spectrum at a unit price factor which varies in accordance with the licensing areas corresponding to the States in the Federation or the Federal Capital Territory and categorised into tiers. This reflects the different market potential and economic activities across the country. For instance, Tier 1 which is Lagos, 1 MHz has an annual unit cost (U) of NGN 3 000 000 while the same 1 MHz spectrum has an annual unit cost (U) of NGN 300 in the Tier 5 which comprises of Adamawa, Ebonyi, Ekiti, Gombe, Jigawa, Katsina, Kebbi, Nasarawa, Sokoto, Taraba, Yobe, and Zamfara.[52] The NCC uses a pricing formula that reflects the economic value of spectrum to encourage the efficient usage and stimulate growth. The price of spectrum (excluding microwave frequencies) is calculated on an annual per state basis using the following formula.

47 https://www.uspf.gov.ng/projects/bts
48 https://www.uspf.gov.ng/projects/rubi
49 USF Report
50 GSMA Effective Pricing in Africa
51 https://www.ncc.gov.ng/operators/regulations-guidelines/regulations
52 https://www.ncc.gov.ng/technical-regulation/spectrum/frequency-fees-pricing

Spectrum Fee = (U) × (B) × (K1) × (K2) per State[53]

Where:

U = Unit price: This varies according to licensing region/tier of the state in which the applicant seeks to operate

B = Assigned bandwidth (spectrum size) in MHz

K1 = Band factor

K2 = Tenure duration factor

According to Section 14(3) of the 2004 regulations, the price of spectrum may vary subject to the frequency band; and the band price must reflect the level of congestion, market demand and the relative cost of deploying network infrastructure.

Similarly, the NCC published spectrum trading guidelines in 2022 aimed at enhancing the deployment of communications services across the country and to further liberalise the spectrum management policy towards

- efficient and flexible transfer of spectrum to users who value it most;
- lessening the barriers to market entry by allowing flexible access to spectrum;
- deepening competition;
- promoting innovation by enabling licensees to acquire spectrum and offer new services.

The guidelines also cover various transactions through which spectrum can be traded on the secondary market including spectrum transfer, spectrum leasing and spectrum sharing.

[53] https://www.ncc.gov.ng/technical-regulation/spectrum/frequency-fees-pricing

5. Conclusion

This report provides a foundational framework for reducing capital and operational costs within Nigeria's telecommunications industry. It highlights key cost factors affecting the sector and underscores the need for a regulatory and policy environment that fosters efficiency and sustainable investment.

One of the major cost considerations is **taxation**. While taxes are a crucial revenue source for the government, excessive taxation on the telecommunications sector can hinder network expansion and investment, ultimately slowing the rollout of a national digital economy. To address this, the ministry responsible for the ICT sector should collaborate with the Ministry of Finance to review sector-specific taxes and consider aligning them with those of other industries to support growth and competitiveness.

The **regulatory framework** is another critical factor. A structured and predictable regulatory environment supports sustainable investment in telecommunications. The Nigerian Communications Commission (NCC) has proactively addressed key regulatory challenges by issuing several instruments to enhance infrastructure deployment and service expansion. These include the *Guidelines on Colocation and Infrastructure Sharing (2021)*, the *Guidelines on Spectrum Trading (2022)*, the *Guidelines on National Roaming (2020)*, and the *Guidelines on Technical Specifications for the Deployment of Infrastructure in the Nigerian Communications Sector (2023)*. These frameworks have strengthened the regulatory landscape and facilitated cost reduction by promoting efficient resource utilization.

Infrastructure sharing has been an essential mechanism for lowering costs and improving delivery service. The NCC has implemented a thorough regulatory framework that enables both passive and active infrastructure sharing, fostering competition and reducing barriers to network expansion. While tower leasing and sharing remain a significant part of operational costs, the introduction of these regulatory instruments has created a conducive environment for cost reduction and improved service delivery.

Right of Way (RoW) charges also contribute significantly to the cost of network deployment. The government has set a standardized rate of NGN 145 per linear meter for optical fibre deployment, which should be consistently enforced across all states. Disparities in RoW charges create an uneven business environment, making network expansion more expensive in some regions than others. Ensuring uniform implementation will incentivize operators to extend broadband infrastructure across Nigeria.

Another critical issue affecting the telecommunications sector is the **availability of electricity**. Insufficient power supply from the national grid increases operational costs, as operators rely on diesel generators to power base stations. This dependency not only raises costs but also leads to inefficiencies in service provision. Enhancing electricity supply to telecommunications infrastructure is crucial for cost reduction and improved network reliability.

The significance of reducing costs cannot be overstated, and all stakeholders—both public and private—must work together to create an environment that fosters efficient regulation and facilitates business operations. The ultimate goal is to ensure that the burden of rising costs is not transferred to end-users while maximizing the ICT sector's contribution to Nigeria's Gross Domestic Product (GDP). Recent data from the National Bureau of Statistics indicate that the ICT

sector contributed 18.44% to Nigeria's GDP in the first half of 2022. Strengthening regulatory efficiency and infrastructure investment will further enhance this contribution.

By acknowledging the regulatory advancements made by the NCC and reinforcing an enabling environment, the telecommunications industry can become more cost-efficient and competitive. The successful implementation of these measures will not only mitigate cost burdens on businesses but also position the ICT sector as a key driver of economic growth in Nigeria. A well-regulated and collaborative ecosystem between public and private stakeholders will be essential in achieving this vision.

Annex 1: Questionnaire for Mobile Network Operators

1 Network Infrastructure Geo-Location Data

1.1 Base Stations Data (As of 31 August 2022)

				Location Data		Ownership	
BTS DATA	BTS ID	BTS Name	State Name	Longi-tude (deci-mals)	Latitude (decimals)	Owned/Co-location	Technology deployed (4G/5G)
1	[insert ID used to identify the base station]						(4G/5G)
2							

Please also provide GIS map (geospatial file: .csv, .shp, .gpkg, .kmz, etc.) showing 4G and 5G signal coverage if available.

1.2 Fibre Optic Data (As of 31 August 2022)

Provide total distance of Optics Fibre Network Cable (route in km) Owned: NOT leased.	Route in km		
	Dec-20	*Dec-21*	*Aug-22*
Terrestrial fibre (Total on land fibre deployed)*			
Submarine fibre cable (Total undersea fibre cable)*			

1.3 Microwave Links Data (As of 31 August 2022)

Provide total distance of Optics Fibre Network Cable (route in km) Owned: NOT leased.	Route in km		
	Dec-20	*Dec-21*	*Aug-22*
Total distance covered by deployed micro-wave links			

1.4 Internet Point of Presence Data (As of 31 August 2022)

Internet Point of Presence Data	POP ID	POP Name	State Name	Location Data		Lit Capacity
				Longitude (decimals)	Latitude (decimals)	For example, 1 Gbit/s or 10 Gbit/s and so on. (Lit capacity is amount of capacity that is actually running over the cable)
1	[insert ID used to identify the POP]					

2 Network Infrastructure Costs

2.1 Network equipment purchase cost, installation cost, operating cost, asset life and equipment purchase price trends: Core Network Elements

You are kindly requested to provide the most recent equipment price for each network element below and indicate the units applied.

Period	As of 31 August 2022					
	Network Element	Cost basis (e.g. per unit, per site, per 1 000 subscribers)	Economic lifetime, Years	Purchase price per unit of equipment, USD	Costs of installation, USD	Unit operating & maintenance costs, USD per year
	4G Base Station	per site	x	x	x	x
	5G Base Station	per site	x	x	x	x
	HLR Equipment	per site	x	x	x	x
	Intelligent Network Hardware	per site	x	x	x	x
	MSC Equipment	per site	x	x	x	x
	HLR Equipment	per site	x	x	x	x
	OSS Equipment	per site	x	x	x	x
	SGW	per site	x	x	x	x
	MME/SGSN	per site	x	x	x	x
	UGW	per site	x	x	x	x
	GGSN	per site	x	x	x	x

(continued)

Period	As of 31 August 2022					
	Network Element	Cost basis (e.g. per unit, per site, per 1 000 subscribers)	Economic lifetime, Years	Purchase price per unit of equipment, USD	Costs of installation, USD	Unit operating & maintenance costs, USD per year
	NFVI	per site	x	x	x	x
	Evolved packet core (EPC)	per site	x	x	x	x
	CS	per site	x	x	x	x
	SDM	per site	x	x	x	x
	Firewall	per site	x	x	x	x
	Others (please add any element having a substantial cost implication on core network)	x	x	x	x	x

2.2 Network equipment purchase cost, installation cost, operating cost, asset life and equipment purchase price trends: Radio Access Network (RAN) Elements

You are kindly requested to provide the most recent equipment price for each network element below and indicate the units applied.

It may not be possible to complete the entire table but the more information you can provide the better.

Period	As of 31 August 2022					
	Network Element	Cost basis (e.g. per unit, per site, per 1 000 subscribers)	Economic lifetime, Years	Purchase price per unit of equipment, USD	Costs of installation, USD	Unit operating & maintenance costs, USD per year
	4G Base Station completed site with 360-degree coverage	per site	x	x	x	x
	5G Base Station completed site with 360-degree coverage	per site	x	x	x	x

(continued)

Period	As of 31 August 2022					
	Network Element	Cost basis (e.g. per unit, per site, per 1 000 subscribers)	Economic life-time, Years	Purchase price per unit of equipment, USD	Costs of installation, USD	Unit operating & maintenance costs, USD per year
	Others (please add any element having a substantial cost implication on radio access network)	per site	x	x	x	x

2.3 Transmission costs – Cost of building or leasing transmission links

Period	As of 31 August 2022									
	Transmission equipment	Cost unit	% owned	Economic life-time, Years	Purchase price per unit of equipment or per km of fibre, USD	Costs of installation and commissioning, USD	Unit operating & maintenance costs, USD per year	Annual lease price per unit of equipment or per km, USD per year	Capacities per link (Mbit/s)/ number of fibre cores	Microwave Antenna size, metres
	Trench – Urban	per km	x%	x	x	x	x	x	NA	NA
	Trench – Rural	per km	x%	x	x	x	x	x	NA	NA
	Duct	per km	x%	x	x	x	x	x	NA	NA
	Poles (used for overhead fibre deployment)	per	x%	x	x	x	x	x	NA	NA
	Access Microwave	per link	x%	x	x	x	x	x	x	x
	Backhaul Microwave	per link	x%	x	x	x	x	x	x	x
	Underground Fibre deployment longhauls	per km	x%	x	x	x	x	x	x	A

(continued)

Period	As of 31 August 2022									
	Trans-mission equipment	Cost unit	% own-ed	Econo-mic life-time, Years	Purch-ase price per unit of equip-ment or per km of fibre, USD	Costs of installa-tion and commis-sioning, USD	Unit operating & main-tenance costs, USD per year	Annual lease price per unit of equip-ment or per km, USD per year	Capacities per link (Mbit/s)/ number of fibre cores	Micro-wave Antenna size, metres
	Overhead Fibre deploy-ment longhauls	per km	x%	x	x	x	x	x	x	NA
	Under-ground Fibre deploy-ment shorth-auls (Urban)	per km	x%	x	x	x	x		x	NA
	Overhead Fibre deploy-ment longhauls shorthauls (Urban)	per km	x%	x	x		x	x	x	NA
	Metro Network Active Elements (Access Metro network element)	Per site	x%	x	x	x	x	x	x	NA
	Metro Active Elements (Aggre-gate Metro network element)	Per site	x%	x	x	x	x	x	x	NA
	Right of Way Charges per Km	per km	x%	x	x	x	x	x	x	NA
	DWDM/ OTN	per site	x%	x	x	x	x	x	x	NA

(continued)

Period	As of 31 August 2022									
	Transmission equipment	Cost unit	% owned	Economic lifetime, Years	Purchase price per unit of equipment or per km of fibre, USD	Costs of installation and commissioning, USD	Unit operating & maintenance costs, USD per year	Annual lease price per unit of equipment or per km, USD per year	Capacities per link (Mbit/s)/ number of fibre cores	Microwave Antenna size, metres
	Others (please add any element having a substantial cost implication on Transmission network)	per site	x%	x	x	x	x	x	x	NA

2.4 Site costs: Tower Infrastructure

Please enter the most recent information for site acquisition.

Period	As of 31 August 2022						
	Network Element	Cost basis (e.g. per unit, per site, per 1 000 subscribers)	Tower Height, metres	Purchase price per site, USD	Costs of Tower construction, USD	Unit operating & maintenance costs, USD per year	Annual lease per site, USD per year
	30 Metres Tower Infrastructure	Per tower	30	x	x	x	x
	40 Metres Tower Infrastructure	Per tower	40	x	x	x	x
	50 Metres Tower Infrastructure	Per tower	50	x	x	x	x
	60 Metres Tower Infrastructure	Per tower	60	x	x	x	x

(continued)

Period	As of 31 August 2022						
	Network Element	Cost basis (e.g. per unit, per site, per 1 000 subscribers)	Tower Height, metres	Purchase price per site, USD	Costs of Tower construction, USD	Unit operating & maintenance costs, USD per year	Annual lease per site, USD per year
	70 Metres Tower Infrastructure	Per tower	70	x	x	x	x
	80 Metres Tower Infrastructure	Per tower	80	x	x	x	x
	Others (please add any element having a substantial cost implication on tower infrastructure deployment)	x	x	x	x	x	x

2.5 Licence fees and Levies

Please provide any licence fees and where appropriate any other regulatory payments made to regulatory authorities.

Initial operating licence fee	
Year	x
Currency unit	USD
Amount	

Costs	Currency unit	2019	2020	2021	2022
		actual	actual	actual	estimate
Annual operating licence fee	USD				
Annual access frequency spectrum fee	USD				
Annual transmission frequency spectrum fee	USD				
Annual universal service levy	USD				
Right of Way Charges per km	USD				
Other annual levies	USD				
Other annual fees	USD				
Sales & Installation of Terminal Equipment (S & I)-Satellite Telecommunications terminal equipment	USD				
Value Added Services (VAS)	USD				
Internet Services (ISP)	USD				
Paging	USD				
Internet Exchange Services	USD				
Interconnect Exchange Services	USD				
Metropolitan Fibre Cable Network (MFCN)	USD				
Full Gateway Services (FGS)	USD				
International Cable Infrastructure & Landing Station Licence	USD				
Mobile Number Portability	USD				
Numbering Fees	USD				
Company income tax	USD				
Prior year tax under provision of company income tax	USD				
Education tax	USD				
Nigerian police trust fund	USD				

2.5 (a) Other Passive Network Infrastructure elements

Please enter the most recent information for the following passive infrastructure elements where applicable.

Period	As of 31 August 2022					
	Network Element	Purchase price per site, USD	Costs of installation, USD	Unit operating & maintenance costs, USD per year	Capacities	Capacity measurement unit
	Diesel Generator per site	x	x	x	x	kWh
	Solar/Wind Energy System per site	x	x	x	x	kWh
	Electricity connection per site	x	x	x	x	kWh
	Other power equipment per site	x	x	x	x	kWh
	Air conditioners required per site	x	x	x	x	Watts
	Indirect costs (please list specific items where applicable)	x	x	x	x	

2.5 (b) Other Passive Network Infrastructure elements

Please enter the most recent information for the following passive infrastructure elements where applicable.

Period	As of 31 August 2022		
	Network Element	Purchase price per site, USD	Unit operating & maintenance costs, USD per year
	Land acquisition	x	
	Leasehold land	x	
	IRU dark fibre per Km	x	x

3 Business Outlook and General Cost Questions

Please provide your input to the following general questions relating to the project.

a)	Provide general comments on the cost of telecommunications infrastructure and maintenance.	
b)	What is the availability of electrical power from main Grid per year in %?	
c)	Number of International Gateways in use and corresponding International Internet Capacity or Submarine Capacity in Gbit/s?	
d)	Provide cost of 1 Mbit/s paid to ISP upstream provider in USD. This is the international segment. (For example, if MNO pays USD 11,000 to upstream provider per month for 150 Mbit/s International bandwidth, then cost per Mb will be calculated as follows: monthly recurring charges divided by international bandwidth i.e., 11,000/150)	
e)	Provide total cost of 1 Mbit/s paid to ISP upstream providers and local backhaul provider in USD per year. This is both International and local segments.	
f)	What is the cost of leasing out 1 Mbit/s for one year?	
g)	List of taxes and levies payable to various Government and State Authorities	
h)	Please indicate constraints and suggestions for reducing the cost of providing telecommunications services.	

Annex 2: Questionnaire for Infrastructure Company

Telecommunication Infrastructure Data, Costs, and analysis in Nigeria Project
Country:
Type of Organisation:
Organisation/Company Name:
URL:
First Name:
Last Name:
Job Title:
Email:
Phone:
Last Name:

Background

ITU the United Nations specialized agency for ICTs, is working with the Digital Access Programme (DAP) for the United Kingdom Foreign, Commonwealth and Development Office (FCDO) to conduct a study of the supply-side conditions of telecommunication infrastructure and Internet service delivery in Nigeria. During the exercise, a consultant has been engaged who will collect data on the relevant microeconomic indicators and provide data logging to the ITU mapping team. Further the consultant will analyse the data and prepare a report that provides insights into the pattern and factors of telecommunication infrastructure construction, maintenance, and service delivery costs with clear recommendations for telecommunication business and policy in Nigeria.

This study will build on and complement the ongoing work of the ITU on connectivity and infrastructure mapping. Therefore, this study focuses on supply- side data on the cost of telecommunication infrastructure construction, maintenance, and Internet service delivery in Nigeria.

The aim is to analyse the costs of connecting entities to the Internet and providing Internet services in Nigeria. In particular, connectivity will be realized using various technology options such as fibre-optic networks, microwave lines, mobile broadband cellular links, cellular communication, satellite communication and many others.

Objectives for Sending this Questionnaire

Like many countries across the globe, several social amenity institutions such as hospitals and schools among others need to have access to affordable broadband Internet services in order for them to efficiently provide their services. As such, the ITU issues this questionnaire to solicit information on supply-side data on the cost of telecommunication infrastructure construction, maintenance, and Internet service delivery to extend affordable, high-speed broadband to the country's unconnected public social entities in Nigeria. ITU anticipates that this request for information will be a primary means of industry input and shall form a critical component to any secondary sources of information.

The respondents are hereby kindly requested to ensure that their full current contact details (contact person details, postal/e-mail/telephone) are included in their submission. Furthermore, the information provided will not be publicly disclosed and is intended to be used internally at ITU.

Therefore, you are kindly requested to provide us with the information captured in the following worksheets.

1) Sheet I: Information on network infrastructure geo-location
2) Sheet II: Information on network infrastructure costs
3) Sheet III: Information on business outlook and general costing questions

1 Network Infrastructure Geo-Location Data

1.1 Tower Data (As of 31 August 2022)*

Tower DATA	Tower ID	Tower Name	Tower Height	State Name	Location Data		Ownership	Operational Status
					Longitude (decimals)	Latitude (decimals)	Owned/Co-location	Operational/under construction/ Planned
1	[insert ID used to identify the base station]							
2								
3								
4								
5								
6								
7								
8								

* You may submit the information requested in any existing format you already have.

1.2 Fibre Optic Data (As of 31 August 2022)

Provide total distance of Optics Fibre Network Cable (route in km) Owned: NOT leased.	Route in Km	
	Dec-21	*Aug-22*
Terrestrial fibre (Total on land fibre deployed)		
Submarine fibre cable (Total undersea fibre cable)		

1.3 Internet Point of Presence Data (As of 31 August 2022) if applicable

Internet Point of Presence Data	POP ID	POP Name	State Name	Location Data		Lit Capacity For example 1 Gbit/s or 10 Gbit/s and so on. (Lit capacity is amount of capacity that is actually running over the cable)
				Longitude (decimals)	Latitude (decimals)	
1	[insert ID used to identify the POP]					

(continued)

Internet Point of Presence Data	POP ID	POP Name	State Name	Location Data		Lit Capacity For example 1 Gbit/s or 10 Gbit/s and so on. (Lit capacity is amount of capacity that is actually running over the cable)
				Longitude (decimals)	Latitude (decimals)	
2						
3						
4						
5						
6						
7						
8						

2 Network Infrastructure Costs

2.1 Transmission costs – Cost of building or leasing transmission links

You are kindly requested to enter the most recent information for transmission infrastructure prices.

As of 31 August 2022								
Transmission equipment	Cost unit	% owned	Economic lifetime (Years)	Purchase price per unit of equipment (USD)	Costs of installation and commissioning	Unit operating & maintenance costs	Annual lease price per unit of equipment (USD)	Number of Cores
Trench – Urban	per km	x%	x	x	x	x	x	x
Trench – Rural	per km	x%	x	x	x	x	x	x
Duct	per km	x%	x	x	x	x	x	x
Poles	per pole	x%	x	x	x	x	x	x
Access Microwave	per link	x%	x	x	x	x	x	x
Backhaul Microwave	per link	x%	x	x	x	x	x	x

(continued)

As of 31 August 2022								
Transmission equipment	Cost unit	% owned	Economic lifetime (Years)	Purchase price per unit of equipment (USD)	Costs of installation and commissioning	Unit operating & maintenance costs	Annual lease price per unit of equipment (USD)	Number of Cores
Underground Fibre	per km	x%	x	x	x	x	x	x
Overhead Fibre	per km	x%	x	x	x	x	x	x
DWDM/OTN	per site	x%	x	x	x	x	x	x

2.2 Site costs

Please enter the most recent information for site acquisition.

Period	As of 31 August 2022						
	Network Element	Number of sites	Tower Height	Purchase price per site (USD)	Costs of Tower construction	Unit operating & maintenance costs	Annual lease per site (USD)
	30 Metres Tower Infrastructure	x	x	x	x	x	x
	40 Metres Tower Infrastructure	x	x	x	x	x	x
	50 Metres Tower Infrastructure	x	x	x	x	x	x
	60 Metres Tower Infrastructure	x	x	x	x	x	x
	70 Metres Tower Infrastructure	x	x	x	x	x	x
	Others	x	x	x	x	x	x

2.3 Licence fees and Levies

Please provide any licence fees and where appropriate any other regulatory payments made to regulatory authorities.

Initial operating licence fee	
Year	x
Currency unit	USD
Amount	

Costs	Currency unit	2019	2020	2021	2022
		actual	actual	actual	estimate
Annual operating licence fee	USD	x	x	x	x
Annual access frequency spectrum fee	USD	x	x	x	x
Annual transmission frequency spectrum fee	USD	x	x	x	x
Annual universal service levy	USD	x	x	x	x
other annual levies	USD	x	x	x	x
Right of Way Charges per Km	USD	x	x	x	x
Other annual operating fees	USD	x	x	x	x

3 Business Outlook and General Cost Questions

Please provide your input to the following general questions relating to the project.

a)	Provide general comments on the cost of telecommunications infrastructure and maintenance.	
b)	What is the availability of electrical power from main Grid per year in %?	
c)	Number of International Gateways in use and corresponding International Internet Capacity or Submarine Capacity in Gbit/s?	
d)	Provide cost of 1 Mbit/s paid to ISP upstream provider in USD. (*For example, if operator pays USD 11,000 to upstream provider per month for 150 Mbit/s international bandwidth, then cost per Mb will be calculated as follows: monthly recurring charges divided by international bandwidth i.e., 11,000/150*)	
e)	What is the cost of leasing out 1 Mbit/s for one year?	
f)	List of taxes and levies payable to various Government and State Authorities.	
g)	Please indicate constraints and suggestions for reducing the cost of providing telecommunications services.	

Annex 3: Questionnaire for Internet Service Provider

1 Network Infrastructure Geo-Location Data

1.1 Wi-Fi Hotspots Data (As of 31 August 2022)

WIFI HOTSPOT DATA	Wi-Fi hotspot ID	Wi-Fi hotspot Name	State Name	Location Data	
				Longitude (decimals)	Latitude (decimals)
1	[insert ID used to identify the base station]				
2					
3					
4					
5					
6					
7					
8					

1.2 Fibre Optic Data (As of 31 August 2022)

Provide total distance of Optics Fibre Network Cable (route in km) Owned: NOT leased.	Route in Km	
	Dec-21	Aug-22
Terrestrial fibre (Total on land fibre deployed)*		
Submarine fibre cable (Total undersea fibre cable)*		

1.3 Internet Point of Presence Data (As of 31 August 2022)

Internet Point of Presence Data	POP ID	POP Name	State Name	Location Data		Lit Capacity For example 1 Gbit/s or 10 Gbit/s and so on.)
				Longitude (decimals)	Latitude (decimals)	
1	[insert ID used to identify the POP]					
2						
3						
4						
5						

(continued)

Internet Point of Presence Data	POP ID	POP Name	State Name	Location Data		Lit Capacity For example 1 Gbit/s or 10 Gbit/s and so on.)
				Longitude (decimals)	Latitude (decimals)	
6						
7						
8						

2 Network Infrastructure Costs

2.1 Network equipment purchase cost, installation cost, operating cost, asset life and equipment trends

You are kindly requested to provide the most recent equipment price for each network element below.

It may not be possible to complete the entire table but the more information you can provide the better.

Period	As of 31 August 2022				
	Network Element	Cost basis (e.g. per unit, per site, per 1 000 subscribers)	Economic lifetime (Years)	Purchase price per unit of equipment (USD)*	Costs of installation*
	Outdoor Router				
	Indoor Router				
	Billing system				
	Switches				
	Bandwidth Manager				
	Subscriber module				
	Firewall				
	Others (please add any element having a substantial cost implication)				

2.2 Transmission costs – Cost of building or leasing transmission links

You are kindly requested to enter the most recent information for transmission infrastructure prices.

It may not be possible to complete the entire table but the more information you can provide the better.

As of 31 August 2022							
Transmission equipment	Cost unit	%owned	Economic lifetime (Years)	Purchase price per unit of equipment *(USD)	Costs of installation and commissioning*	Unit operating & maintenance costs*	Annual lease price per unit of equipment* (USD)
Trench – Urban	per km						
Trench – Rural	per km						
#REF!	per km						
Poles	per pole						
Access Microwave	per link						
Backhaul Microwave	per link						
Underground Fibre	per km						
Overhead Fibre	per km						
DWDM/OTN	per site						

2.3 Site costs

Please enter the most recent information for site acquisition.

Period	As of 31 August 2022						
	Network Element	Number of sites	% owned	Purchase price per site* (USD)	Costs of installation and commissioning*	Unit operating & maintenance costs*	Annual lease per site (USD)
	Microwave towers						
	Others						

2.4 Licence fees and Levies

Please provide any licence fees and where appropriate any other regulatory payments made to regulatory authorities.

Initial operating licence fee	
Year	
Currency unit	
Amount	

Costs	Currency unit	2019	2020	2021	2022
		actual	actual	actual	estimate
Annual operating licence fee					
Annual access frequency spectrum fee					
Annual transmission frequency spectrum fee					
Annual universal service levy					
other annual levies					
Right of Way Charges per Km					
Other annual operating fees					

2.5 (a) Other Passive Network Infrastructure elements

Please enter the most recent information for the following passive infrastructure elements where applicable.

	Network Element	Purcha se price per site* (USD)	Costs of installation*	Unit operating & maintenance costs*
	Diesel Generator per site			
	Solar/Wind Energy System per site			
	Electricity connection per site			
	Other power equipment per site			
	Air conditioners required per site			
	Indirect costs (please list specific items where applicable)			

2.5 (b) Other Passive Network Infrastructure elements

Please enter the most recent information for the following passive infrastructure elements where applicable.

Period	As of 31 August 2022		
	Network Element	Purchase price per site* (USD)	Unit operating & maintenance costs
	Land acquisition		
	Leasehold land		
	IRU/Bandwidth per year		

3 Business Outlook and General Cost Questions

Please provide your input to the following general questions relating to the project.

a)	Provide general comments on the cost of telecommunications infrastructure and maintenance.	
b)	What is the availability of electrical power from main Grid per year in %?	
c)	Number of International Gateways in use and corresponding International Internet Capacity or Submarine Capacity in Gbit/s?	
d)	Provide cost of 1 Mbit/s paid to ISP upstream provider in USD. This is the international segment. (For example, if operator pays USD 11 000 to upstream provider per month for 150 Mbit/s international bandwidth, then cost per Mb will be calculated as follows: monthly recurring charges divided by international bandwidth i.e., 11 000/150)	
e)	Provide total cost of 1 Mbit/s paid to ISP upstream providers and local backhaul provider in USD per year. This is both International and local segments.	
f)	What is the cost of leasing out 1 Mbit/s for one year?	
g)	List of taxes and levies payable to various Government and State Authorities	
h)	Please indicate constraints and suggestions for reducing the cost of providing telecommunications services.	

Annex 4: Questionnaire for Satellite Service Provider

1 Network Infrastructure Geo-Location Data

1.1 Satellite Data (As of 31 August 2022)

International Satellite Links	Antenna Type (Indicate if VSAT or Satellite Earth Station)	State Name	Antenna Location		Maximum (available) data capacity Mbit/s Up/Down	Current capacity utilisation (Mbit/s) Up/Down
			Latitude (decimal)	Longitude (decimal)		
1						
2						
3						
4						
5						
6						
7						
8						

2 Infrastructure Costs

2.1 Network costs – Cost of building or leasing microwave links

You are kindly requested to enter the most recent information for the network infrastructure prices.

It may not be possible to complete the entire table but the more information you can provide the better.

Period	As of 31 August 2022							
	Network equipment	Cost basis (e.g. per unit, per site, per capacity, per Dish size)	% owned	Economic lifetime (Years)	Purchase price per unit of equipment (USD)*	Costs of installation*	Unit operating & maintenance costs*(Annual)	Annual lease price per unit of equipment (USD)
	VSAT equipment	x	x%	x	x	x	x	x
	Microwave	per link	x%	x	x	x	x	x

(continued)

Period	As of 31 August 2022							
	Network equipment	Cost basis (e.g. per unit, per site, per capacity, per Dish size)	% owned	Economic lifetime (Years)	Purchase price per unit of equipment (USD)*	Costs of installation*	Unit operating & maintenance costs*(Annual)	Annual lease price per unit of equipment (USD)
	Others (please add any element having a substantial cost implication)	x	x%	x	x	x	x	x

2.2 Licence fees and Levies

Please provide any licence fees and where appropriate any other regulatory payments made to regulatory authorities.

Initial operating licence fee	
Year	x
Currency unit	USD
Amount	

	Currency unit	2019	2020	2021	2022
Costs		actual	actual	actual	estimate
Annual operating licence fee	USD				
Annual access frequency spectrum fee	USD				
Annual transmission frequency spectrum fee	USD				
Annual universal service levy	USD				
other annual levies	USD				
Right of Way Charges per Km	USD				
Other annual operating fees	USD				

2.3 (a) Other Passive Network Infrastructure elements

Please enter the most recent information for the following passive infrastructure elements where applicable.

Period	As of 31 August 2022			
	Network Element	Purchase price per site* (USD)	Costs of installation*	Unit operating & maintenance costs*
	Diesel Generator per site	x	x	x
	Solar/Wind Energy System per site	x	x	x
	Electricity connection per site	x	x	x
	Other power equipment per site	x	x	x
	Air conditioners required per site	x	x	x
	Indirect costs (please list specific items where applicable)	x	x	x

2.3 (b) Other Passive Network Infrastructure elements

Please enter the most recent information for the following passive infrastructure elements where applicable.

Period	As of 31 August 2022		
	Network Element	Purchase price per site* (USD)	Unit operating & maintenance costs
	Land acquisition	x	
	Leasehold land	x	
	IRU/Bandwidth per year	x	x

3 Business Outlook and General Cost Questions

Please provide your input to the following general questions relating to the project.

a)	Provide general comments on the cost of telecommunications infrastructure and maintenance.	
b)	What is the availability of electrical power from main Grid per year in %?	
c)	Number of International Gateways in use and corresponding International Internet Capacity or Submarine Capacity in Gbit/s?	
d)	Provide cost of 1 Mbit/s paid to ISP upstream provider in USD. This is the international segment. (For example, if operator pays USD 11 000 to upstream provider per month for 150 Mbit/s international bandwidth, then cost per Mb will be calculated as follows: monthly recurring charges divided by international bandwidth i.e., 11 000/150)	
e)	Provide total cost of 1 Mbit/s paid to ISP upstream providers and local backhaul provider in USD per year. This is both International and local segments.	
f)	What is the cost of leasing out 1 Mbit/s for one year?	
g)	List of taxes and levies payable to various Government and State Authorities	
h)	Please indicate constraints and suggestions for reducing the cost of providing telecommunications services.	

Annex 5: Targeted Nigerian telecommunication/ICT operators.

1 Mobile Network Operators

Ref No	Mobile Network Operator
1	MTN Nigeria
2	Airtel Nigeria
3	Globacom
4	9Mobile

2 Collocation/Infrastructure sharing operators.

Ref No	Collocation/Infrastructure sharing operator
1	Merit Telecoms Limited
2	Alliance Towers Limited
3	Airtel Networks Limited
4	East castle Infrastructure Limited
5	Emerging Telecommunications Markets Services
6	MTN Communications Nigeria PLC
7	PAN African Tower Limited
8	ATC Wireless Infrastructure Limited
9	Globacom Limited
10	IHS Nigeria Limited

3 Internet Service Provider

Ref No	Internet Service Providers
1	InQ
2	MainOne
3	Smile
4	Spectranet Ltd
5	Tizeti Network Ltd
6	ipNX Nigeria Ltd
7	Astramix Ltd
8	VDT Comms Ltd

(continued)

Ref No	Internet Service Providers
9	Suburban Broadband Ltd
10	Cyberspace Network Ltd
11	Cobranet Ltd
12	Radical Tech Network Ltd
13	Ngcom Ltd
14	Dotmac Technologies Ltd
15	Galaxy Backbone Limited
16	Hyperia Ltd
17	I-World Networks Ltd

4 Satellite Broadband providers

Ref No	Satellite Broadband provider
1	Hyperia
2	Starlink SpaceX
3	Coollink
4	Eutelsat
5	SES
6	Viasat
7	Avanti
8	YahClick
9	T11N iDirect Evolution service for Africa
10	VSAT Satellite Broadband
11	Businesscomm's Dedicated Network
12	Cybernet (+) VSAT
13	Talia VSAT
14	OneWeb Broadband Satellite
15	Netcom VSAT
16	VSAT iFast Services [Ku & C Band]

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